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IS THERE A SYNCHRONIZATION OF BUSINESS CYCLES IN THE EURO AREA?

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ABSTRACT

The introduction of the euro was a major structural change that transformed Europe's financial architecture. When countries join a monetary union they leave to a supranational decision maker, traditional instrument for the control of the business cycles. One of the main perceived costs from monetary integration is that member countries loose direct control over national monetary policy. This prevents them from undertaking business-cycle stabilization: the cost that is represented by wider cyclical fluctuations, is more severe when shocks are asymmetric vis-ά-vis the other partner countries. Differences in levels of economic activity are persistent. Some countries seem to converge; others do not seem to catch up. Business cycle fluctuations in countries with similar starting conditions are driven by euro area wide shocks which propagate in an homogeneous way. Contrary, periphery countries are largely affected from some idiosyncrasies. Heterogeneity is generated by small and persistent idiosyncratic shocks while most output variation is explained by a common shock.

Keywords: business cycles, monetary union, convergence, fiscal idiosyncrasies, heterogeneity, periphery and core countries, correlations, variance decomposition.

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1. EMU

The establishment of EMU is a project totally connected with the course of European integration in political and economical level. The starting point for EMU might be the Treaties of Rome on 1st January 1958 which main idea was limited to realizing a customs union and a common agricultural market. Moreover, at the time of the European Economic Community (EEC) and until the end of the 1960s, countries were part of an international monetary system (the Breton Woods system). Within this system, exchange rates were fixed but adjustable and remained relatively stable within the European Economic Union and globally. Thus, the Member States considered that intra-EEC exchange rate stability could be secured and there was no need for any new institutional arrangements at the Community level. In the nearly 1960s, the Breton Woods system was showing signs of increasing strains because of US balance of payments policy. As a result, the EEC Members were led to several exchange rates and balance of payments crises which disrupted the function of the common market. Also the members had substantially different priorities in their economic policies. The situation made clear that a mechanism of stable exchange rates, inside the Community, should have been proposed, otherwise the market integration had never been fulfilled.

In 1970 the European Commission published the Werner Report which proposed to create economic and monetary union in several stages by 1980. As part of the first stage, the Member States established a Community system for the progressive convergence of the fluctuations of the national currencies. This system, which became known as the ‘‘snake’’, was put into operation in April 1972. Under the snake, the spot exchange rates of the participating currencies were to be kept within a band of 2.25%, compared with a theoretically possible spread of 4.5% resulting from each currency’s fluctuation margin of ±2.25% around its central rate vis-ά-vis the US dollar (snake in the tunnel). The respective maximum limits of fluctuation were to be defended by intervention in US dollars and Community currencies.

In 1973 the European Monetary Cooperation Fund (EMCF) was set up as the nucleus of a future Community organization of central banks. By the mid-1970s the ‘snake’ didn’t function well. It became an exchange rate mechanism among the Deutsche Mark, the Benelux currencies and the Danish krone. The other Community currencies remained outside the system and the EMCF had not enough legal power to control the Members’ central banks.

In 1979 the process of monetary integration was re-launched with the creation of the European Monetary System (EMS). The EMS was established by a resolution of the European Council and its operating procedures were laid down in an Agreement between the participating central banks (agreement of the 13 March 1979 between the central banks of the Member States of the European Economic Community laying down the operating procedures for the European Monetary System). The new mechanism was similar to the ‘snake’ but it had the legal power to keep the stability of the currencies’ exchange rates. It was also built around a grid of fixed but adjustable rates among the participating Community currencies. A new feature was the introduction of the European Currency Unit (ECU), which was defined as a ‘‘basket’’ of fixed quantities of the currencies of the Member States. The ECU was served as the numeraire of the exchange rate mechanism (ERM), as a unit of account to denominate operations in the intervention and credit mechanisms and as a reserve asset and means of settlement among the participating central banks.

The EMS proved to be the proper instrument in furthering European Monetary integration. It achieved a high degree of exchange rate stability and fostered a convergence of inflation rates among the Members. The participants adopted disinflation policies, managed to moderate cost increases, relaxed capital controls. Thus, they improved their overall economic performance. Although the EMS became the focal point of improved monetary policy coordination, its success in bringing about greater convergence of economic policies was rather limited due to the lack of sufficient convergence in fiscal policy. Some countries had large budget deficits and this was inconsistent with its technical stable currency. That was the reason for the several exchange rates crises happened at the beginning of the 1990s (Pound sterling’s forced withdrawal from the ERM).

The currency crises over the last years of the ERM, grew consensus among policy makers that the economic integration should had been accompanied with closer links among the national economies. A market of goods and services without internal borders and the full freedom of capital flows formulate a system which leads to economic great performance. But the important assumption is the intensive and effective policy coordination among the Members. If greater convergence did not occur, full freedom of capital movements and integrated financial markets was expected to put an undue burden on monetary policy. At this period, it was made clear that the Single Market was not able to reach its full potential without a single currency. A single currency would ensure greater price transparency for consumers and investors, eliminate exchange rate risks within the Single Market, reduce transaction costs and, as a result, significantly increase economic welfare in the Community. Taking all these considerations into account, the then 12 Member States of the European Economic Community decided in 1988 to re-launch the EMU project.

In June 1988, the European Council confirmed the objective of the progressive realization of Economic and Monetary Union (EMU). It mandated a committee chaired by Jacques Delors, the then President of the European Commission, to study and propose concrete stages leading to this union. The committee was composed of the governors of the then European Community (EC) national central banks; Alexandre Lamfalussy, the then General Manager of the Bank for International Settlements (BIS); Niels Thygesen, professor of economics, Denmark; and Miguel Boyer, the then President of the Banco Exterior de España. The resulting Delors Report proposed that economic and monetary union should be achieved in three discrete but evolutionary steps.

The first step realized on 1 July 1990, when all restrictions on the movement of capital between Member States were abolished. Furthermore, the Members' central banks laid down their previous responsibilities under Council's Decision. Their new tasks included holding consultations on, and promoting the coordination of, the monetary policies of the Member States, with the aim of achieving price stability. For the realization of Stages Two and Three, it was necessary to revise the Treaty of Rome in order to establish the required institutional structure. Negotiations resulted in the Treaty on European Union which was agreed in December 1991 and signed in Maastricht on 7 February 1992. The Treaty introduced the European System of Central

Banks and the European Central Bank and set the convergence criteria prior to entering the EMU.

The second step marked the establishment of the European Monetary Institute (EMI) on 1 January 1994. The two main tasks of the EMI was to strengthen central banks cooperation and monetary policy coordination, and to make the preparations required for the establishment of the European System of Central Banks (ESCB), for the conduct of the single monetary policy and for the creation of a single currency in the third step. In December 1995 the European Council agreed to name the European currency unit to be introduced, the 'euro'. Also, in December 1996 the EMI formed the principles and fundamental elements of the new exchange rate mechanism (ERM II), which was adopted in June 1997. In order to complement and to specify the Treaty provisions on EMU, the European Council adopted the Stability and Growth Pact in June 1997- two Regulations form part of the Stability and Growth Pact, which aims to ensure budgetary discipline in respect of EMU. This procedure lays down the conditions that must prevail for a budgetary position to be judged sound. Member States shall avoid excessive government deficits". Compliance with this requirement is assessed on the basis of a reference value for the government deficit-to-GDP ratio of 3%, and a reference value for the government debt-to-GDP ratio of 60%. Under conditions defined in the Treaty and further specified in the Stability and Growth Pact (SGP), such as an annual fall of real GDP of at least 2%, deficit or debt ratios above the reference values may be tolerated, and will not be considered as implying the existence of an excessive deficit. Should the EU Council decide that an excessive deficit exists in a certain country, the excessive deficit procedure provides for further steps to be taken, including sanctions. The Pact was supplemented and the respective commitments enhanced by a Declaration of the Council in May 1998. On 2 May 1998 the Council of the European Union decided that 11 Member States had fulfilled the conditions necessary for the participation in the third stage of EMU and the adoption of the single currency on 1 January 1999. The initial participants were Belgium, Germany, Spain, France, Ireland, Italy, Luxembourg, the Netherlands, Austria, Portugal and Finland. The Heads of State or Government also reached a political understanding on the persons to be recommended for appointment as members of the Executive Board of the European Central Bank (ECB). The establishment of the ECB was marked on 1 June 1998 and the ECB with the national central banks of the participating Member States constitute the Euro-system.

On 1 January 1999 the third and final step of EMU commenced with the irrevocable fixing of the exchange rates of the currencies of the 11 Member States initially participating in Monetary Union and with the conduct of a single monetary policy under the responsibility of the ECB. The number of participating Member States increased to 12 on 1 January 2001, when Greece entered the EMU. Slovenia became the 13th member of the euro area on 1 January 2007, followed one year later by Cyprus and Malta, by Slovakia on 1 January 2009 and by Estonia on 1 January 2011. On the day each country joined the euro area, its central bank automatically became part of the Euro-system. On 1 May 2004 ten new Member States - the Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovenia and Slovakia – joined the European Union. Two years and eight months later, on 1 January 2007, the EU welcomed Bulgaria and Romania. Today, the EU has 27 members and the EMU has 17 members. Participation in the euro area requires an EU Member State to fulfill the necessary conditions for adopting the euro, namely, a high degree of price stability, a sound fiscal situation, stable exchange rates and converged long-term interest rates. The current euro area members had to fulfill the same criteria. Before they enter in the EMU, the candidates are committed to the objectives of EMU and their national central banks, become members of the ESCB on the date of accession and prepare themselves for their eventual integration into the Euro-system.

The financial sector made extensive preparations for operating in the integrated financial markets as from the start of Stage Three. The financial industry was itself interested in a rapid and comprehensive changeover of financial markets to the euro and no group of market participants wished to be left behind by its competitors. With the assistance of the EMI, financial market associations agreed on conventions for unifying market practices, and leading interest rate indicators (e.g. the EURIBOR and the EONIA) were developed. Thanks to these preparations, the financial markets were able to convert to the euro at once as from the start of Stage Three of EMU. Trading in financial markets was exclusively in euro and the bulk of outstanding tradable debt instruments was converted to euro. All large-value cross-border payment systems functioned in euro. Not only was the changeover of the financial market immediate, but it also went very smoothly. Whereas the corporate sector gradually converted to the euro during the transitional period, individuals - in the absence of euro-denominated cash - did not at first use the euro much for transactions. That would all change of course with the introduction of euro banknotes and coins on 1 January 2002.

1.1 ESCB

The primary objective of the ESCB shall be to maintain price stability and without prejudice to the objective of the price stability, the ESCB shall support the general economic policies in the Community with a view to contributing to the achievement of the objectives of the Community as laid down in Article 2 of the Treaty on European Union. The objectives of the Union are a high level of employment and sustainable and non-inflationary growth. The basic tasks are:

- The definition and implementation of monetary policy for the euro area;
- The conduct of foreign exchange operations;
- The holding and management of the official foreign reserves of the euro area countries (portfolio management).
- The promotion of the smooth operation of payment systems.

The primary objective of the ECB's monetary policy is to maintain price stability. This is the best contribution monetary policy can make to economic growth and job creation. The objective of price stability refers to the general level of prices in the economy and implies avoiding both prolonged inflation and deflation. There are several ways in which price stability contributes to achieving high levels of economic activity and employment. Price stability makes it easier for people to recognize changes in relative prices since such changes are not obscured by fluctuations in the overall price level. This enables firms and consumers to make better-informed decisions on consumption and investment. This in turn allows the market to allocate resources more efficiently. By helping the market to guide resources to where they can be used most productively, price stability raises the productive potential of the economy. If investors can be sure that prices will remain stable in the future, they will not demand an "inflation risk premium" to compensate them for the risks associated with holding nominal assets over the longer term. By reducing such risk premia in the real interest rate, monetary policy can contribute to the allocative efficiency of the capital market and thus increases the incentives to invest. This in turn fosters economic welfare. The credible maintenance of price stability also makes it less likely that individuals and firms will divert resources from productive uses to hedge against inflation. For example, in a high inflation environment there is an incentive to stockpile real goods since they retain their value better than money or some financial assets in such circumstances. However, stockpiling goods is not an efficient investment decision, and therefore hinders economic growth. Tax and welfare systems can create perverse incentives that distort economic behavior. In most cases, these distortions are exacerbated by inflation or deflation. Price stability eliminates the real economic costs entailed when inflation exacerbates the distortionary impact of tax and social security systems.

Maintaining price stability prevents the considerable and arbitrary redistribution of wealth and income that arises in both inflationary and deflationary environments. An environment of stable prices therefore helps to maintain social cohesion and stability. Several cases in the twentieth century have shown that high rates of inflation or deflation tend to create social and political instability.

The ECB has been assigned exclusive responsibility for the single monetary policy for the euro area. A single currency requires a single monetary policy with centralized decision-making. Monetary policy operates by steering short-term interest rates, thereby influencing economic developments, in order to maintain price stability for the euro area over the medium term. The price stability has been defined as a year-on-year increase in the Harmonized Index of Consumer Prices (HICP) for the euro area of below 2%. In the pursuit of price stability, the ECB aims at maintaining inflation rates below, but close to, 2% over the medium term. The medium-term orientation gives the ECB the flexibility required to respond in an appropriate manner to the different economic shocks that might occur. It is impossible for any central bank to keep inflation always at a specific point target or to bring it back to a desired level within a very short period of time. Consequently, monetary policy needs to act in a forward-looking manner and can only maintain price stability over longer periods of time. At the same time, to retain some flexibility, it is not advisable to specify ex-ante a precise horizon for the conduct of monetary policy, since the transmission mechanism spans a variable, uncertain period of time. Also, the optimal monetary policy response to ensure price stability always depends on the specific nature and size of the shocks affecting the economy. Monetary policy decisions are taken after a thorough monetary analysis. The monetary analysis focuses on a longer-term horizon than the economic analysis. It exploits the long-run link between money and prices. The monetary analysis mainly serves as a means of cross-checking, from a medium to long-term perspective, the short to medium-term indications for monetary policy coming from the economic analysis.

Also, based on conceptual considerations and empirical studies, and in line with international practice, the Euro-system has defined a narrow (M1), an “intermediate” (M2) and a broad monetary aggregate (M3). These aggregates differ with regard to the degree of liquidity (as assessed on the basis of the criteria of transferability, convertibility, price certainty and marketability) of the assets they include. M1 comprises currency, i.e. banknotes and coins, and overnight deposits. These deposits can immediately be converted into currency or used for cashless payments. M2 comprises M1 and, in addition, deposits with an agreed maturity of up to and including two years or redeemable at a period of notice of up to and including three months. These deposits can be converted into components of narrow money, but some restrictions may apply, such as the need for advance notification, penalties and fees. M3 comprises M2 and certain marketable instruments issued by the resident MFI sector. These marketable instruments are repurchase agreements, money market fund shares/units and debt securities with a maturity of up to and including two years (including money market paper). A high degree of liquidity and price certainty make these instruments close substitutes for deposits.

As a result of their inclusion, broad money is less affected by substitution between various liquid asset categories and is more stable than narrower definitions of money. Monetary policy decisions are taken by the ECB's Governing Council. The Council meets every month to analyze and assess economic and monetary developments and the risks to price stability and to decide on the appropriate level of the key interest rates, based on the ECB's strategy. The three key interest rates for the euro area are:

- The interest rate on the **main refinancing operations** (MROs), which normally provide the bulk of liquidity to the banking system. The Euro-system may execute its tenders in the form of fixed rate or variable rate tenders.
- The rate on the **deposit facility**, which banks may use to make overnight deposits with the Euro-system.
- The rate on the **marginal lending facility**, which offers overnight credit to banks from the Euro-system.

The operational framework of the Euro-system consists of the following set of instruments:

- **Open market operations** which differ in Main refinancing operations, Longer-term refinancing operations, Fine-tuning operations, Structural operations. Main refinancing operations are regular liquidity-providing reverse transactions with a frequency and maturity of one week. Longer-term refinancing operations are liquidity-providing reverse transactions that are regularly conducted with a monthly frequency and a maturity of three months. Fine-tuning operations can be executed on an ad hoc basis to manage the liquidity situation in the market and to steer interest rates. Structural operations can be carried out by the Euro-system through reverse transactions, outright transactions and issuance of debt certificates.
- **Standing facilities** aim to provide and absorb overnight liquidity, signal the general monetary policy stance and bound overnight market interest rates. Counterparties can use the marginal lending facility to obtain overnight liquidity from the NCBs against eligible assets. The interest rate on the marginal lending facility normally provides a ceiling for the overnight market interest rate. Counterparties can also use the deposit facility to make overnight deposits with the NCBs. The interest rate on the deposit facility normally provides a floor for the overnight market interest rate.
- **Minimum reserves** requirements for credit institutions. The intent of the minimum reserve system is to pursue the aims of stabilizing money market interest rates, creating (or enlarging) a structural liquidity shortage and possibly contributing to the control of monetary expansion. The reserve requirement of each institution is determined in relation to elements of its balance sheet.

The Euro-system conducts foreign exchange operations according to Article 105 and consistent with the provisions of Article 111 of the Treaty establishing the European Community. Exchange rate possibly has also been denationalized and centralized. As a single currency has a single exchange rate, there can only be one single exchange rate policy. Foreign exchange operations include

- foreign exchange interventions;
- operations such as the sale of foreign currency interest income and so-called commercial transactions.

The ECB's investment activities are organized in such a way as to ensure that no insider information about central bank policy actions may be used when making investment decisions. A set of rules and procedures, known as the Chinese Wall, separates the ECB business units involved in operational investment activities from other business units. The ECB owns and manages two portfolios:

- The foreign reserves portfolio. It ensures that, the ECB has sufficient liquidity to conduct its foreign exchange operations involving non-EU currencies.
- The own funds portfolio. The purpose of this portfolio is to provide the ECB with income to help to cover its operating expenses and is also to be a reserve (capital) to cover possible losses.

The fourth task of the ESCB is the promotion of the smooth operation of payment systems. It describes the surveillance and proper function of the financial market infrastructure which enables the safe and efficient flow of payments and financial instruments. The Euro-system has unique responsibilities with regard to the market infrastructure for the euro. The Euro-system's keen interest in a safe and efficient infrastructure is closely interlinked with its responsibilities in the fields of monetary policy and financial stability. Financial integration, globalization and the launch of the euro in 1999 have led to a reshaping and harmonization of the infrastructure for euro payments and for the trading, clearing and settlement of financial instruments. The greatest progression in terms of reshaping and consolidating the infrastructure has been in large-value payments, whereas post-trading services for financial instruments and retail payment services are still largely fragmented. Projects are, however, underway with a view to further enhancing integration in the latter two segments.

1.4 LEGAL BASIS AND CHARACTERIZATION

Monetary sovereignty has been transferred to the supranational level under the terms and conditions of the EC Treaty. The present European Union is not a state but it rests on the European Communities and the policies and forms of cooperation established by the EU Treaty. This means that EMU is governed by Community law and not by intergovernmental law. This approach has built on and further developed the existing institutional framework (avoiding the establishment of separate institutions) and greatly facilitated the setting up of the ECB as an organization which is independent the Member States and the Community bodies. Furthermore, the monetary and economic aspects of EMU have been organized differently. Whereas monetary and exchange rate policies have been denationalized and centralized at the Community level, the responsibility for economic policy has remained with the Member States although national economic policies are to be conducted within a Community framework for macroeconomic policies. The differences in organization respect the principle of subsidiary (Article 5 of the EC Treaty) the allocation of policy responsibilities to the Community level is only justified:

- if the Member States cannot sufficiently achieve the given objectives by themselves or
- if the Community, by reason of the scale or effects of the proposed action, is better placed to achieve the objectives.

As it is obviously implicated, there is an asymmetry between the monetary and economic aspects of EMU because there is no EU government in the same way as there are national governments.

2. <u>REVIEW OF THE LITERATURE</u>

2.1 BUSINESS CYCLE

In 2002 CEPR established a Business Cycle Dating Committee for the euro area. The Committee's mission is to establish the chronology of the euro area business cycle, by identifying the recessions and expansions of the 11 original euro area member countries from 1970 to 1998, and of the euro area as a whole since 1999. The Committee defines a recession as

> *"a significant decline in the level of economic activity, spread across the economy of the euro area, usually visible in two or more consecutive quarters of negative growth in GDP, employment and other measures of aggregate economic activity for the euro area as a whole; and reflecting similar developments in most countries."* A recession begins just after the economy reaches a peak of activity and ends when the economy reaches its trough. Between trough and peak, the economy is formally in an expansion; between peak and trough it is in a recession. In both cases, growth rates may be very low. In determining the chronology of the euro area business cycle, the CEPR Committee adopted a definition of a recession similar to that used by the National Bureau of Economic Research (NBER), which has for many years dated the US business cycle. The Committee had to adapt the NBER definition, however, to reflect specific features of the euro area. The CEPR Committee's task is significantly different from that of the NBER. The euro area groups together a set of different countries. Although subject to a common monetary policy since 1999, they even now have heterogeneous institutions and policies. Moreover, European statistics are of uneven quality, long time series are not available, and data definitions differ across countries and sources. These differences explain why some of the CEPR criteria for dating business cycles differ from those used by the NBER:

- Unlike NBER, the CEPR committee dates episodes in terms of quarters rather than months. Quarterly series are currently the most reliable European data for our purposes and those around which a reasonable consensus can be achieved.
- The CEPR Committee analyses euro area aggregate statistics, but it also monitors country statistics to make sure that expansion or recessions are widespread over the countries of the area. There is no fixed rule by which country information is weighted.
- The CEPR Committee views real GDP (euro area aggregate, as well as national) as the main measure of macroeconomic activity, but it also looks at additional macroeconomic variables, for several reasons. First, euro area GDP series constructed for the pre-EMU era reflect not only movements in economic activity but also changes in exchange rates, which are problematic. Second, GDP statistics are sometimes subject to large subsequent revisions, and this makes them an imperfect indicator of current business cycle conditions. Third, measured GDP does not always move in parallel with its individual major components (which may indeed be moving in different directions) or other macroeconomic aggregates such as employment. Fourth, these variables are known to display more cyclicality than GDP and are useful in strengthening opinions when the GDP data do not seem very decisive. They are also available (with the exception of investment) earlier and at a higher frequency than GDP.
- For recent euro area data (since the end of the 1990s) we use, where possible, official Eurostat statistics and focus primarily but not exclusively on (1) quarterly GDP (Eurostat source); (2) quarterly employment (OECD); (3) monthly industrial production (Eurostat); (4) quarterly business investment (Eurostat); (5) consumption and its main components (Eurostat and ECB). For country data, we use Eurostat and OECD sources and monitor Germany, France and Italy systematically.
- Historical euro area data since the 1970s are provided by the OECD and the ECB. We mainly use the ECB source. For national data, we have used the OECD and the IMF. We do not use a fixed rule to weight different data series, although we give primary emphasis to GDP.
- The committee informally assesses the depth, duration and severity of a recession.

Hence although recessions are usually characterized by at least two consecutive quarters of declining GDP, this is not a fixed rule.

The Committee has identified four cyclical episodes since 1970, with peaks and troughs dated as follows:

Thus the Committee has identified three recessions:

- 1974q3 to 1975q1
- 1980q1 to 1982q3
- 1992q1 to 1993q3
- 2008q1 to 2009q2

The Committee concluded that the euro area experienced a prolonged pause in the growth of economic activity rather than a full-fledged recession in 2003q1 and 2003q2. The Committee concluded on 31 March 2009 that economic activity in the euro area peaked in the first quarter of 2008. The peak marked the end of an expansion that began in the third quarter of 1993 and lasted 57 quarters. Identifying the month in which activity peaked is more difficult for the euro area, but the Committee's best judgment is January 2008The Committee determined that a trough in economic activity occurred in the second quarter of 2009. The trough marks the end of the recession that began in the first quarter of 2008. The recession lasted 5 quarters or 15 months. The total decline in output from peak to trough is 5.5 percent. Identifying the month of the trough is more difficult. The Committee found a clear trough in industrial production in April 2009. Sales data show a more erratic picture, and unemployment kept rising (this is not unusual at the end of recessions). Given the clear trough of industrial production the Committee declared April 2009 to mark the end of the recession, which began in January 2008 and lasted 15 months..

CEPR's definitions of recession, expansion, peaks and troughs correspond to the so called "growth cycle". It defines a recession, for example, as a prolonged period of declining growth in the cyclical component of GDP (as measured by the movements of EuroCOIN). Analogously, an expansion is a prolonged period of increasing growth. Troughs and peaks are defined as the ending points of expansions and recessions respectively, i.e. as points of minimal or maximal growth. There is, of course, an alternative approach to defining the business cycle, based on the concept of the "classical business cycle". The "classical" approach defines recessions as periods of low (or even negative) growth, and expansions as periods of high growth. This is, for example, the definition adopted by the NBER's Business Cycle Dating Committee. Expressing the indicator in terms of quarterly changes has an important advantage: it reveals all the information necessary to determine the cyclical turning points for both concepts of the cycle (classical and growth).

2.2 OCA

As long as fixed exchange rates and rigid wage and price levels do not allow international trade promote the adjustment process in the economy, the international economic system will face periodic balance of payments crises. A system of flexible exchange rates can tackle unemployment with depreciation of the currency and moderate inflation pressures with appreciation. So the system corrects the results of external balance deficits or surpluses. Mundell arouses the question whether the exchange rates should be flexible or fixed. He defined a currency area as a domain within which exchange rates are fixed and asked 'what is the domain of a currency area'? A single currency implies a single central bank which has the absolute right to enforce monetary policy. But in currency area (not a single currency) with many central banks will be a difference between interregional adjustments even though exchange rates are fixed. Each central bank will find difficult to completely synchronize its policy with the others.

As far as the imbalances among countries are concerned, the policy of surplus countries in restraining prices imparts a recessive (for the surplus countries is a good system but a bad one for countries with unemployment) tendency to the world economy on fixed exchange rates or to a currency area with many separate currencies. In a currency area comprising different countries with national currencies the pace of employment in deficit countries is set by the willingness of surplus countries to inflate. But in a currency area comprising many regions and a single currency, the pace of inflation is set by the willingness of central authorities to allow unemployment in deficit regions. In fact, there is no currency area of either type which can prevent both unemployment and inflation among its members. Instead, different currencies with flexible rates are able to correct external imbalances and cope with both unemployment and inflation in different countries. But it cannot fix the same problems between two regions of the same country.

A system of flexible exchange rates was originally propounded as an alternative to the gold standard mechanism which many economists blamed for the world wide spread of depression after 1929. But if the arguments against the gold standard were correct, then a similar argument should apply against a common currency system in a multiregional country. Finally, Mundell believes that the optimum currency area is the region with its own currency and the region defined in terms of high internal factor mobility and external immobility. Factor mobility is explained as the easy shift of the excessive workforce to the place with excessive demand. Among the optimum currency areas there is a flexible exchange rates system. The efficiency of this system is strongly related with: (1) an international price system based on flexible exchange rates which is dynamically stable after taking speculative demands into account; (2) the exchange rate changes necessary to eliminate normal disturbances to dynamic equilibrium are not so large as to cause violent and reversible shifts between export and import –competing industries; (3) the risks created by variable exchange rates can be covered at reasonable costs in the forward markets; (4) central banks will refrain from monopolistic speculation; (5) monetary discipline will be maintained by the unfavorable political consequences of continuing depreciation, as it is to some extent maintained today by threats to the levels of foreign exchange reserves; (6) reasonable protection of debtors and creditors can be assured to maintain an increasing flow of long-term capital movements; and (7) wages and profits are not tied to a price index in which import goods are heavily weighted.

The basic points of the Optimum Currency Theory are described because this theory has been most frequently applied in the European economic and monetary union. As we saw, Optimality is defined in terms of several OCA properties, including the mobility of labor and other factors of production, price and wage flexibility, economic openness, diversification in production and consumption, similarity in inflation rates, fiscal integration and political integration. Sharing the above properties reduces the usefulness of nominal exchange rate adjustments within the currency area by fostering internal and external balance, reducing the impact of some types of shocks or facilitating the adjustment thereafter. Countries would form a currency area in expectation that current and future benefits exceed costs. Also, all the above properties have been gradually implemented through institutional reforms and cooperation.

Questions about the nature of EU business cycles were at the heart of the debate over the feasibility of a monetary union between the member states of the EU and remain central to the long-term prospects for EMU. The logical point of departure for any discussion of a monetary union is the theory of optimum currency areas. Less than one definition, a collection of countries or regions constitutes an optimal currency area if fixing the nominal exchange rate between the currencies issued by the countries or regions does not impose any net real costs on them. This will be the case either if prices and wages are perfectly flexible, or if factors of production are perfectly mobile. The point is that the discussion of the optimality of a currency area is in terms of response to the shocks that produce the fluctuations in economic activity that we call business cycles.

The most important features of EMU are a central bank that determines monetary policy for the participating countries, and a common currency that has replaced the national currencies of the participating countries (the euro). This institutional arrangement is not unlike that governing the process whereby monetary policy is made in the United States. The Federal Reserve System was designed in 1913 to diffuse power away from the financial centers and to give the different regions in the country a say in policy decisions. Thus, the system has 12 regional Reserve Banks, whose presidents participate in monetary policy deliberations at Federal Open Market Committee (FOMC) meetings in Washington.[4] Of course, the analogy is not perfect: the countries of Europe are sovereign nations, while the states that make up the 12 Federal Reserve districts are less at liberty to act independently of the federal government. A more detailed comparison of the structures of the Federal Reserve System and the European System of Central Banks is presented in Wynne (1999).

2.3 LITERATURE

The feature of euro area business cycles have hardly changed since the beginning of the EMU. The loss of flexibility in exchange rate and monetary policy had almost no effect on output co-movements across countries even if, as it has been emphasized by many observers, EMU members states have differed from one another for what concerns degree of competitiveness, real interest rates and other economic characteristics.

Many economists talk about the 'European business cycle', also assuming that there are either European-specific business cycle driving factors, or a leading economy or an artificial weighted average economy that are taken as reference of the European cycle. Supporting this view, significant examples are Artis et al. (1997), Forni et al. (2000), del Negro and Ottrok (2003), Mansour (2003), and Artis et al. (2004a)

The introduction of the euro was a major structural change that transformed Europe's financial architecture. The available empirical evidence suggests that it has had two particularly relevant effects: first, the elimination of risks associated with intra-euro area exchange rates and the subsequent removal of the exchange rate risk premium, thereby fostering trade and financial integration among the euro area countries; and second, the introduction of a new monetary regime firmly oriented towards maintaining price stability, which has contributed to a better anchoring of inflation expectations across the euro area. The elimination of intra-euro area exchange rates was perhaps the most immediate consequence of the introduction of the euro. The previous monetary arrangement allowed for bilateral realignments vis-a-vis the anchor currency. As a result, changes in interest rates in the anchor country were often associated with differential effects on the exchange and domestic interest rates of ERM countries. With the irrevocable fixing of exchange rates and the single monetary policy, this phenomenon has been eliminated and, as a result, the exchange rate channel is more uniform across countries. The elimination of the intra-euro area exchange rate risk has implied a reduction in transaction costs and higher capital market integration. While the exact magnitude differs across studies, most of them confirm that the euro has contributed to a significant increase in trade, the aggregate impact of which has been estimated to be in the range of 5-10%. The increase in cross-border bank holdings and transactions has also been significant, an effect that can essentially be attributed to the elimination of currency risk.

The centralization of monetary policy decisions and the creation of a common central bank in charge of the euro area's single monetary policy brought with them a new monetary regime characterized by a high degree of credibility and a clear focus on maintaining price stability. An immediate impact of this was better and more solidly anchored inflation expectations. Measures of inflation expectations extracted from both survey-based data and long-term government bonds corroborate this fact. Another issue is that when countries join a monetary union they leave to a supranational decision maker traditional instrument for the control of the business cycles. Obviously, the optimality of this delegation of the decisions to a higher authority will be a direct function of the similarities across these economies. If the economies move together, we might think that they need the same type of economic policy decisions at the same time. If, there is no synchronization of their business cycle co-movements, we might think that different solutions are optimal for different economies and probably, the costs associated to an economic union might be higher than the gains.

Much of the discussion about the viability of EMU has been centered on questions of whether different countries are subject to demand or supply shocks, or whether nation- or sector-specific shocks have tended to drive the business cycle in the different countries.

A number of surveys which were conducted before the third stage of the EMU suggest that there was a high degree of synchronization among business cycles even before the common currency.

An important attempt to examine and document the business cycle regularities in all EU countries was Christodoulakis *et al.* (1995), well before the adoption of the common currency. Their analysis is specifically intended to address concerns about the business cycle that might arise from increased integration between EU members, and they look at the 12 countries that made up the EU before the most recent enlargement. They identify the critical question associated with greater integration as being 'whether the economies involved in the integration process appear to have a similar and synchronous response to shocks, or whether their cycles differ with regards to their intensity, duration and timing' (Christodoulakis *et al.* 1995, p. 1). Their sample covers the period 1960-90 and the data are of an annual as well as a quarterly basis. The main statistical source is the OECD publications. They first display the pattern of volatility and persistence for output and industrial production, respectively and most of the countries are found to be within the area of one standard deviation range around the mean. The exceptions are France, which is less volatile and more persistent than the others, and Portugal and Luxembourg, which are more volatile than the average. They find that the behavior of GDP, consumption, investment, prices and, to a smaller degree, net exports are quite similar, while the behavior of government purchases, money and terms of trade vary substantially across countries. These results can be interpreted as implying that only variables under the direct control of the government behave differently. This is taken to suggest that the type of shocks and the propagation mechanism are fairly similar across the EC countries; hence the process of European integration under a set of uniform institutions and policies should not be a problem as far as the business cycle is concerned. Their findings also suggest that there are remarkable similarities in the way individual EU economies respond to shocks, even if the shocks impringing upon there are different. Moreover, most of these differences in shocks were found to be related to institutions, such as features of labor markets, and policy variables, such as government consumption and money supplies They also emphasize that observed differences in shocks and business cycle mechanisms will tend to melt down as common institutions and policies start to emerge.

Anna- Maria Agresti and Benoit Mojon (2001) analyze the business cycle components of up to 20 economic time series for each country, as well as for 24 series of the euro area aggregate. The variables belong to 6 main categories: GDP components and other activity indicators such as industrial production and unemployment, price level indices, money and credit aggregates, market and retail bank interest rates, exchange rate and asset prices.

Euro area variables are actually EU-11 aggregates (euro area less Greece, which joined EMU in 2001). These variables come from the current version of the Euro Area Wide model (AWM), which has been constructed by the staff of the Econometric Modeling Division of the ECB. The aggregation has been done with fixed weights, based on 1995 PPP GDP. They first address the historical pattern of the euro area business cycle comparing the movements in GDP for the euro area with those for the US. They follow this procedure looking for a driving force of the EU's business cycles. They found that, long periods of increases and short periods of declines of output characterize these two economies. There are some similarities in the timing of their cyclical patterns as well. This suggests the view that the business cycle of the euro area may be studied, to a great approximation, following approaches and models already used for the US Economy. But the US business fluctuations are more volatile and the US cycle tends to lead the euro area cycle. They also find that the business cycle fluctuation of GDP, consumption and investment of most euro area countries were, even before stage three of EMU, highly synchronized with, respectively, the business cycle fluctuations of GDP, consumption and investment of the euro area. There is also high synchronicity of the national cycles and the euro area aggregate cycle. This synchronicity is observed for the main GDP components as well as for the short term interest rate and it is particularly high for the largest countries of the euro area and for countries of the core ERM. The exception is some specific periods where each country deviated from the rest of the euro area due to special events. For example, during the Germany reunification, the German cycle diverged significantly from the European one. In France, the most striking deviation occurred around the fiscal expansion undertaken by the socialist government in 1981. The Spanish business cycle appears to "converge" with the area cycle after 1986, the date when Spain joined the European Community. The Finish financial deregulation of the second part of the 1980's and the trade shock after the collapse of the Soviet Union mark the largest deviations of the Finnish business cycle. Italy, although highly synchronized with the area business cycle throughout the sample period, experienced much larger fluctuations in the 1970s. This is likely due to the heavy Italian reliance on imported oil. The Italian fluctuations subsequently decreased as the share of energy related imports declined (by around 40 %) during the 1980s. Finally they document several consistent patterns about the lead-lag relationships amongst these data (at both the area wide and national level). Interest rates lead the business cycle. The business cycle in turn leads inflation. They also briefly review the correlations of each national business cycle with the aggregate euro area cycle.

After the establishment of the EMU, it seems that the standard paradigm used in the literature to describe the European business cycles is the so-called core and periphery scheme. Some countries, which exhibit higher synchronization are typically situated in the business cycle core, whose cycle recognized as the representation of the European business cycle. The periphery

countries are situated around this core and represent economies with more particular business cycles.
Artis and Zhang (1997), also analyzes cycles before and after 1979 (the beginning of the first ERM) find increased synchronicity since the ERM for countries belonging to the ERM. However Artis (2003) revisits these findings using data up to 2001 and concludes, on a sample of twenty-three countries, that there is no evidence of a European cycle. Artis uses quarterly GDP data for some 30 years up to and including 2001, to examine the identity and development of the European business cycle. Cycles are identified by using a band-pass filter version of the Hodrick-Prescott filter and affiliations are examined using clustering techniques and classical multidimensional scaling applied to cross-correlations and other measures of cyclical sympathy. Twenty-three (23) countries are examined, of which 15 are European. The sample is divided into three 10-year periods to examine changes in affiliation. He asks whether there seems to be a cycle we would identify as "European" and if so which European countries belong to it, and how it has emerged over the past 30 years. He finds that the European business cycle is a more elusive phenomenon than we might have expected; whilst some European countries seem to "stick together", there are many which do not. In any case, the US and Japan are often to be found as closely associated with those European countries that do stick together as with others. This is a little bit more than the familiar core and periphery story; it may be suggested, that globalization is at least as important as Europeanization. When he tries to examine those factors that might make for cyclical affiliation he does so from a slightly different angle than has been pursued in most studies to date. He takes as a hypothesis the idea that most shocks are common shocks so that business cycle differences are not due, particularly, to asymmetry in the initiating shock, but primarily to asymmetries in the propagation mechanism. He thinks that those asymmetries may be due to differences in the structure of labor markets, financial markets and product markets.

Artis reports that the US and Japan are often to be found as closely associated with those European countries that do stick together as with others. This is highlighted in many other papers too. Many papers have focused on a variety of concepts of business cycle and stressed similarities to rather than differences from the US. Those papers start with the observation that, although level cycles are strikingly similar in the two economies, the growth rate of output in the euro area is less volatile than in the US and more persistent. Persistence implies that the effect of an exogenous shock in the euro area is longer than in the US and, as a consequence, the ratio between the long-run variance and the total variance of output growth is larger (Giannone and Reichlin, 2005). For example a technology shock is rapidly absorbed by the US economy, but it takes longer to work its effect through European economies. The immediate effect of the shock is a divergence between the level of economic activity in the US and the euro area. The divergence seems to reach its maximum in the middle of the cycle (roughly five years). Europe eventually catches up, but the catching up lasts about ten years. Assuming that there are no long-run differences in trend, Europe loses welfare because, after a technology shock, it reaches its steady state later than the US. In other words, the US enjoys all the advantages of growth immediately while Europe has to wait much longer. In Europe, losses in terms of both output and consumption during recessions are not as drastic as in the US and they are distributed over a long period of time. Recessions are less sharp, but recoveries are very slow. Given that expansions are the normal state of affairs in the economy (the mean of the shock is positive) and recessions are rare, at realistic real interest rate values, the larger loss of welfare that the US incurs on impact is more than compensated for by the rapid recovery. One could easily draw the conclusion that the European Economic Union does not fulfill properly the basic elements of the Optimum Currency Area such as the factors mobility. Thus, it faces a lag it adjusts to external shocks.

The high rapidity with which technology is absorbed in the US seems to induce high short-term volatility. But in the euro area the bulk of the variance is in the long run because it takes longer to absorb shocks. It seems that the world growth is led by the US, with the euro area following with lag. (Giannone and Reichlin 2005) also believe that Europe loses welfare because after a technology shock it reaches its steady state later than the US. In other words, the US enjoys all the advantages of growth immediately, while Europe has to wait much longer. Notice, however, that this also implies that losses, during recessions, are not as drastic as in the US and they are distributed over a long period of time.

The practice of looking to the US experience for insights into the problems and functioning of a monetary union has a long precedent in the literature on fixed exchange rates in general, and in the literature on EMU in particular. For example, in making an argument for fixed exchange rates, Rolnick and Weber (1994) note that the USA can be viewed as having a system of fixed exchange rates between currencies issued by the 12 regional Federal Reserve Banks. They argue that the notes issued by the 12 banks are not strictly identical, and that the difference between the notes creates the possibility that the United States could have a system of floating exchange rates among the 12 Federal Reserve districts. They go on to examine the features of the relationship among the 12 regional Federal Reserve Banks that make a system of fixed exchange rates between them feasible, in the process drawing lessons for how a monetary union among the countries of the EU might work.

2.4 Great Moderation

One could easily suggest that business cycles synchronization in the EMU is supported by the so called ‘Great Moderation’ theory.

Over the last 20 years or so, the volatility of aggregate economic activity has fallen dramatically in most of the industrialized world. The timing and nature of the decline vary across countries, but the phenomenon has been so widespread and persistent that it has earned the label: "the Great Moderation."

A growing body of research has focused on The Great Moderation and its possible explanations, The most commonly proposed explanations for The Great Moderation fall into three broad categories: better monetary policy, structural changes in inventory management, and good luck.

Analysts have studied extensively whether improved monetary policymaking has been largely responsible for the drop in output volatility. The idea has considerable intuitive appeal.

Lower output volatility is a result of central bankers' greater emphasis on, and success at, controlling inflation. The explanation does not rest on the idea that monetary policy has directly reduced output volatility—in fact, there has been considerable disagreement about whether policy actually has had a direct effect. Instead, the idea holds that monetary policy may have been important in reducing output volatility to the extent that policy changes have resulted in lower and more stable inflation.

A second leading explanation for The Great Moderation relates to changes in inventory management. Inventories act as a buffer between production and sales. Excess of production over sales leads to inventory accumulation. Excess sales demand over production can be met by inventory holdings—at least to the extent they are available. The inventory-based explanations of The Great Moderation rest on the observation that the volatility of durable goods *sales* has remained essentially constant, while the volatility of durable goods production has declined by an amount similar to that of GDP!

In addition,Justini-ano and Primiceri (2006) show that biased-technology shocks alone account for most of the Great Moderation. Neutral technology shocks play a much more important role in driving business cycle fluctuations than do investment-specific technology shocks, a result similar to that found in. Wage markup shocks, along with the distortions associated with wage and price stickiness, captures the wedge between the intra-temporal marginal rate of substitution (MRS) and the marginal product of labor, which, as argued by Chari, Kehoe, and McGrattan (2007), plays an important role in accounting for the business cycle fluctuations.
The depreciation shock, on the other hand, acts as a wedge in the intertemporal capital accumulation decision, which is also an important source of the business cycle fluctuations. The investment-specific technology shock also enters the intertemporal capital accumulation decisions.

The volatility of output growth declined substantially in the euro area over the past three decades. Volatility, as measured by the standard deviation of y-o-y GDP growth, fell from over 2% in the 1970s to 1.1% in the most recent decade (1998Q1-2007Q3). The decline was particularly pronounced in the late 1970s and early 1980s. Since then, output growth volatility has followed a cyclical pattern marked by temporary increases coinciding with periods of cyclical peaks or early phases of downturn. These temporary phases were observed both in the early 1990s and early 2000s. Volatility remained quite low by historical standards in the past few years. A comparison with the US shows both similarities and differences in the moderation process. The decline in output growth volatility was somewhat sharper in the US than in the euro area, although starting from a much higher level. The process also seems to have begun later in the US. On the other hand, the temporary bouts of higher volatility in the 1990s and 2000s were relatively similar in both regions, although they took place slightly earlier in the US, in line with that country's cyclical lead relative to the euro area.

The decline in output growth volatility is a common feature to all euro-area Member States but also to virtually all industrialized countries.

While there is clear evidence of a reduction in output growth volatility everywhere, the magnitudes and timings differ substantially across countries. Some countries experienced a much stronger decrease than the euro area (e.g. New Zealand, Switzerland, the UK and the US) and others a more moderate one (e.g. Canada). The general decline in output volatility was actually associated with a convergence in volatility levels across countries. The countries which experienced the strongest moderation process are also those which posted the highest volatility level in the 1970s. Regarding timing, the moderation process started in the early 1980s in some countries (e.g. most euro-area Member States), while it only began in the second half of the 1980s in others (e.g. most anglo-saxon countries but also the Netherlands). In a number of cases, the moderation process was relatively continuous and may have pursued its course in recent years (e.g. Denmark, Greece, Austria and New Zealand) while in others the decline in output volatility took place mostly in the 1980s (e.g. Belgium, Switzerland and Italy) or was temporary reversed in the early 1990s (e.g. Finland and Sweden).

The substantial degree of cross-country heterogeneity in the Great Moderation process casts some doubt on explanations of the reduction in output volatility focusing exclusively on common shocks. Somehow, both changes in shocks and changes in economic policies and structures must have been at play.

In addition to the fall in the volatility of its individual components, two other possible sources of moderation in GDP fluctuations should be considered, namely compositional effects and changes in co-movements between components. Regarding the first one, increased GDP growth stability could be partly explained by shifts in composition towards more stable GDP components.

The other possible source of moderation relates to the fact that the volatility of GDP growth depends on the volatility of its individual components but also on their co-movements. Ceteris paribus, a decrease in the co-movements between GDP components will entail a decrease in the volatility of GDP. In particular, inventories which tended to move in tandem with other GDP components in the 1970s, thereby amplifying cyclical fluctuations, now seem to be acting more as a buffer of demand shocks. This positive contribution of the inventories-related correlations to the moderation of output volatility probably reflects improvements in the management of inventories. It has, nevertheless, been offset by movements in the opposite direction of the correlations between other GDP components. In particular, although the correlation of imports with GDP is subject to large swings, it seems that imports now tend to dampen fluctuations in domestic demand shocks less than in the past. Overall, the moderation of the volatility of GDP growth can be mostly traced back to the decline in the volatility of individual GDP components with relatively little additional effects of changes in composition or in correlations. Inventories seem to have played a key role in the process (both due to their reduced volatility and to their increasing role in absorbing demand fluctuations) followed by investment and consumption.

Two additional stylized facts of the Great Moderation are worth stressing which suggest that both changes in the conduct of monetary policy and in the functioning of labor markets may have helped to dampen output volatility. First, the moderation of output growth volatility was accompanied by a decline in the level of inflation and its volatility in the euro area as well as in most OECD countries. Explanations for the moderation of inflation tend to centre around changes in monetary institutions (central bank independence, inflation targeting etc.). It is tempting to interpret the parallel decline in nominal and real volatility as evidence of the effect of improved monetary policy on output stability. Second, looking at the supply side, a decomposition of the variance of GDP into its employment and productivity components gives a prominent role to a drop in the volatility of productivity in the Great Moderation process in the euro area. The volatility of growth in productivity decreased sharply in the 1980s and dropped again in the 2000s to hit a three-decade low. In contrast, the volatility of employment increased temporarily in the 1990s before falling back in recent years. It is currently low but it occasionally reached equally low levels in the past.

The large differences in the timing and scope of the reduction in output growth volatility across OECD countries suggest that the process cannot be solely ascribed to a reduction in the size or frequency of common shocks. Over the past three decades, economies policies have been altered significantly, resulting in far-reaching changes in the macroeconomic framework and the functioning of product, labor and financial markets. Critically, these changes have been put in place to varying degrees and paces across countries and therefore constitute good candidates for explaining country differences in the pattern of the drop in output volatility.

2.5 BC AND TRADE

Trade integration can affect output volatility via several and sometimes conflicting channels. Increased trade integration means that a larger part of country-specific shocks are smoothed by being transferred to trading partners. This would a priori suggest a negative link between trade integration and volatility. However, trade integration may also foster production specialization and therefore the occurrence of country-specific shocks.

According to Jeffrey A. Frankel and Andrew K. Rose (1997) trade intensity among countries is considered to be a crucial factor for their business cycles correlations. Countries with closer trade links tend to have more tightly correlated business cycles. It follows that countries are more likely to satisfy the criteria for entry into a currency union after taking steps toward economic integration than before. The benefits of being a member include a reduction in the transactions costs associated with trading goods and services between countries with different moneys. Countries with close trade links to EMU members will benefit more from monetary union and are therefore more likely to join EMU themselves. But joining EMU also brings costs. Entrants loose the independency of counter-cycle monetary policy and countries with idiosyncratic business cycles loose an important stabilizing tool if they join. Thus, they are less likely to join EMU.

Continued European trade liberalization can be expected to result in more tightly correlated European business cycles, making a common European currency both more likely and more desirable. Indeed, monetary union itself may lead to a further boost to trade integration and hence business cycle symmetry. Countries which join EMU, no matter what their motivation, may satisfy OCA criteria.

Integration changes over time. European countries trade with each other more than in the past and this trend may continue.

The distances across Euro economies are more closely linked than distances across newcomers, and these newcomers are on average further away from the Euro countries than across themselves. Finally, Camacho and Perez have shown that the linkages across Euro economies are prior to the establishment of the union, showing that the smooth transition towards a more integrated economic area could be due to previous strong business cycles correlations, fundamentally through trade. This is not the case of the current enlargement because the differences among the newcomers and the current members (and among themselves) seem to be much more important than the differences that the actual members exhibited prior to the establishment of the union.

But trade integration and business cycle symmetry is not universally accepted. Authors such as Krugman (1993) have pointed out that as trade becomes more highly integrated, countries can specialize more. Increased specialization may reduce the international correlation of incomes, given sufficiently large supply shocks.

2.6 Financial integration

The theoretical effect of financial liberalization / integration on output stability is equally ambiguous. By improving opportunities to diversify and share risks, financial liberalization allows better consumption smoothing and should thereby contribute to curb output volatility. Nevertheless, in an argument that looks very similar to the one developed for trade, financial liberalization - by severing the link between output fluctuations and consumption - may also facilitate production specialization and therefore the risk of sectoral shocks, leading simultaneously to an increase in output volatility and a reduction in consumption volatility. Finally, historical evidence also shows that phases of financial liberalization may be associated with temporary spells of increased volatility as economic agents take time to come to grip with the full implications of the new financial environment. The overall impact of increased financial integration will depend on which of these three channels dominates. The few studies which have explored the question empirically have generally reported a positive link between financial development and output stability.

Economic literature analyzing the transmission of monetary policy has suggested that, in addition to their direct effect on final demand, investment and prices, interest rate changes may also have an impact on the real economy through their indirect effect on the cost to firms of obtaining external financing and on banks' ability to lend. The impact of monetary policy changes on the supply of bank loans is known as the bank lending channel. The following is a traditional textbook example of this channel: a cut in the policy-driven interest rates leads, over time, to a reduction in the availability of bank deposits (especially those with a short maturity). Unless banks are able to increase their funding via other sources, the reduction in the availability of bank funds may induce a downward adjustment of bank assets, including loans, independent of changes in the demand for loans. Such an effect is more likely to affect banks of a smaller size, with lower capital positions and insufficient liquidity buffers. the process of financial innovation in credit markets has been widespread across developed financial systems over the last ten years. This process was particularly rapid and dramatic in the euro area, favored by the introduction of the euro and the associated increase in financial market integration.

The literature is ambiguous on the effect of financial integration on the synchronization of business cycles. Kalemli-Ozcan et al. (2003) argue that countries with a high degree of financial integration tend to have more specialized industrial patterns and less synchronized business cycles. Evidence from the financial crises and contagion literature, however, indicates a direct, positive effect of capital flows to business cycle synchronization. Kose et al. (2003) point out that financial integration enhances international spillovers of macroeconomic fluctuations leading to more business cycle synchronization. Moreover, Imbs (2004) tests this direct link and finds a positive effect dominating the indirect link via specialization dynamics.

Moreover, there is a variety of strategies of how to measure financial integration. A recent ECB survey on financial integration indicators by Baele et al. (2004) identifies two major measurement categories. The first and theoretically most accurate category comprises price-based measures. According to the law of one price, a financial market is completely integrated if all differences in asset prices and returns are eliminated which stem from the geographic origin of the assets. Hence, the degree of price-based financial integration is measured by interest rate spreads of comparable assets across countries. Unfortunately, the data of homogeneous, long-term asset yields in Europe are not available for long-term studies such as ours. Therefore, many authors resort to the second major category, quantity-based measures. These include asset quantities and flows across countries and can be considered as complementary to the price-based measures. Quantity-based indicators attempt to measure capital flows and cross-border listings among countries; hence, they can be regarded as measures of financial intensity. One pitfall of price-based and of most quantity-based measures is the lack of bilateral, country-to-country information.

In principle, financial market integration should make it easier for consumers, to insure against income risk through borrowing and lending and cross-country ownership of financial assets.

The volatility-dampening effect of monetary policy appears to have been particularly large in some euro-area Member States - those where monetary policy mismanagement was particularly acute in the 1970s.

Also, a stabilizing role has been found for the participation in the ERM/euro (on top of any ERM/euro effect indirectly captured by the monetary policy variable), but only for some GDP components and not for GDP as a whole. Fiscal policy is found to have a positive impact on output stability via the size of government and automatic stabilizers but changes in discretionary policy are not found to be a meaningful explanatory variable. The relation between government size and output stability presents strongly non-linear features in the sense that size is positively associated with stability up to a certain level of government spending in GDP and becomes negatively correlated with GDP beyond that level.

Domenico Giannone, Michele Lenza, and Lucrezia Reichlin (NBER Working Paper 14529, 2008) intent to describe the basic characteristics of real economic activity in the area as a whole and in member countries as well as the dynamic relations between national cycles over the last forty years. Having formed a view on these features for a sufficiently long historical period (their sample starts in 1970), they then address the question of changes related to the EMU. Giannone and Reichlin (as Agresti and Mojon did before) also base their analysis in the euro area aggregate cycle in relation to that of the US, the other large common currency area in the world. The choice of US output as a conditioning variable is motivated by the findings in Giannone and Reichlin (2005, 2006) and some additional results reported in this paper (NBER Working Paper 14529, 2008) which show that the dynamic correlation between US and euro area growth is robust and has been stable over time.

Domenico Giannone, Michele Lenza, and Lucrezia Reichlin (2008) find a core group with level of output per capita close to the average which is composed of Italy (IT), Germany (GE), France (FR), Belgium (BE), Austria (AT), the Netherlands (NE) and Finland (FI). In the periphery we have Portugal (PT), Luxembourg (LU), Greece (GR), Ireland (IE) and Spain (SP). They used data from 1970 throughout the nineties and the establishment of the euro in 1999. They underline the fact that the countries in the core group have remained homogeneous throughout the sample while countries with heterogeneous starting conditions have no general tendency to become closer to the euro area. Differences in levels of economic activity are persistent. Some countries seem to converge, like Spain, others do not seem to catch up, like Greece. Ireland, on the other hand, caught up and over overshot. Overall, by superficial inspections of these numbers, nothing much seems to have changed since the nineties. Also, their results suggest that most of the business cycle fluctuations in countries with similar starting conditions are driven by euro area wide shocks which propagate in an homogeneous way. Furthermore, asymmetries are very small for countries with similar level of development and larger for countries with low GDP per capita relative to the euro area. Asymmetries have declined over time as an effect of decline output volatility in the early eighties ("Great Moderation"). Since asymmetries have changed very little as a consequence of the EMU, the costs of business cycle heterogeneity associated with it have been small.

They compute a VAR on output per capita of twelve countries of the euro area. Their controlled experiment consists of computing the expected path of a member country, conditioning on the pre-EMU correlation structure and on the entire path of the euro area, and then asks whether intra euro area relations have changed since the EMU.
They collect all the time series in a vector

$$Yt = (y1, t, \dots, y12, t)'$$

They consider the model

$$Yt = c + A1Yt - 1 + \cdots + ApYt - p + et$$, where et~WN(0,Σ).

Since, with twelve variables and twenty nine years of data, there are too many parameters to estimate, they use Bayesian shrinkage and set the shrinkage parameter as in Banbura, Giannone, and Reichlin (2008). They denote the vector of the estimated parameters for the pre-EMU years as $\theta_{pre\text{-}emu}$. The expectation of GDP per capita for each member country on the basis of pre-EMU data, conditional on the aggregate outcome, that is the entire (pre and post EMU) path of area-wide aggregate GDP, is:

[yi, /yea,70, yea,71,...yea,05, yea,06]

for t=70,...,06 where yea,t denotes the euro area average output per capita.

They also compute uncertainty around the conditional expectations, which allows us to assess the statistical significance of the differences between observed euro area and country growth rates and the conditional expectations of the latter.
What emerges from the Figures is that, for the countries of the core, uncertainty around the country's forecasts, conditional on observed area-wide developments, is rather limited.

Moreover, for each country, realized GDP growth is within the confidence bands (Carter and Kohn algorithm) around the conditional forecasts. These two facts indicate that country specific fluctuations are rather limited and that the linkages among those countries and the aggregate are strong. In addition, for each country, GDP growth is very close to the growth rate of the euro area. Also, the individual country's GDP growth forecasts, conditional on the euro area, are not significantly different from the euro area GDP growth itself. This is not only a further indication that asymmetric, idiosyncratic shocks are small, but also implies that asymmetries in the propagation of shocks are limited. In contrast, for the so-called periphery, the picture is more complex. For countries of this group, GDP growth dynamics is less similar to that of the euro area. However, uncertainty around the conditional forecast is large, indicating that the linkages between each of these countries and the rest of the euro area have been rather weak. As a consequence of such uncertainty, realized GDP is, in general, not statistically different from the forecast conditional on the average. This is the case not only in the pre-EMU period, but also during the EMU years. Overall, these results tell us that some idiosyncrasies are definitely present and, in general, they have not decreased over time, but they remain confined to the experience of small countries, both before and after the introduction of the common currency. Given the uncertainty, any statement on the real effect of the EMU in these countries is likely to be ill founded.

Forni and Reichlin (2001) and Croux, Forni, and Reichlin (2001) have shown, on the basis of data including only a couple of years of the EMU sample, that a regional component, orthogonal to the national one, explains a large component of national European cycles (around 30 %).

On the basis of data up to 2007, seven euro area and three European non euro area countries, Canova, Ciccarelli, and Ortega (2008) find that a European Union (EU) cycle emerges in the 1990s, but this is common to EMU and non EMU countries. The same authors find that a European cycle was absent until the mid-eighties.

Z. Darvas, G. Szapary carried out a study in order to see whether synchronization in the euro zone countries has increased in the run-up period to the EMU and since the start of the monetary union in order to test for OCA endogeneity.

They use a dynamic factor model

$$Y_{i,t}= \beta_i^{EU} Z_t^{EU} + \beta_i Z_{i,t} + v_{i,t} \quad i=1,\ldots,k$$

$$Z_t^{EU} = \gamma^{EU} Z_{t-1}^{EU} + u_t^{EU}$$

$$Z_{i,t} = \gamma_i Z_{\iota,\tau-1} + u_{i,t} \quad i=1,\ldots,k$$

where y_{ijt} is the detrended GDP of country i, is the (unobservable) index of European activity, i.e. the common factor, and z_{it} is the (unobservable) index of country specific economic activity not explained by the common factor. This formulation allows the adoption of the standard assumption behind empirical state-space models of no contemporaneous or lagged correlation among the error terms of the equations. The β and γ are parameters to be estimated along with the standard errors of the innovations.

The dynamic effect of any shocks depends on the persistence of the series: for highly persistent series, the shock has a long-lasting effect, while for weakly persistent series the effect of the shock diminishes sooner. Consequently, from the perspective of synchronization, similar persistence is rather important. The measure they use is the first order autocorrelation coefficient of the cycle. Persistence defined this way reflects a mixture of the effects of various shocks and the effects of transmission mechanism through which these shocks pass on to the economies. Some shocks could have longer-term effects while others might diminish sooner, and some economies could react to a given shock differently than the other. Therefore, this simple measure does not allow the identification of the relative importance of various shocks and the way the economies react to them; rather this measure reflects the aggregate effect of the similarities of shocks and their transmission. They do not formulate any normative statement on whether a

"high" or a "low" persistence is better; they are simply interested in whether persistence is similar across countries.
They also compute impulse-response as the accumulated effect (up to six quarters) of a euro area shock (proxied as a shock to the common factor) on the individual countries. When correlation is contemporaneous and large and the volatility and the persistence of the cycle is the same as in the euro area, then this measure will not deliver results different from the previous ones. However, whenever any of the above conditions are not satisfied, then it can give an additional indicator of synchronization by showing a measure of the magnitude of the impact of a euro area shock. Moreover, by calculating the impact from a VAR, which by definition includes own lags as well, this indicator can assess whether the results from the previous unconditional correlation coefficient are blurred by persistence. To some extent, this can be regarded as a summary measure of the previous four measures of synchronization. The six-quarter period for adding up the responses was selected to measure the cumulative impact for a period which is usually regarded as the one during which monetary policy takes its effect.

The impulse-responses were calculated from three-variable VARs including the common factor, the euro area aggregate, and the individual country studied. They calculated their measure based on the "generalized impulse-response function" of Pesaran and Yongcheol (1998), which is independent of the ordering of the variables. They calculated the accumulated impulse-response up to six quarters and normalized it with the effect of the common factor on the euro area itself. Therefore, the value of one indicates perfect synchronization according to this measure, while a larger (smaller) value indicates greater (lesser) sensitivity; a value of zero means no transmittal at all of the euro area shock. Due to the large number of parameters to be estimated, they estimated the models for the most recent 10-year long period of 19932002. They look at the impulse-response only for GDP, not its components. They found that the EMU member countries have become more synchronized over time according to all the correlation measures calculated. The movement toward greater synchronization is particularly evident since 1993, the start of the run-up to the EMU. Interestingly, some of the control group countries are more synchronized than the smaller EMU-members (Portugal, Finland, and Ireland). First, there has been a clear trend toward a reduction in volatility in all countries. Second, all their observations allow them to group the countries according to their degree of synchronization. They split the EMU countries into two groups: the "core" countries (Austria, Belgium, France, Germany, Italy and The Netherlands) which show higher synchronization, and the "periphery" countries (Finland, Ireland, Portugal, Spain) which exhibit lower co movement. It is remarkable that the core EMU countries show a high degree of synchronization according to all the measures we use and this not only for GDP, but for its components as well. The synchronization has significantly increased between 1993-97 and 1998-2002, a period consisting of the run-up to EMU, followed by membership in the monetary union. For the periphery EMU countries, the same overall trends can be observed, but their level of synchronization is less advanced. The periphery countries had lower income per capita and were on a catch-up growth path toward the average of EU level, which could be a reason for the slower convergence in business cycles, since the catch-up period could be accompanied by more intensive country specific shocks and uncertainties. Another reason could be that these countries joined the EU much later, hence they integrated into the EU trade later.

Maximo Camacho, Gabriel Perez-Quiros and Lorena Saiz use the monthly (seasonally adjusted) Industrial Production series as an indicator of the general economic activity, in their business cycle analysis. They choose this type of data because they try to use a more comprehensive measure activity rather than using aggregate GDP. . However, the frequency of this series is quarterly, not monthly, the sample is shorter and, for most of these countries, the GDP is not calculated from national accounts on a quarterly basis but the series is annual and converted into a quarterly frequency using indicators. The sample of the countries include all the European Union countries, all the accession countries but Malta, and all the negotiating countries but Bulgaria. Computing the degree to which the economies move together(correlations among the series) , it seems that the industrial production of some, but not all, of these countries move together. As they find evidence that different de-trending methods may produce different results, they propose three different measures of co-movements. The first is based on VAR estimations, following Den Haan (2000); the second, based on spectral analysis, following Reichlin, Forni and Croux (2001); and the third, based on business cycle dummy variables, following Harding and Pagan (2002). They find that the synchronization across old members has not significantly increased since the establishment of the common currency. By contrast, it seems that the existing synchronization among old members is prior to the implementation of the Euro. In this respect, the degree of synchronization obtained through the Euro is not higher than in some periods of the recent history. Consequently, they do not find empirical evidence supporting the core and periphery distinction. Finally they find that, apart from trade, there is a significant role for other structural variables and some economic policy variables (Fiscal variables) to explain these business cycle co-movements.

2.7 FISCAL DIVERGENCE AND EMU

Most economists—particularly non-Europeans—view the Maastricht convergence criteria with skepticism. The reason is simple: they have little to do with standard economic arguments concerning "optimal currency areas," monetary unions that are desirable and sustainable. The consensus in economics is that from a theoretical viewpoint, monetary unions make sense for countries with synchronized business cycles, integrated markets, flexibility, and mechanisms to share risk. The overlap between the Maastricht convergence criteria and the optimum currency area criteria is small. Clearly the direct correspondence between the (Maastricht) criteria actually applied for EMU entry and the appropriate (optimum currency area) criteria is poor.

Fiscal policy was highly divergent at the signing of the Maastricht Treaty. In 1992, four European countries had total government budget deficits in excess of 6 percent of GDP (Belgium 8 percent; Greece 12.2 percent; Italy 10.7 percent; and UK 6.5 percent), while another four had deficits of less than 3 percent of GDP (Austria 1.9 percent; Denmark 2.2 percent; Germany 2.6 percent; and Luxembourg .3 percent).[8] The Maastricht treaty encouraged fiscal convergence since it pointed potential EMU entrants towards lower deficits.

Darvas and Rose using a panel of data that includes 21 countries and 40 years of data, show that countries with divergent fiscal policies (i.e., large average cross-country differences in the ratio of general government net lending/borrowing to GDP) tend to have less synchronized business cycles. They also show that reduced levels of primary fiscal deficits (or increased primary surpluses) tend to increase the level of business cycle synchronization, though the evidence for this effect is somewhat weaker.

a larger panel of OECD data indicates that fiscal convergence (in either the total or primary budget balance) is systematically associated with more synchronized economic activity. Whether or not it was intentional, the application of the Maastricht convergence criteria may have moved the EMU entrants closer to being an optimum currency area, since fiscal convergence tends to synchronize business cycles'.

Fiscal convergence, by definition, usually occurs because a country that has been fiscally irresponsible—that is, a country that has run persistently high budget deficits—reforms and closes the fiscal gap with other countries. Intuitively, countries that are fiscally irresponsible—i.e., countries that run persistently high budget deficits—are also countries that create idiosyncratic fiscal shocks. (This seems a natural association to us; irresponsible behavior is often idiosyncratic, for individuals as well as fiscal authorities.) In this case, reducing the budget deficit of a country simultaneously reduces its scope for idiosyncratic fiscal shocks, raising the coherence of its business cycle with the business cycle of others. That is, fiscal convergence raises business cycle synchronization since responsible fiscal behavior tends to be less idiosyncratic fiscal behavior.

If fiscal policy divergence is a response to asymmetric shocks then it may be associated with enhanced business cycle coherence; if fiscal shocks themselves cause business cycles, then the opposite may be true. Without persistent shocks (or shocks with persistent effects), there may be no relationship at all between fiscal policy divergence and business cycle synchronization.

A standard argument used against the Stability and Growth Pact is that countries that are constrained to have the same monetary policy should have good access to counter-cyclic fiscal policy. Countries that use fiscal policy counter-cyclically sometimes have persistent deficits, but so do countries with pro-cyclic fiscal policy. Darvas and Rose have found strong evidence that persistent cross-country differences in government budget positions have a (negative) effect on the synchronization of their business cycles. There is strong evidence that fiscal divergence (of both total and primary balances) reduces the coherence of business cycles.

Darvas and Rose established that fiscal convergence seems to induce greater business cycle synchronization. This is because fiscal divergence tends to occur when one country runs a substantially and persistently higher budget deficit than other countries, and simultaneously creates fiscal shocks. That is, irresponsible fiscal policy (a persistently high deficit) coincides with idiosyncratic (fiscal) instability. When the budget deficit is closed (fiscal convergence), the fiscal shocks diminish; business cycles tend to become more synchronized. Succinctly, fiscal policy that is irresponsible is also fiscal policy that creates idiosyncratic shocks and thus macroeconomic volatility.

An additional cause of idiosyncratic shocks is the political business cycles. Political business cycle models feature the idea that, in majoritarian systems, governments improve their reelection prospects by stimulating aggregate demand in pre-election periods. The policies before elections can give rise to electoral or partisan cycles. Electoral (opportunistic) cycles are defined as persistent cyclical patterns of key target and policy variables regardless of the ideological orientation of the incumbent government (Nord-haus, 1975; Lindbeck, 1976). Partisan cycles are defined as the persistent differences in such patterns conditional upon the ideology of the party in power (Hibbs, 1977; Haynes and Stone, 1990 ;). Proportional political systems, with several parties forming coalition governments, are not prone to yield political cycles, especially partisan cycles. Through policy moderation, coalition governments are slow to react to shocks due to the veto power over the choice of policies by their members (Alesina, 1987; Alesina et al., 1997). Moreover, they have a tendency to create larger budget deficits and build up government debt (Alesina et al., 1997).

3. DATA

I use GDP series for the ten European Monetary Union countries that I choose to contain in my research and two additional GDP series for the US and the United Kingdom. The two last are used in order to compute the correlations among the US and EMU countries and the correlations among the United Kingdom and the EMU countries. Data are in quarterly basis, from 1980 to 2010, thus I have 123 observations. I choose this period of time because data are more reliable. Also GDP series have been drawn from the OECD data base in both current and constant prices. For the years before the introduction of the common currency, GDP is calculated in euro by an OECD method. Real data are also calculated in different base year (2000, 2005, and 2006) but this does not affect my final results. In most of the countries, quarterly GDP was annualized and I had to transform the quarter figures.

Rather than filtering data, we consider annual growth rate. This is partly because business cycle facts are not robust to different de-trending techniques (see, for example, Canova, 1998) and annual growth rates are easily interpretable, partly because considering any smoother component of growth rates implies extracting a moving average with the consequence of losing points at the end of the sample, which, for the EMU regime, is already quite short.

The main obstacle in working with my data was the fact that there is no an EMU series that is drawn back from 1980. So I choose to build one in the way I describe. First, having the nominal series of the ten EMU countries, take their sum for each year and then calculate each country weights.

$$\frac{country's\ nominal\ GDP}{sum\ of\ GDPs}$$

Second, I produce the log, first differences of the EMU GDP as the weighted average of the ten countries, where the weights are taken from the method above. This is my new series that replicates the EMU GDP.

4. EMPIRICAL EXERCISE

Firstly, I spend an amount of time and effort computing the degree to which the economies move together. I compute some descriptive statistics, separating my sample in three sub-periods, in ordering to get an overall point. The sub-periods are 1980-1989, 1990-1999, 2000-2010. The most standard measures to deal with the co-movements across time series are the correlations among the series. The correlations matrices contain the correlations between a country and another EMU participant and, there is the average correlation of each country with the other nine. It is also calculated the average correlation of the ten countries in the particular sub-period.

[Table 1], [Table 2], [Table 3] and [Table 4], [Table 5], [Table 6]

I also calculate correlations between each country of my sample and the United Kingdom and the US (OECD data, logarithmic first differences of real GDP) during the three sub-periods (1980-1989, 1990-1999, 2000-2010).

[Table 7], [Table 8]

In the main part of my exercise, my controlled experiment consists of computing a bivariate VAR between each country's logarithmic first differences series of GDP and the logarithmic first differences series of EMU GDP excluding the country's series that I use in the VAR.

According to Sims (1980) , if there is simultaneity among a number of variables ,then all these variables should be treated in the same way. In other words there should be no distinction between endogenous and exogenous variables. Therefore, once this distinction is abandoned, all variables are treated as endogenous. This means that in its general reduced form each equation has the same set of regressors which leads to the development of the VAR models. So, when we are not confident that a variable is really exogenous, we have to treat each variable symmetrically. The vector auto regression (VAR) is commonly used for forecasting systems of interrelated time series and for analyzing the dynamic impact of random disturbances on the system of variables. The VAR approach sidesteps the need for structural modeling by treating every endogenous variable in the system as a function of the lagged values of all of the endogenous variables in the system. Also, Sims (1980) identified VARs using Cholesky decompositions of the covariance matrix. Since there are as many of these decompositions as there are ways to order the η variables in the VAR system (i.e., n! orderings), these decompositions are sometimes called Cholesky orderings. Cholesky decompositions are particularly convenient since they are simple to calculate and a unique decomposition exists for each ordering.

The mathematical representation of the VAR is:

$$Y_t = c + A_1 Y_{t-1} + \dots + A_p Y_{t-p} + e_t \tag{1}$$

Where y_t is a k vector of endogenous variables, $A1, \dots, A_p$ and B are matrices of coefficients to be estimated, and e_t is a vector of innovations that may be contemporaneously correlated but are uncorrelated with their own lagged values and uncorrelated with all of the right-hand side variables. Since only lagged values of the endogenous variables appear on the right-hand side of the equations, simultaneity is not an issue and OLS yields consistent estimates. Moreover, even though the innovations e_t may be contemporaneously correlated, OLS is efficient and equivalent to GLS since all equations have identical regressors. In my model there are two endogenous variables, Y_i is the country's logarithmic first differences series of GDP, Y_{EU} is the EU's logarithmic first differences series of GDP. I compute the VAR in two different periods for all the countries. The sub-periods are 1980q1 to 1999q4, which is the period before the established of the EMU, and 2000q1 to 2010q4 which is the decade with the common currency. My intention is to find any differences in the variance decompositions between the two periods, testing impulse responses and Granger Causality, too.

Variance decomposition separates the variation in an endogenous variable into the component shocks to the VAR. Thus, the variance decomposition provides information about the relative importance of each random innovation in affecting the variables in the VAR. It also provides the forecast error of the variable at the given forecast horizon. The source of this forecast error is the variation in the current and future values of the innovations to each endogenous variable in the VAR. The variance decomposition based on the Cholesky factor. In linear algebra, the Cholesky decomposition or Cholesky triangle is a decomposition of a Hermitian, positive-definite matrix into the product of a lower triangular matrix and its conjugate transpose. It was discovered by Andre-Louis Cholesky for real matrices. When it is applicable, the Cholesky decomposition is roughly twice as efficient as the LU decomposition for solving systems of linear equations. In a loose, metaphorical sense, this can be thought of as the matrix analogue of taking the square root of a number. A symmetric n x n matrix A is positive definite if the quadratic form x^TAx is positive for all nonzero vectors x or, equivalently, if all the eigenvalues of A are positive. Positive definite matrices have many important properties, not least that they can be expressed in the form $A= X^TX$ for a nonsingular matrix X. The Cholesky factorization is a particular form of this factorization in which X is upper triangular with positive diagonal elements; it is usually written $A= R^TR$ or $A= LL^T$ and it is unique. In the case of a scalar (n = 1), the Cholesky factor R is just the positive square root of A. However, R should in general not be confused with the square roots of A, which are the matrices Y such that $A = Y^2$, among which there is a unique symmetric positive definite square root, denoted $A^{1/2}$. It is commonly used to solve the normal equations $A^TAx = A^Tb$ that characterize the least squares solution to the over determined linear system $Ax = b$. A variant of Cholesky factorization is the factorization $A = LDL^T$, where L is unit lower triangular (that is, has unit diagonal) and D is diagonal.

This factorization exists and is unique for definite matrices. If D is allowed to have no positive diagonal entries the factorization exists for some (but not all) indefinite matrices. When A is positive definite the Cholesky factor is given by $R = D^{1/2}L^T$. The Cholesky decomposition is known to be informative for some simple departures from a perfectly recursive structure. For example, structural responses to a predetermined variable are obtained by placing this variable first in a recursive ordering.

A shock to the i-th variable not only directly affects the i-th variable but is also transmitted to all of the other endogenous variables through the dynamic (lag) structure of the VAR. An impulse response function traces the effect of a one-time shock to one of the innovations on current and future values of the endogenous variables.

If the innovations e_t are contemporaneously uncorrelated, interpretation of the impulse response is straightforward. The i-th innovation $e_{i\,t}$ is simply a shock to the i-th endogenous variable $y_{i\ t}$. Innovations, however, are usually correlated, and may be viewed as having a common component which cannot be associated with a specific variable. In order to interpret the impulses, it is common to apply a transformation P to the innovations so that they become uncorrelated:

$$u_t = Pe_t \sim (0, D) \qquad (2)$$

where D is a *diagonal* covariance matrix. For stationary VARs, the impulse responses should die out to zero at the end of the period, we examine. I also use Cholesky ordering d.f. adjusted.

Cholesky factor imposes an ordering of the variables in the VAR and attributes all of the effect of any common component to the variable that comes first in the VAR system. The d.f. adjustment option makes a small sample degrees of freedom correction when estimating the residual covariance matrix used to derive the Cholesky factor

The first step is to check if the series are stationary though the first differences de-trending method, usually produce stationary series. **A** univariate test for the presence of a unit root (and thus non-stationarity) that is becoming quite common is the augmented Dickey-Fuller test (ADF). Augmented Dickey-Fuller is an extention of the Dickey and Fuller test. A number of tests for a unit root have been proposed, with the most popular being the Sargan and Bhargava (1983) CRDW test, the Dickey-Fuller (DF) test, the augmented Dickey-Fuller (ADF) test, and the test developed by Phillips and Perron based on the Phillips (1987) Z test. With the DF and ADF tests the presence of serial correlation will affect the distributions of the test statistics and therefore invalidate the tests. It includes extra lagged terms of the dependent variable in order to eliminate autocorrelation. The lag length on these extra terms is determined by Schwarz Bayesian Criterion (SBC). The three possible forms of the ADF test are given by the following equations:

$$\Delta y_t = \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + u_t \qquad (3)$$

$$\Delta y_t = \alpha_0 + \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-1} + u_t \qquad (4)$$

$$\Delta y_t = \alpha_0 + \gamma y_{t-1} + \alpha_2 t + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + u_t \qquad (5)$$

The difference among the three regressions concerns the presence of the deterministic elements α_0 and $\alpha_2 t$. (Asteriou). For the ADF test the presence (or otherwise) of drift and/or trend necessitates that if the null hypothesis of a unit root ($H_0: a = 0$) is not rejected [using Fuller's (1976) τ_τ distribution of the t- statistic of γ), then it is necessary to proceed to test the joint hypothesis that $\gamma = 0$ and $\alpha_2 = 0$ (using the F-statistic Φ_3 given in Dickey and Fuller (1981)]. As Dolado, Jenkinson and Sosvilla-Rivero (1990) point out, if the trend is significant under the null of a unit root, then normality of the t-statistic of γ follows, and the standardized normal tables should be used. If the trend is not significant, the null is then tested with the constraint that $\alpha_2 = 0$. Again, failure to reject means testing the joint hypothesis that $\gamma = 0$ and $\alpha_0 = 0$ [this time using the F-statistic Φ_λ given in Dickey and Fuller (1981)]. If the constant under the null hypothesis is significant, then the test for the unit root should be repeated using the standardized normal; otherwise, Fuller's f should be used.

The optimum lag structure of the VAR is selected based on the Schwarz criterion. According to Lutkepohl (1991) the Schwarz criterion estimates the order correctly most often and produces the smallest square forecasting error on average. Gideon Schwarz (1978) solved the problem of selecting one of a number of models of different dimensions by finding its Bayes solution, and evaluating the leading terms of its asymptotic expansion. These terms are a valid large-sample criterion beyond the Bayesian context, since they do not depend on the a priori distribution. Statisticians are often faced with the problem of choosing the appropriate dimensionality of a model that will fit a given set of observations. Typical examples of this problem are the choice of degree for a polynomial regression and the choice of order for a multi-step Markov chain.

In such cases the maximum likelihood principle invariably leads to choosing the highest possible dimension. Therefore it cannot be the right formalization of the intuitive notion of choosing the "right" dimension. An extension of the maximum likelihood principle is suggested by Akaike for the slightly more general problem of choosing among different models with different numbers of parameters. His suggestion amounts to maximizing the likelihood function separately for each model y, obtaining, say, $Mj(X_{19} \cdot \cdot \cdot ,\ X_n)$, and then choosing the model for which log $Mj(X_{19} \cdot \cdot \cdot ,\ X_n)$ — k_5 is largest, where k_3- is the dimension of the model. Schwarz presented an alternative approach to the problem. In a model of given dimension maximum likelihood estimators can be obtained as large-sample limits of the Bayes estimators for arbitrary nowhere vanishing a priori distributions. Therefore he looked for the appropriate modification of maximum likelihood, by studying the asymptotic behavior of Bayes estimators under a special class of priors. These priors are not absolutely continuous, since they put positive probability on some lower-dimensional subspaces of the parameter space, namely the subspaces that correspond to the competing models. In the large-sample limit, the leading term of the Bayes estimator turns out to be just the maximum likelihood estimator. Only in the next term something new is obtained. This was to be expected, since the leading term depends on the prior only through its support, while the second order term does reflect singularities of the a priori distribution.

Correlation does not necessarily imply causation in any meaningful sense of that word. The Granger (1969) approach to the question of whether *x* causes *y* is to see how much of the current *y* can be explained by past values of *y* and then to see whether adding lagged values of *x* can improve the explanation. *y* is said to be Granger-caused by if *x* helps in the prediction of *y*, or equivalently if the coefficients on the lagged x's are statistically significant. Note that two-way causation is frequently the case; *x* Granger causes *y* and *y* Granger causes *x*. It is important to note that the statement "x Granger causes *y*" does not imply that *y* is the effect or the result of *x* . Granger causality measures precedence and information content but does not by itself indicate causality in the more common use of the term. The Granger causality test for the case of two stationary variables Y_t and $X_{t,}$ involves as a first step the estimation of the following VAR model:

$$Y_t = a_1 + \sum_{i=1}^{n} \beta_i X_{t-1} + \sum_{j=1}^{m} \gamma_i Y_{t-j} + e_{1t} \tag{6}$$

$$X_t = a_2 + \sum_{i=1}^{n} \theta_i X_{t-i} + \sum_{j=1}^{m} \delta_j Y_{t-j} + e_{2t} \tag{7}$$

where it is assumed that both e_{yt} and e_{xt} are uncorrelated white noise error terms. In this model we can have the following different cases:

The lagged X terms in (6) may be statistically different from zero as a group, and the lagged Y terms in (7) not statistically different from zero. In this case we have that X_t causes Y_t.

The lagged Y terms in (7) may be statistically different from zero as a group, and the lagged X terms in (6) not statistically different from zero. In this case we have that Y_t causes X_t.

Both sets of X and Y terms are statistically different from zero in (6) and (7), so that we have bi-directional causality.

Both sets of X and Y terms are not statistically different from zero in (6) and (7), so that X_t is independent of Y_t.

The Granger causality test, then, involves the following procedure. First, estimate the VAR model given by equations (6) and (7). Then check the significance of the coefficients and apply variable deletion tests first in the lagged X terms for equation (6), and then in the lagged Y terms in equation (7). According to the result of the variable deletion tests we may conclude about the direction of causality based upon the four cases mentioned above.

More analytically, and for the case of one equation, (we will examine equation (6), it is intuitive to reverse the procedure in order to test for equation (7)), we perform the following steps:

Step 1 Regress Y_t on lagged Y terms as in the following model:

$$Y_t = a_1 + \sum_{j=1}^{m} \gamma_j Y_{t-j} + e_{1t} \qquad (8)$$

and obtain the RSS of this regression (which is the restricted one) and label it as RSS_R.

Step 2 Regress Y_t on lagged Y terms plus lagged X terms as in the following model:

$$Y_t = a_1 + \sum_{i=1}^{n} \beta_i X_{t-i} + \sum_{j=1}^{m} \gamma_j Y_{t-j} + e_{1t} \qquad (9)$$

and obtain the RSS of this regression (which now is the unrestricted one) and label it as RSS_U.

Step 3 Set the null and the alternative hypotheses as below:

H0: $\sum_{i=1}^{n} \beta_i = 0$ or X_t does not cause Y_t

H1: $\sum_{i=1}^{n} \beta_i \neq 0$ or X_t does cause Y_t

Step 4 Calculate the F-statistic for the normal Wald test on coefficient restrictions given by:

$$F = \frac{\frac{RSS_R - RSS_U}{m}}{\frac{RSS_U}{n-k}} \qquad (10)$$

which follows the $F_{m,n-k}$ distribution. Here k= m + n + 1.

Step 5 If the computed F value exceeds the F-critical value, reject the null hypothesis and Conclude that X_t causes Y_t.

Finally, I compute the same VAR model between the country and the EU using all the observations of my sample (1980q1 – 2010q4). Afterwards, I isolate the equation which contains the country's growth rate as the endogenous variable and run it as a simple equation. My intention is to search for any structural breaks particular in the timing of the launch of EMU (2000, 2001).

The idea of the breakpoint Chow test is to fit the equation separately for each subsample and to see whether there are significant differences in the estimated equations. A significant difference indicates a structural change in the relationship. For example, you can use this test to examine whether the demand function for energy was the same before and after the oil shock. The test may be used with least squares and two-stage least squares regressions.

The Chow breakpoint test tests whether there is a structural change in all of the equation parameters. To carry out the test, I partition the data into two or more subsamples. Each subsample must contain more observations than the number of coefficients in the equation so that the equation can be estimated. The Chow breakpoint test compares the sum of squared residuals obtained by fitting a single equation to the entire sample with the sum of squared residuals obtained when separate equations are fit to each subsample of the data. Three test statistics are reported for the Chow breakpoint test. The *F*-statistic is based on the comparison of the restricted and unrestricted sum of squared residuals and in the simplest case involving a single breakpoint, is computed as:

$$F = \frac{\dfrac{(\tilde{u}'\tilde{u} - (u'_1 u_1 + u'_2 u_2))}{k}}{\dfrac{(u'_1 u_1 + u'_2 u_2)}{(T - 2k)}} \qquad (11)$$

where $\tilde{u}'\ \tilde{u}$ is the restricted sum of squared residuals from subsample i, T is the total number of observations, and k is the number of parameters in the equation. This formula can be generalized naturally to more than one breakpoint. The F-statistic has an exact finite sample F-distribution if the errors are independent and identically distributed normal random variables.

The log likelihood ratio statistic is based on the comparison of the restricted and unrestricted maximum of the (Gaussian) log likelihood function. The LR test statistic has an asymptotic χ distribution with degrees of freedom equal to $(m - 1)k$ under the null hypothesis of no structural change, where m is the number of subsamples.

The Wald statistic is computed from a standard Wald test of the restriction that the coefficients on the equation parameters are the same in all subsamples. As with the log likelihood ratio statistic, the Wald statistic has an asymptotic χ distribution with $(m - 1)k$ degrees of freedom, where m is the number of subsamples.

One major drawback of the breakpoint test is that each subsample requires at least as many observations as the number of estimated parameters. This may be a problem if, for example, you want to test for structural change between wartime and peacetime where there are only a few observations in the wartime sample.

5. RESULTS

It is obvious, that the growth rates of the ten countries are getting more correlated over the three decades. This could easily be evidence that synchronization among Euro-zone countries is higher than it was before. But the controversial point here is whether this co-movement exists due to the launch of EMU or how strong, if it does exist, is the effect of the participation in the EMU.

A serious position would undermine the EMU's effect, underscoring the 'Great Moderation' theory (it is thoroughly described in the previous section). According to this theory, GDP growth rates in the Euro area follow the same pattern as well with the other industrialized economies. I try to prove this by computing correlations between each country of my sample and the United Kingdom and the US. The results show that the increased synchronization has been at least as large in the non-euro area as in the euro area economies. The UK appears to be more synchronized with the EMU-wide cycle than some euro area members, such as Greece and Finland. These two countries (the UK and the US) are major key players of the global economy so the increase in the calculated figures could have been expected. However, the magnitude of the increase in the correlations through the three decades and the strong theoretical support of the 'Great Moderation' theory might somehow undermine the EMU's effect in the synchronization.

The literature suggests that simple calculating correlations cannot give us robust results. As I said the main purpose of computing the VAR models is to compare the differences of the variance decompositions among the two periods. Any significant increase of the GDP's growth variance which is explained by the EU's shocks, is a key proof that there is a synchronization between the two business cycles and that EU's GDP growth rate is a driving force of the country's growth rate.

[Table 9], [Table 10], [Table 11], [Table 12], [Table 13], [Table 14], [Table 15], [Table 16], [Table 17], [Table 18].

Indeed, there is a significant difference between the two periods but that does not concern all the countries. In fact, I could separate them in two categories, similar to the 'core and periphery' characterization of Giannone and Reichlin (2008). The first group contains Austria, Italy, Germany, France, Portugal, the Netherlands and Finland. It is found that 30% to 50% of their growth rates is produced by EU's growth rates. An important change, comparing with the first two decades of the sample, when the percentage extended from 1% to 5% . As a result, a big part of their GDP cyclical component could be explained from the Union's one.

This fact is more intense in Austria, the Netherlands and Finland. The last one which was thought to belong in the so called periphery shows an enormous difference from the previous period. Portugal also gives unexpected results for a participant which is characterized from its idiosyncratic behavior.

In the same group, Germany, France and Italy gives us more moderate results which is easily attributed to the size of their economy.

The second group that is emerged from my research contains Spain, Ireland and Greece. Those three EMU participants belong to the so called periphery (Giannone and Reichlin, 2008). Actually, we could suggest that they also have reached a degree of synchronization watching the difference in the figures [Table 16], [Table 17], [Table 18]. However, the difference between the two periods and the comparison with the other countries show that EU's growth movements do not play a major role in countries' growth path. It is assumed that the three of the periphery are largely affected from some idiosyncrasies.

An extra empirical exercise is the search for structural breaks in the coefficients of my models. Ireland, Greece, Portugal and Spain show structural breaks in the year 2000, which is the date of the adoption of the common currency. The existence of such a break at the particular date could indicate that these countries business cycles enter a new course that is connected with these date. I may support that this fact is a sign of a convergence of cycles and an indicator of a new driving force, these countries are subjected to. However, this assumption could be offended. Structural breaks indicate a reason of misspecification in the model and this reason would be the sudden change of nominal interest rates due to the countries' introduction in the EMU.

When countries join a monetary union they leave to a supranational decision maker, traditional instruments for the control of the business cycles. Obviously, the optimality of this delegation of the decisions to a higher authority will be a direct function of the similarities across these economies. I think that an appropriate answer to these questions is necessary to understand deeply the benefits and the costs that for different economies imply leaving traditional instruments for controlling aggregate demand to a supranational decision maker.

Ten years of history of the European Monetary Union are too short to identify new tendencies of output growth synchronization since historically GDP growth rates have been persistent and it is difficult to distinguish trends from persistent fluctuations. However, it seems that cycles are synchronized. Heterogeneity is generated by small and persistent idiosyncratic shocks while most output variation is explained by a common shock.

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7. TABLES

Table1

CORRELATION MATRIX 1980-1989

	AU	FI	FR	GE	GR	IR	IT	NE	PO
AU		0.0973	0.2920	0.2780	-0.0269	-0.0497	0.2183	0.2626	0.2208
FI	0.0973		0.2473	0.0448	-0.2817	0.0703	-0.0145	0.0153	0.1674
FR	0.2920	0.2473		0.1670	0.4211	0.3218	0.4174	0.2318	0.4729
GE	0.2780	0.0448	0.1670		0.4444	0.0485	0.2328	-0.0011	0.0435
GR	-0.0269	-0.2817	0.4211	0.4444		0.1048	0.4087	0.1312	0.0420
IR	-0.0497	0.0703	0.3218	0.0485	0.1048		0.2489	0.0536	0.2999
IT	0.2183	-0.0145	0.4174	0.2328	0.4087	0.2489		0.2848	0.2297
NE	0.2626	0.0153	0.2318	-0.0011	0.1312	0.0536	0.2848		0.0722
PO	0.2208	0.1674	0.4729	0.0435	0.0420	0.2999	0.2297	0.0722	
SP	0.2760	-0.1157	0.3868	-0.0229	0.1897	0.1374	0.1296	0.3260	0.4400
	1.5684	0.0256	0.3287	0.1372	0.1593	0.1373	0.2395	0.1529	0.2209

Table 2

CORRELATION MATRIX 1990-1999

	AU	FI	FR	GE	GR	IR	IT	NE	PO
AU		0.1601	0.4879	0.1285	0.1151	0.2842	0.2412	0.2272	0.4954
FI	0.1601		0.4647	-0.1075	0.0967	0.6920	0.2956	0.3071	0.1679
FR	0.4879	0.4647		0.0743	-0.0252	0.5021	0.5955	0.4062	0.4838
GE	0.1285	-0.1075	0.0743		0.3107	-0.1154	-0.0775	0.0574	0.1114
GR	0.1151	0.0967	-0.0252	0.3107		0.0417	-0.0468	0.0008	0.1485
IR	0.2842	0.6920	0.5021	-0.1154	0.0417		0.2945	0.4429	0.4467
IT	0.2412	0.2956	0.5955	-0.0775	-0.0468	0.2945		0.0971	0.3161
NE	0.2272	0.3071	0.4062	0.0574	0.0008	0.4429	0.0971		0.3336
PO	0.4954	0.1679	0.4838	0.1114	0.1485	0.4467	0.3161	0.3336	
SP	0.4705	0.2334	0.2586	0.0964	0.5169	0.3788	0.0490	0.5008	0.3892
	0.2900	0.2567	0.3609	0.0532	0.1287	0.3297	0.1961	0.2637	0.3214

Table 3

CORRELATION MATRIX 2000-2010

	AU	FI	FR	GE	GR	IR	IT	NE	PO
AU		0.8053	0.6956	0.1787	0.1958	0.4283	0.8031	0.7427	0.5070
FI	0.8053		0.8058	0.3152	0.3404	0.4265	0.8505	0.7747	0.5336
FR	0.6956	0.8058		0.1315	0.3497	0.5088	0.8482	0.7328	0.4184
GE	0.1787	0.3152	0.1315		-0.0905	0.0338	0.2161	0.1794	-0.0719
GR	0.1958	0.3404	0.3497	-0.0905		0.3871	0.3289	0.3825	0.2158
IR	0.4283	0.4265	0.5088	0.0338	0.3871		0.4684	0.3873	0.3106
IT	0.8031	0.8505	0.8482	0.2161	0.3289	0.4684		0.7468	0.5512
NE	0.7427	0.7747	0.7328	0.1794	0.3825	0.3873	0.7468		0.5198
PO	0.5070	0.5336	0.4184	-0.0719	0.2158	0.3106	0.5512	0.5198	
SP	0.6609	0.7325	0.7080	0.0752	0.6981	0.5421	0.7621	0.7270	0.4003
	0.5575	0.6205	0.5776	0.1075	0.3120	0.3881	0.6195	0.5770	0.3761

Table 4

CORRELATION MATRIX 1980-1989

	AU	FI	FR	GE	GR	IR	IT	NE	PO	SP	
AU											
FI	0.0973										
FR	0.2920	0.2473									
GE	0.2780	0.0448	0.1670								
GR	-0.0269	-0.2817	0.4211	0.4444							
IR	-0.0497	0.0703	0.3218	0.0485	0.1048						
IT	0.2183	-0.0145	0.4174	0.2328	0.4087	0.2489					
NE	0.2626	0.0153	0.2318	-0.0011	0.1312	0.0536	0.2848				
PO	0.2208	0.1674	0.4729	0.0435	0.0420	0.2999	0.2297	0.0722			
SP	0.2760	-0.1157	0.3868	-0.0229	0.1897	0.1374	0.1296	0.3260	0.4400		Average correlation
	0.1743	0.0167	0.3456	0.1242	0.1753	0.1849	0.2147	0.1991	0.4400		0.2083

Table 5

CORRELATION MATRIX 1990-1999

	AU	FI	FR	GE	GR	IR	IT	NE	PO	SP	
AU											
FI	0.1601										
FR	0.4879	0.4647									
GE	0.1285	-0.1075	0.0743								
GR	0.1151	0.0967	-0.0252	0.3107							
IR	0.2842	0.6920	0.5021	-0.1154	0.0417						
IT	0.2412	0.2956	0.5955	-0.0775	-0.0468	0.2945					
NE	0.2272	0.3071	0.4062	0.0574	0.0008	0.4429	0.0971				
PO	0.4954	0.1679	0.4838	0.1114	0.1485	0.4467	0.3161	0.3336			
SP	0.4705	0.2334	0.2586	0.0964	0.5169	0.3788	0.0490	0.5008	0.3892		Average correlation
	0.2900	0.2687	0.3279	0.0639	0.1322	0.3907	0.1541	0.4172	0.3892		0.2704

Table 6

CORRELATION MATRIX 2000-2010

	AU	FI	FR	GE	GR	IR	IT	NE	PO	SP	Average correlation
AU											
FI	0.8053										
FR	0.6956	0.8058									
GE	0.1787	0.3152	0.1315								
GR	0.1958	0.3404	0.3497	-0.0905							
IR	0.4283	0.4265	0.5088	0.0338	0.38712						
IT	0.8031	0.8505	0.8482	0.21606	0.32894	0.46845					
NE	0.7427	0.7747	0.7328	0.17937	0.38251	0.3873	0.7468				
PO	0.507	0.5336	0.4184	-0.0719	0.21583	0.31064	0.5512	0.5198			
SP	0.6609	0.7325	0.708	0.07521	0.69812	0.54209	0.7621	0.727	0.4003		
	0.5575	0.5974	0.5282	0.057	0.40251	0.42712	0.6867	0.6234	0.4003		0.4756

Table 7

UK	1980-1989	1990-1999	2000-2010
AU	0.2918	-0.0130	0.7564
FI	0.1252	0.6592	0.8498
FR	0.3771	0.3817	0.8144
GE	-0.0101	-0.1004	0.0991
GR	0.0690	0.1850	0.4300
IR	-0.1217	0.5298	0.5523
IT	0.2249	0.2860	0.8311
NE	0.1504	0.1693	0.7204
PO	0.1927	-0.0704	0.4250
SP	0.2783	0.1318	0.8274
Average correlation	0.1578	0.2159	0.6306

Table 8

	US		
	1980-1989	1990-1999	2000-2010
AU	0.0951	0.0225	0.5736
FI	-0.0632	0.5066	0.5893
FR	0.1340	0.3994	0.6666
GE	0.0064	0.0564	0.1724
GR	0.1319	-0.0971	0.1522
IR	0.0213	0.4695	0.4691
IT	0.2686	0.0986	0.6101
NE	0.2916	0.2497	0.5431
PO	-0.2265	-0.0075	0.2761
SP	0.1082	-0.0096	0.5767
Average correlation	0.0767	0.1689	0.4629

Table 9

Variance Decomposition of AUSTRIA (1980-1999)

Period	S.E.	EU	AU
1	0.011033	0.000213	99.99979
2	0.011179	1.986763	98.01324
3	0.011853	4.076750	95.92325
4	0.011871	4.245443	95.75456
5	0.011972	4.366111	95.63389
6	0.011974	4.394910	95.60509
7	0.011985	4.392915	95.60708
8	0.011986	4.392707	95.60729
9	0.011988	4.397524	95.60248
10	0.011988	4.397515	95.60249

Cholesky Ordering: EU AU

Variance Decomposition of AUSTRIA (2000-2010)

Period	S.E.	EU	AU
1	0.004812	34.51230	65.48770
2	0.006949	46.71017	53.28983
3	0.007396	52.13987	47.86013
4	0.007806	48.68312	51.31688
5	0.008019	46.97186	53.02814
6	0.008122	46.05769	53.94231
7	0.008211	45.05784	54.94216
8	0.008257	44.67835	55.32165
9	0.008263	44.64529	55.35471
10	0.008264	44.64970	55.35030

Cholesky Ordering: EU AU

Table 10

Variance Decomposition of ITALY (1980-1999)

Period	S.E.	EU	IT
1	0.005721	10.13879	89.86121
2	0.005968	11.81364	88.18636
3	0.005997	12.08210	87.91790
4	0.006155	12.46148	87.53852
5	0.006182	12.47283	87.52717
6	0.006192	12.53685	87.46315
7	0.006194	12.54250	87.45750
8	0.006204	12.50926	87.49074
9	0.006205	12.54592	87.45408
10	0.006208	12.61363	87.38637

Cholesky Ordering: EU IT

Variance Decomposition of ITALY (2000-2010)

Period	S.E.	EU	IT
1	0.006021	39.13384	60.86616
2	0.007394	37.92010	62.07990
3	0.007708	36.47174	63.52826
4	0.007917	35.79674	64.20326
5	0.007941	35.66949	64.33051
6	0.007947	35.74298	64.25702
7	0.007959	35.92538	64.07462
8	0.007975	36.01240	63.98760
9	0.007987	35.99776	64.00224
10	0.007990	35.99624	64.00376

Cholesky Ordering: EU IT

Table 11

Variance Decomposition of THE NETHERLANDS (1980-1999)

Period	S.E.	EU	NE
1	0.008940	2.712621	97.28738
2	0.009003	2.752050	97.24795
3	0.009137	3.531888	96.46811
4	0.009199	4.828545	95.17145
5	0.009202	4.855793	95.14421
6	0.009213	4.867952	95.13205
7	0.009218	4.976630	95.02337
8	0.009249	5.594682	94.40532
9	0.009251	5.592890	94.40711
10	0.009254	5.591475	94.40853

Cholesky Ordering: EU NE

Variance Decomposition of THE NETHERLANDS (2000-2010)

Period	S.E.	EU	NE
1	0.005936	55.35786	44.64214
2	0.007110	60.31761	39.68239
3	0.007390	62.90108	37.09892
4	0.007621	65.11578	34.88422
5	0.007725	65.20107	34.79893
6	0.007874	62.75707	37.24293
7	0.007970	61.27815	38.72185
8	0.008010	60.73505	39.26495
9	0.008053	60.33380	39.66620
10	0.008070	60.19679	39.80321

Cholesky Ordering: EU NE

Table 12

Variance Decomposition of GERMANY (1980-1999)

Period	S.E.	EU	GE
1	0.017143	3.499081	96.50092
2	0.017499	3.521481	96.47852
3	0.017739	3.763274	96.23673
4	0.017894	3.711474	96.28853
5	0.022844	3.700928	96.29907
6	0.023306	3.582943	96.41706
7	0.023580	3.539534	96.46047
8	0.023785	3.496578	96.50342
9	0.026903	3.328261	96.67174
10	0.027320	3.228834	96.77117

Cholesky Ordering: EU GE

Variance Decomposition of GERMANY (2000-2010)

Period	S.E.	EU	GE
1	0.008800	6.790518	93.20948
2	0.011041	32.04558	67.95442
3	0.011625	29.64832	70.35168
4	0.011807	29.73378	70.26622
5	0.013616	25.68829	74.31171
6	0.013972	24.40738	75.59262
7	0.014287	23.71388	76.28612
8	0.014295	23.70240	76.29760
9	0.015846	21.30685	78.69315
10	0.016103	21.44292	78.55708

Cholesky Ordering: EU GE

Table 13

Variance Decomposition of FINLAND (1980-1999)

Period	S.E.	EU	FI
1	0.009154	1.026304	98.97370
2	0.009169	1.323084	98.67692
3	0.009881	5.698527	94.30147
4	0.010528	6.322189	93.67781
5	0.010595	7.224498	92.77550
6	0.011106	10.22979	89.77021
7	0.011400	12.66604	87.33396
8	0.011471	13.60980	86.39020
9	0.011645	14.67641	85.32359
10	0.011731	15.69145	84.30855

Cholesky Ordering: EU FI

Variance Decomposition of FINLAND (2000-2010)

Period	S.E.	EU	FI
1	0.011469	74.96677	25.03323
2	0.013340	81.24296	18.75704
3	0.013552	80.52279	19.47721
4	0.013802	79.59223	20.40777
5	0.013904	78.68951	21.31049
6	0.013960	78.06203	21.93797
7	0.013979	78.05379	21.94621
8	0.013994	77.88452	22.11548
9	0.013995	77.87507	22.12493
10	0.013997	77.88070	22.11930

Cholesky Ordering: EU FI

Table 14

Variance Decomposition of FRANCE (1980-1999)

Period	S.E.	EU	FR
1	0.004037	17.04438	82.95562
2	0.004262	15.88235	84.11765
3	0.004526	15.41198	84.58802
4	0.004784	14.96337	85.03663
5	0.004805	14.88107	85.11893
6	0.004839	14.67271	85.32729
7	0.004848	14.61858	85.38142
8	0.004849	14.63388	85.36612
9	0.004850	14.62804	85.37196
10	0.004853	14.72449	85.27551

Cholesky Ordering: EU FR

Variance Decomposition of FRANCE (2000-2010)

Period	S.E.	EU	FR
1	0.005149	29.42362	70.57638
2	0.005557	29.97343	70.02657
3	0.005924	28.91304	71.08696
4	0.006014	29.00076	70.99924
5	0.006022	28.94678	71.05322
6	0.006022	28.95895	71.04105
7	0.006025	29.02013	70.97987
8	0.006029	29.00105	70.99895
9	0.006031	29.01271	70.98729
10	0.006032	28.99835	71.00165

Cholesky Ordering: EU FR

Table 15

Variance Decomposition of PORTUGAL (1980-1999)

Period	S.E.	EU	PO
1	0.003742	1.331455	98.66855
2	0.005465	1.244463	98.75554
3	0.005992	1.221255	98.77875
4	0.006519	1.625395	98.37461
5	0.007030	1.715099	98.28490
6	0.007254	1.659001	98.34100
7	0.007374	1.651444	98.34856
8	0.007480	1.836178	98.16382
9	0.007538	1.859434	98.14057
10	0.007561	1.847826	98.15217

Cholesky Ordering: EU PO

Variance Decomposition of PORTUGAL (2000-2010)

Period	S.E.	EU	PO
1	0.009183	32.64820	67.35180
2	0.009294	33.05758	66.94242
3	0.009345	33.76789	66.23211
4	0.009493	35.66681	64.33319
5	0.009513	35.52377	64.47623
6	0.009514	35.53349	64.46651
7	0.009539	35.37542	64.62458
8	0.009549	35.41107	64.58893
9	0.009590	35.95333	64.04667
10	0.009595	36.02828	63.97172

Cholesky Ordering: EU PO

Table 16

Variance Decomposition of SPAIN (1980-1999)

Period	S.E.	EU	SP
1	0.007947	0.048961	99.95104
2	0.008083	0.205958	99.79404
3	0.008722	0.185030	99.81497
4	0.008805	0.421265	99.57873
5	0.008809	0.479822	99.52018
6	0.008979	0.489367	99.51063
7	0.008983	0.493432	99.50657
8	0.009012	0.541984	99.45802
9	0.009022	0.558741	99.44126
10	0.009022	0.562797	99.43720

Cholesky Ordering: EU SP

Variance Decomposition of SPAIN (2000-2010)

Period	S.E.	EU	SP
1	0.002575	16.13870	83.86130
2	0.003571	9.975627	90.02437
3	0.004346	7.288449	92.71155
4	0.005435	5.076837	94.92316
5	0.006057	7.107966	92.89203
6	0.006431	10.35686	89.64314
7	0.006768	12.57260	87.42740
8	0.006970	15.67564	84.32436
9	0.007078	17.67736	82.32264
10	0.007133	18.13912	81.86088

Cholesky Ordering: EU SP

Table 17

Variance Decomposition of IRELAND (1980-1999)

Period	S.E.	EU	IR
1	0.002443	0.329905	99.67009
2	0.004782	0.459449	99.54055
3	0.006763	0.261333	99.73867
4	0.008476	0.167985	99.83202
5	0.009149	0.173218	99.82678
6	0.009370	0.259521	99.74048
7	0.009471	0.286368	99.71363
8	0.009506	0.284875	99.71512
9	0.009634	0.290503	99.70950
10	0.009891	0.326582	99.67342

Cholesky Ordering: EU IR

Variance Decomposition of IRELAND (2000-2010)

Period	S.E.	EU	IR
1	0.020385	14.40705	85.59295
2	0.020632	14.44720	85.55280
3	0.021440	14.32567	85.67433
4	0.022601	13.36617	86.63383
5	0.022626	13.34415	86.65585
6	0.023063	12.94376	87.05624
7	0.023070	12.97034	87.02966
8	0.023141	12.94879	87.05121
9	0.023210	12.89064	87.10936
10	0.023211	12.89096	87.10904

Cholesky Ordering: EU IR

Table 18

Variance Decomposition of GREECE (1980-1999)

Period	S.E.	EU	GR
1	0.022257	12.60092	87.39908
2	0.024306	10.56799	89.43201
3	0.025069	11.01433	88.98567
4	0.025247	11.40885	88.59115
5	0.025982	13.86697	86.13303
6	0.026084	14.31088	85.68912
7	0.026274	14.86445	85.13555
8	0.026414	15.75699	84.24301
9	0.026697	17.26153	82.73847
10	0.026782	17.77001	82.22999

Cholesky Ordering: EU GR

Variance Decomposition of GREECE (2000-2010)

Period	S.E.	EU	GR
1	0.006622	13.78703	86.21297
2	0.006977	16.29111	83.70889
3	0.007585	18.30945	81.69055
4	0.008540	22.22299	77.77701
5	0.008872	22.43751	77.56249
6	0.009472	25.09120	74.90880
7	0.009907	26.15266	73.84734
8	0.010297	27.13884	72.86116
9	0.010585	26.67640	73.32360
10	0.010930	27.23984	72.76016

Cholesky Ordering: EU GR

Table 19

AUSTRIA

1980-1999

Vector Autoregression Estimates

Standard errors in ( )
& t-statistics in [ ]

	EU	AU
EU (-1)	-0.238236	0.085830
	(0.08393)	(0.08131)
	[-2.83856]	[1.05559]
EU(-2)	-0.200952	0.137458
	(0.08357)	(0.08096)
	[-2.40470]	[1.69786]
EU(-3)	-0.220889	0.173839
	(0.08402)	(0.08140)
	[-2.62908]	[2.13570]
EU(-4)	0.695667	0.169355
	(0.08390)	(0.08128)
	[8.29203]	[2.08364]
AU(-1)	0.385326	-0.002016
	(0.13158)	(0.12748)
	[2.92835]	[-0.01582]
AU(-2)	0.053486	-0.261513
	(0.13821)	(0.13389)
	[0.38700]	[-1.95315]
AU(-3)	0.197026	-0.181649
	(0.13604)	(0.13180)
	[1.44828]	[-1.37825]
AU(-4)	-0.005440	-0.071901
	(0.13716)	(0.13288)
	[-0.03966]	[-0.54110]
C	0.001985	0.005913

	(0.00161)	(0.00156)
	[1.23573]	[3.80049]
R-squared	0.858733	0.145575
Adj. R-squared	0.841610	0.042008
Sum sq. resids	0.003296	0.003093
S.E. equation	0.007067	0.006846
F-statistic	50.15013	1.405618
Log likelihood	269.8021	272.1793
Akaike AIC	-6.954722	-7.018115
Schwarz SC	-6.676623	-6.740016
Mean dependent	0.005913	0.005974
S.D. dependent	0.017756	0.006995

Determinant resid covariance (dof adj.)	2.13E-09
Determinant resid covariance	1.65E-09
Log likelihood	545.5891
Akaike information criterion	-14.06904
Schwarz criterion	-13.51284

Table 20

1980-1999	Obs	F-Statistic	Prob.
AU does not Granger Cause EU	75	2.40364	0.0584
EU does not Granger Cause AU		1.63045	0.1770

Table 21

AUSTRIA

2000-2010

Vector Autoregression Estimates

Standard errors in ( )
& t-statistics in [ ]

	EU	AU
EU(-1)	0.112243	0.246398
	(0.14920)	(0.12148)
	[0.75232]	[2.02838]
EU(-2)	0.019705	0.262500
	(0.14738)	(0.11999)
	[0.13371]	[2.18762]
EU(-3)	0.110745	0.220821
	(0.14585)	(0.11875)
	[0.75928]	[1.85948]
EU(-4)	0.856102	0.245654
	(0.14174)	(0.11540)
	[6.04000]	[2.12866]
AU(-1)	0.466544	0.834782
	(0.25108)	(0.20443)
	[1.85817]	[4.08353]
AU(-2)	-0.583350	-0.984218
	(0.28914)	(0.23542)
	[-2.01750]	[-4.18067]
AU(-3)	0.374317	0.298616
	(0.31602)	(0.25730)
	[1.18447]	[1.16055]
AU(-4)	-0.906134	-0.383708
	(0.22060)	(0.17961)
	[-4.10759]	[-2.13632]

C	0.002323	0.002626
	(0.00122)	(0.00099)
	[1.90507]	[2.64499]

R-squared	0.737961	0.660078
Adj. R-squared	0.678066	0.582381
Sum sq. resids	0.001223	0.000810
S.E. equation	0.005910	0.004812
F-statistic	12.32097	8.495585
Log likelihood	168.3683	177.4125
Akaike AIC	-7.244012	-7.655113
Schwarz SC	-6.879064	-7.290165
Mean dependent	0.002269	0.004124
S.D. dependent	0.010416	0.007446

Determinant resid covariance (dof adj.)	5.30E-10
Determinant resid covariance	3.35E-10
Log likelihood	355.0935
Akaike information criterion	-15.32243
Schwarz criterion	-14.59254

Table 22

Null Hypothesis:	Obs	F-Statistic	Prob.
AU does not Granger Cause EU	44	8.12934	0.0001
EU does not Granger Cause AU		1.55753	0.2073

Table 23

FINLAND

Null Hypothesis: EU has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic based on SIC, MAXLAG=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.925975	0.0025
Test critical values:	1% level	-3.486551	
	5% level	-2.886074	
	10% level	-2.579931	

Null Hypothesis: FI has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic based on SIC, MAXLAG=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.526800	0.0000
Test critical values:	1% level	-3.485115	
	5% level	-2.885450	
	10% level	-2.579598	

Table 24

FINLAND

1980-1999

Vector Autoregression Estimates

Standard errors in ( )
& t-statistics in [ ]

	EU	FI
EU(-1)	0.056310	0.071745
	(0.11306)	(0.15311)
	[0.49803]	[0.46857]
EU(-2)	-0.147748	-0.269354
	(0.06438)	(0.08719)
	[-2.29483]	[-3.08932]
EU(-3)	-0.137686	-0.129316
	(0.06783)	(0.09185)
	[-2.02993]	[-1.40784]
EU(-4)	0.727742	-0.109464
	(0.06731)	(0.09115)
	[10.8116]	[-1.20086]
EU(-5)	-0.242004	-0.236980
	(0.10817)	(0.14648)
	[-2.23730]	[-1.61779]
FI(-1)	-0.004522	-0.018809
	(0.09177)	(0.12428)
	[-0.04928]	[-0.15135]
FI(-2)	0.042231	0.331311
	(0.08938)	(0.12104)
	[0.47250]	[2.73722]
FI(-3)	-0.115756	0.384814
	(0.08236)	(0.11154)

	[-1.40547]	[3.45016]
FI(-4)	0.003154	-0.014326
	(0.07668)	(0.10384)
	[0.04114]	[-0.13797]
FI(-5)	0.263306	0.003713
	(0.07570)	(0.10252)
	[3.47821]	[0.03622]
C	0.003258	0.005712
	(0.00157)	(0.00212)
	[2.07880]	[2.69160]

R-squared	0.877202	0.434190
Adj. R-squared	0.857710	0.344379
Sum sq. resids	0.002878	0.005279
S.E. equation	0.006759	0.009154
F-statistic	45.00382	4.834483
Log likelihood	270.7186	248.2797
Akaike AIC	-7.019422	-6.412965
Schwarz SC	-6.676926	-6.070468
Mean dependent	0.005931	0.006171
S.D. dependent	0.017919	0.011305

Determinant resid covariance (dof adj.)	3.79E-09
Determinant resid covariance	2.75E-09
Log likelihood	519.3800
Akaike information criterion	-13.44270
Schwarz criterion	-12.75771

Table 25

Pairwise Granger Causality Tests

Sample: 1980Q1 1999Q4
Lags: 5

Null Hypothesis:	Obs	F-Statistic	Prob.
FI does not Granger Cause EU	74	3.57165	0.0066
EU does not Granger Cause FI		2.42281	0.0451

Table 26

FINLAND

2000-2010

Vector Autoregression Estimates

Sample: 2000Q1 2010
Included observations: 44
Standard errors in ( ) & statistics in [ ]

	EU	FI
EU(-1)	0.103211	0.881251
	(0.23608)	(0.42495)
	[0.43718]	[2.07379]
EU(-2)	-0.029312	0.511306
	(0.23898)	(0.43016)
	[-0.12266]	[1.18864]
EU(-3)	0.183002	0.911924
	(0.21423)	(0.38561)
	[0.85424]	[2.36490]
EU(-4)	0.858816	0.604391
	(0.22920)	(0.41256)
	[3.74698]	[1.46497]
FI(-1)	0.223364	0.117386
	(0.16050)	(0.28890)
	[1.39168]	[0.40632]
FI(-2)	-0.144119	-0.480182
	(0.14772)	(0.26590)
	[-0.97560]	[-1.80587]
FI(-3)	-0.124120	-0.249592
	(0.14451)	(0.26011)
	[-0.85892]	[-0.95956]
FI(-4)	-0.321595	-0.292992
	(0.11609)	(0.20897)

	[-2.77014]	[-1.40210]
C	0.001139	0.001806
	(0.00112)	(0.00202)
	[1.01517]	[0.89402]

R-squared	0.692119	0.395310
Adj. R-squared	0.621746	0.257095
Sum sq. resids	0.001421	0.004604
S.E. equation	0.006372	0.011469
F-statistic	9.835018	2.860111
Log likelihood	165.0614	139.1991
Akaike AIC	-7.093700	-5.918140
Schwarz SC	-6.728752	-5.553192
Mean dependent	0.002298	0.005059
S.D. dependent	0.010360	0.013306

Determinant resid covariance (dof adj.)	1.34E-09
Determinant resid covariance	8.46E-10
Log likelihood	334.7297
Akaike information criterion	-14.39681
Schwarz criterion	-13.66691

Table 27

FINLAND

Pairwise Granger Causality Tests

Sample: 2000Q1 2010Q4
Lags: 4

Null Hypothesis:	Obs	F-Statistic	Prob.
FI does not Granger Cause EU	44	5.57523	0.0014
EU does not Granger Cause FI		1.67181	0.1785

Table 28

FRANCE

1980-1999

Null Hypothesis: EU has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.860312	0.0549
Test critical values:	1% level	-3.520307	
	5% level	-2.900670	
	10% level	-2.587691	

Null Hypothesis: FR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.378279	0.0000
Test critical values:	1% level	-3.516676	
	5% level	-2.899115	
	10% level	-2.586866	

Table 29

FRANCE

Vector Autoregression Estimates

Sample (adjusted): 1981Q2 1999Q4
Included observations: 75 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	EU	FR
EU (-1)	-0.156588	-0.041181
	(0.07495)	(0.04559)
	[-2.08930]	[-0.90338]
EU (-2)	-0.146241	-0.010711
	(0.07482)	(0.04551)
	[-1.95459]	[-0.23537]
EU (-3)	-0.147186	-0.010981
	(0.07502)	(0.04563)
	[-1.96183]	[-0.24064]
EU (-4)	0.778996	-0.001789
	(0.07508)	(0.04566)
	[10.3760]	[-0.03919]
FR(-1)	0.164952	0.361372
	(0.20600)	(0.12530)
	[0.80073]	[2.88415]
FR(-2)	0.242428	0.265310
	(0.21455)	(0.13050)
	[1.12992]	[2.03308]
FR(-3)	0.012471	0.173854
	(0.21526)	(0.13093)
	[0.05793]	[1.32787]
FR(-4)	-0.342820	-0.182907
	(0.20125)	(0.12240)
	[-1.70347]	[-1.49429]
C	0.002692	0.002454
	(0.00147)	(0.00090)

	[1.82838]	[2.74057]
R-squared	0.872226	0.290594
Adj. R-squared	0.856739	0.204605
Sum sq. resids	0.002907	0.001075
S.E. equation	0.006637	0.004037
F-statistic	56.31725	3.379443
Log likelihood	274.5101	311.8006
Akaike AIC	-7.080268	-8.074683
Schwarz SC	-6.802170	-7.796585
Mean dependent	0.004746	0.005490
S.D. dependent	0.017534	0.004526

Determinant resid covariance (dof adj.)	5.95E-10
Determinant resid covariance	4.61E-10
Log likelihood	593.3181
Akaike information criterion	-15.34182
Schwarz criterion	-14.78562

Table 30

Pairwise Granger Causality Tests

Sample: 1980Q1 1999Q4
Lags: 4

Null Hypothesis:	Obs	F-Statistic	Prob.
FR does not Granger Cause EU	75	1.13654	0.3471
EU does not Granger Cause		0.46275	0.7628

Table 31

FRANCE

Vector Autoregression Estimates

Sample: 2000Q1 2010Q4
Included observations: 44
Standard errors in ( ) & t-statistics in [ ]

	EU	FR
EU(-1)	-0.308871	0.021015
	(0.16520)	(0.17152)
	[-1.86972]	[0.12252]
EU(-2)	-0.412783	-0.048770
	(0.16306)	(0.16930)
	[-2.53148]	[-0.28807]
EU(-3)	-0.279212	0.011156
	(0.16724)	(0.17364)
	[-1.66949]	[0.06424]
EU(-4)	0.515911	-0.020592
	(0.15473)	(0.16065)
	[3.33418]	[-0.12818]
FR(-1)	0.890211	0.394584
	(0.17871)	(0.18555)
	[4.98123]	[2.12656]
FR(-2)	0.418777	0.247353
	(0.22985)	(0.23864)
	[1.82200]	[1.03652]
FR(-3)	0.069723	-0.033569
	(0.22841)	(0.23715)
	[0.30525]	[-0.14155]
FR(-4)	-0.326921	-0.089585
	(0.19871)	(0.20632)
	[-1.64519]	[-0.43421]

C	-0.001052	0.001569
	(0.00118)	(0.00123)
	[-0.88990]	[1.27860]

R-squared	0.799708	0.296342
Adj. R-squared	0.753927	0.135506
Sum sq. resids	0.000861	0.000928
S.E. equation	0.004959	0.005149
F-statistic	17.46811	1.842513
Log likelihood	176.0893	174.4374
Akaike AIC	-7.594968	-7.519881
Schwarz SC	-7.230021	-7.154933
Mean dependent	0.001654	0.003349
S.D. dependent	0.009997	0.005538

Determinant resid covariance (dof adj.)	4.60E-10
Determinant resid covariance	2.91E-10
Log likelihood	358.1931
Akaike information criterion	-15.46332
Schwarz criterion	-14.73343

Table 32

Pairwise Granger Causality Tests

Sample: 2000Q1 2010Q4
Lags: 4

Null Hypothesis:	Obs	F-Statistic	Prob.
FR does not Granger Cause EU	44	10.4265	1.E-05
EU does not Granger Cause FR		0.08034	0.9879

Table 33

GERMANY

Null Hypothesis: GE has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.951302	0.0443
Test critical values:	1% level	-3.520307	
	5% level	-2.900670	
	10% level	-2.587691	

Null Hypothesis: DEU_DGE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.912595	0.0001
Test critical values:	1% level	-3.516676	
	5% level	-2.899115	
	10% level	-2.586866	

Table 34

GERMANY

Vector Autoregression Estimates

Sample (adjusted): 1981Q2 1999Q4
Included observations: 75 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	EU	GE
EU(-1)	0.410145	0.603808
	(0.12176)	(0.92555)
	[3.36835]	[0.65238]
EU(-2)	0.319416	0.561014
	(0.12863)	(0.97777)
	[2.48313]	[0.57377]
EU(-3)	0.113040	0.027248
	(0.12992)	(0.98753)
	[0.87008]	[0.02759]
EU(-4)	-0.132790	-0.193851
	(0.11940)	(0.90758)
	[-1.11214]	[-0.21359]
GE(-1)	-0.015254	-0.204192
	(0.01030)	(0.07830)
	[-1.48093]	[-2.60793]
GE(-2)	-0.013681	-0.193772
	(0.01037)	(0.07884)
	[-1.31895]	[-2.45766]
GE(-3)	-0.004674	-0.192961
	(0.01050)	(0.07982)
	[-0.44511]	[-2.41750]
GE(-4)	-0.004367	0.745058
	(0.01051)	(0.07992)
	[-0.41529]	[9.32227]
C	0.001420	0.002060

	(0.00051)	(0.00391)
	[2.75913]	[0.52652]
R-squared	0.394846	0.885116
Adj. R-squared	0.321494	0.871190
Sum sq. resids	0.000336	0.019397
S.E. equation	0.002255	0.017143
F-statistic	5.382887	63.56134
Log likelihood	355.4568	203.3342
Akaike AIC	-9.238848	-5.182245
Schwarz SC	-8.960750	-4.904147
Mean dependent	0.003808	0.007400
S.D. dependent	0.002738	0.047766

Determinant resid covariance (dof adj.)	1.44E-09
Determinant resid covariance	1.12E-09
Log likelihood	560.1267
Akaike information criterion	-14.45671
Schwarz criterion	-13.90051

Table 35

Pairwise Granger Causality Tests

Sample: 1980Q1 1999Q4
Lags: 4

Null Hypothesis:	Obs	F-Statistic	Prob.
GE does not Granger Cause EU	75	1.19869	0.3197
EU does not Granger Cause GE		0.38898	0.8158

Table 36

GERMANY

Vector Autoregression Estimates

Sample: 2000Q1 2010Q4
Included observations: 44
Standard errors in ( ) & t-statistics in [ ]

	EU	GE
EU(-1)	0.972545	2.293922
	(0.16246)	(0.48978)
	[5.98628]	[4.68362]
EU(-2)	-0.234247	-0.683390
	(0.23276)	(0.70169)
	[-1.00640]	[-0.97392]
EU(-3)	0.350046	1.131289
	(0.22549)	(0.67980)
	[1.55236]	[1.66416]
EU(-4)	-0.223905	-2.014778
	(0.16027)	(0.48315)
	[-1.39708]	[-4.17006]
GE(-1)	-0.058552	-0.384376
	(0.03990)	(0.12029)
	[-1.46746]	[-3.19546]
GE(-2)	-0.056721	-0.425036
	(0.04022)	(0.12126)
	[-1.41019]	[-3.50522]
GE(-3)	-0.056619	-0.352301
	(0.04084)	(0.12312)
	[-1.38641]	[-2.86155]
GE(-4)	-0.049595	0.556080
	(0.03815)	(0.11500)

	[-1.30007]	[4.83530]
C	0.000437	0.000382
	(0.00057)	(0.00173)
	[0.76385]	[0.22112]
R-squared	0.635208	0.929181
Adj. R-squared	0.551827	0.912993
Sum sq. resids	0.000298	0.002710
S.E. equation	0.002919	0.008800
F-statistic	7.618143	57.40181
Log likelihood	199.4094	150.8553
Akaike AIC	-8.654972	-6.447970
Schwarz SC	-8.290024	-6.083022
Mean dependent	0.002301	0.000715
S.D. dependent	0.004360	0.029832

Determinant resid covariance (dof adj.)	6.15E-10
Determinant resid covariance	3.89E-10
Log likelihood	351.8118
Akaike information criterion	-15.17326
Schwarz criterion	-14.44337

Table 37

Pairwise Granger Causality Tests

Sample: 2000Q1 2010Q4
Lags: 4

Null Hypothesis:	Obs	F-Statistic	Prob.
GE does not Granger Cause EU	44	0.57003	0.6861
EU does not Granger Cause GE		11.4151	5.E-06

Table 38

ITALY

Null Hypothesis: EU has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.986333	0.0408
Test critical values:	1% level	-3.520307	
	5% level	-2.900670	
	10% level	-2.587691	

Null Hypothesis: IT has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.459867	0.0000
Test critical values:	1% level	-3.516676	
	5% level	-2.899115	
	10% level	-2.586866	

Table 39

ITALY

Vector Autoregression Estimates

Sample (adjusted): 1981Q2 1999Q4
Included observations: 75 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	EU	IT
EU(-1)	-0.204899	0.069389
	(0.07757)	(0.06575)
	[-2.64136]	[1.05537]
EU(-2)	-0.195503	0.028151
	(0.07857)	(0.06659)
	[-2.48841]	[0.42276]
EU(-3)	-0.194502	0.035817
	(0.07897)	(0.06693)
	[-2.46294]	[0.53511]
EU(-4)	0.725273	0.056097
	(0.07817)	(0.06626)
	[9.27781]	[0.84666]
IT(-1)	0.371406	0.260427
	(0.14790)	(0.12536)
	[2.51112]	[2.07745]
IT(-2)	-0.076573	-0.007981
	(0.15218)	(0.12898)
	[-0.50317]	[-0.06188]
IT(-3)	0.100367	0.202449
	(0.14901)	(0.12630)
	[0.67354]	[1.60293]
IT(-4)	-0.098114	-0.225227
	(0.14655)	(0.12421)

	[-0.66948]	[-1.81323]
C	0.003137	0.002948
	(0.00138)	(0.00117)
	[2.27962]	[2.52762]
R-squared	0.869584	0.161192
Adj. R-squared	0.853776	0.059518
Sum sq. resids	0.003007	0.002160
S.E. equation	0.006750	0.005721
F-statistic	55.00916	1.585386
Log likelihood	273.2397	285.6438
Akaike AIC	-7.046392	-7.377167
Schwarz SC	-6.768294	-7.099068
Mean dependent	0.005303	0.004923
S.D. dependent	0.017652	0.005899

Determinant resid covariance (dof adj.)	1.34E-09
Determinant resid covariance	1.04E-09
Log likelihood	562.8924
Akaike information criterion	-14.53046
Schwarz criterion	-13.97427

Table 40

Pairwise Granger Causality Tests

Sample: 1980Q1 1999Q4
Lags: 4

Null Hypothesis:	Obs	F-Statistic	Prob.
IT does not Granger Cause EU	75	1.69878	0.1608
EU does not Granger Cause IT		0.39721	0.8099

Table 41

ITALY

Vector Autoregression Estimates

Sample: 2000Q1 2010Q4
Included observations: 44
Standard errors in ( ) & t-statistics in [ ]

	EU	IT
EU(-1)	-0.232507	-0.045032
	(0.15478)	(0.20485)
	[-1.50213]	[-0.21984]
EU(-2)	-0.311301	-0.108386
	(0.15286)	(0.20229)
	[-2.03655]	[-0.53578]
EU(-3)	-0.187734	-0.032175
	(0.15249)	(0.20181)
	[-1.23110]	[-0.15943]
EU(-4)	0.641659	-0.033308
	(0.14796)	(0.19582)
	[4.33657]	[-0.17010]
IT(-1)	0.750277	0.733568
	(0.14278)	(0.18895)
	[5.25487]	[3.88224]
IT(-2)	-0.050127	-0.089188
	(0.18869)	(0.24972)
	[-0.26566]	[-0.35716]
IT(-3)	0.200583	0.193344
	(0.17492)	(0.23149)
	[1.14672]	[0.83521]
IT(-4)	-0.439387	-0.162423
	(0.15059)	(0.19929)

	[-2.91784]	[-0.81502]
C	0.001861	0.000768
	(0.00114)	(0.00151)
	[1.62969]	[0.50828]
R-squared	0.826537	0.452634
Adj. R-squared	0.786889	0.327521
Sum sq. resids	0.000724	0.001269
S.E. equation	0.004550	0.006021
F-statistic	20.84658	3.617819
Log likelihood	179.8810	167.5514
Akaike AIC	-7.767320	-7.206881
Schwarz SC	-7.402372	-6.841933
Mean dependent	0.002183	0.001140
S.D. dependent	0.009855	0.007342

Determinant resid covariance (dof adj.)	4.57E-10
Determinant resid covariance	2.89E-10
Log likelihood	358.3553
Akaike information criterion	-15.47069
Schwarz criterion	-14.74080

Table 42

Pairwise Granger Causality Tests

Sample: 2000Q1 2010Q4
Lags: 4

Null Hypothesis:	Obs	F-Statistic	Prob.
IT does not Granger Cause EU	44	12.5570	2.E-06
EU does not Granger Cause IT		0.14332	0.9648

Table 43

Null Hypothesis:

NE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.16795	0.0000
Test critical values:	1% level	-3.516676	
	5% level	-2.899115	
	10% level	-2.586866	

Table 44

THE NETHERLANDS

Vector Autoregression Estimates

Sample (adjusted): 1981Q2 1999Q4
Included observations: 75 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	EU	NE
EU(-1)	-0.203281	0.059676
	(0.07681)	(0.09693)
	[-2.64645]	[0.61565]
EU(-2)	-0.187498	0.107938
	(0.07663)	(0.09670)
	[-2.44691]	[1.11625]
EU(-3)	-0.193167	0.186053
	(0.07496)	(0.09459)
	[-2.57700]	[1.96691]
EU(-4)	0.713877	0.085179
	(0.07608)	(0.09600)
	[9.38362]	[0.88725]
NE(-1)	0.091030	-0.117178
	(0.09863)	(0.12447)
	[0.92292]	[-0.94144]
NE(-2)	0.260111	0.128828
	(0.09604)	(0.12120)
	[2.70826]	[1.06294]
NE(-3)	0.051476	-0.002836
	(0.10096)	(0.12741)
	[0.50986]	[-0.02226]
NE(-4)	0.014974	-0.046613
	(0.09335)	(0.11779)

	[0.16041]	[-0.39571]
C	0.002137	0.004849
	(0.00155)	(0.00195)
	[1.38031]	[2.48201]
R-squared	0.858961	0.101799
Adj. R-squared	0.841865	-0.007074
Sum sq. resids	0.003313	0.005275
S.E. equation	0.007085	0.008940
F-statistic	50.24439	0.935028
Log likelihood	269.6102	252.1624
Akaike AIC	-6.949606	-6.484331
Schwarz SC	-6.671508	-6.206232
Mean dependent	0.005693	0.006813
S.D. dependent	0.017816	0.008909

Determinant resid covariance (dof adj.)	3.90E-09
Determinant resid covariance	3.02E-09
Log likelihood	522.8039
Akaike information criterion	-13.46144
Schwarz criterion	-12.90524

Table 45

Pairwise Granger Causality Tests

Sample: 1980Q1 1999Q4
Lags: 4

Null Hypothesis:	Obs	F-Statistic	Prob.
NE does not Granger Cause EU	75	1.88932	0.1227
EU does not Granger Cause NE		1.25018	0.2985

Table 46

THE NETHERLANDS

Vector Autoregression Estimates

Sample: 2000Q1 2010Q4
Included observations: 44
Standard errors in ( ) & t-statistics in [ ]

	EU	NE
EU(-1)	0.083195	0.167333
	(0.16940)	(0.16872)
	[0.49112]	[0.99180]
EU(-2)	-0.001937	0.310783
	(0.15986)	(0.15922)
	[-0.01212]	[1.95195]
EU(-3)	0.052596	0.125288
	(0.17267)	(0.17198)
	[0.30460]	[0.72852]
EU(-4)	0.866469	0.241591
	(0.15172)	(0.15111)
	[5.71084]	[1.59874]
NE(-1)	0.366619	0.524618
	(0.22549)	(0.22459)
	[1.62585]	[2.33594]
NE(-2)	-0.151664	-0.448646
	(0.23228)	(0.23135)
	[-0.65293]	[-1.93926]
NE(-3)	-0.080972	0.180491
	(0.24142)	(0.24044)
	[-0.33541]	[0.75066]
NE(-4)	-0.635293	-0.365689
	(0.17221)	(0.17152)
	[-3.68897]	[-2.13203]

C	0.002011	0.002139
	(0.00112)	(0.00112)
	[1.79219]	[1.91339]
R-squared	0.726995	0.464084
Adj. R-squared	0.664593	0.341589
Sum sq. resids	0.001243	0.001233
S.E. equation	0.005960	0.005936
F-statistic	11.65032	3.788590
Log likelihood	167.9978	168.1751
Akaike AIC	-7.227171	-7.235233
Schwarz SC	-6.862223	-6.870285
Mean dependent	0.002164	0.003599
S.D. dependent	0.010291	0.007316

Determinant resid covariance (dof adj.)	5.59E-10
Determinant resid covariance	3.54E-10
Log likelihood	353.9157
Akaike information criterion	-15.26890
Schwarz criterion	-14.53900

Table 47

Pairwise Granger Causality Tests

Sample: 2000Q1 2010Q4
Lags: 4

Null Hypothesis:	Obs	F-Statistic	Prob.
NE does not Granger Cause EU	44	6.70084	0.0004
EU does not Granger Cause NE		1.01157	0.4148

Table 48

PORTUGAL

Null Hypothesis: EU has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic based on SIC, MAXLAG=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.951070	0.0023
Test critical values:	1% level	-3.486551	
	5% level	-2.886074	
	10% level	-2.579931	

Null Hypothesis: PO has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic based on SIC, MAXLAG=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.056359	0.0016
Test critical values:	1% level	-3.485115	
	5% level	-2.885450	
	10% level	-2.579598	

Table 49

PORTUGAL

Vector Autoregression Estimates

Sample (adjusted): 1981Q2 1999Q4
Included observations: 75 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	EU	PO
EU (-1)	-0.204355	-0.004131
	(0.07693)	(0.04022)
	[-2.65627]	[-0.10273]
EU(-2)	-0.205452	1.03E-05
	(0.07738)	(0.04045)
	[-2.65500]	[0.00025]
EU(-3)	-0.207580	0.030438
	(0.07749)	(0.04051)
	[-2.67891]	[0.75146]
EU(-4)	0.704850	-0.012115
	(0.07780)	(0.04067)
	[9.05925]	[-0.29788]
PO(-1)	0.573204	1.065263
	(0.23854)	(0.12469)
	[2.40298]	[8.54309]
PO(-2)	-0.428021	-0.474831
	(0.34629)	(0.18102)
	[-1.23602]	[-2.62310]
PO(-3)	0.497662	0.482832
	(0.35748)	(0.18687)
	[1.39214]	[2.58382]
PO(-4)	-0.416083	-0.240450
	(0.24651)	(0.12886)
	[-1.68793]	[-1.86602]
C	0.003660	0.001212
	(0.00146)	(0.00076)

	[2.50470]	[1.58687]
R-squared	0.855790	0.760933
Adj. R-squared	0.838311	0.731955
Sum sq. resids	0.003382	0.000924
S.E. equation	0.007159	0.003742
F-statistic	48.95843	26.25915
Log likelihood	268.8300	317.4809
Akaike AIC	-6.928799	-8.226157
Schwarz SC	-6.650700	-7.948058
Mean dependent	0.006019	0.007634
S.D. dependent	0.017803	0.007228

Determinant resid covariance (dof adj.)	7.08E-10
Determinant resid covariance	5.48E-10
Log likelihood	586.8135
Akaike information criterion	-15.16836
Schwarz criterion	-14.61216

Table 50

Pairwise Granger Causality Tests

Sample: 1980Q1 1999Q4
Lags: 4

Null Hypothesis:	Obs	F-Statistic	Prob.
PO does not Granger Cause EU	75	2.21082	0.0773
EU does not Granger Cause PO		0.58957	0.6713

Table 51

Vector Autoregression Estimates

Sample: 2000Q1 2010Q4
Included observations: 44
Standard errors in ( ) & t-statistics in [ ]

	EU	PO
EU(-1)	0.328378	0.263853
	(0.17004)	(0.23959)
	[1.93115]	[1.10126]
EU(-2)	-0.172953	0.112592
	(0.13357)	(0.18819)
	[-1.29490]	[0.59828]
EU(-3)	-0.060776	0.223019
	(0.13466)	(0.18974)
	[-0.45132]	[1.17538]
EU(-4)	0.644972	-0.077126
	(0.12786)	(0.18015)
	[5.04450]	[-0.42812]
EU(-5)	-0.380152	-0.107724
	(0.15795)	(0.22256)
	[-2.40676]	[-0.48403]
PO(-1)	0.179307	-0.134770
	(0.14452)	(0.20362)
	[1.24075]	[-0.66186]
PO(-2)	0.112838	-0.084321
	(0.14787)	(0.20835)
	[0.76308]	[-0.40470]
PO(-3)	0.001300	-0.024760
	(0.15098)	(0.21273)
	[0.00861]	[-0.11639]
PO(-4)	-0.156404	0.025279
	(0.14651)	(0.20644)
	[-1.06752]	[0.12246]

PO(-5)	-0.180445	0.040213
	(0.13834)	(0.19492)
	[-1.30440]	[0.20631]
C	0.001702	0.001415
	(0.00116)	(0.00164)
	[1.46141]	[0.86211]

R-squared	0.704532	0.135666
Adj. R-squared	0.614996	-0.126254
Sum sq. resids	0.001402	0.002783
S.E. equation	0.006517	0.009183
F-statistic	7.868714	0.517966
Log likelihood	165.3613	150.2743
Akaike AIC	-7.016420	-6.330649
Schwarz SC	-6.570373	-5.884602
Mean dependent	0.002358	0.002145
S.D. dependent	0.010503	0.008653

Determinant resid covariance (dof adj.)	2.41E-09
Determinant resid covariance	1.36E-09
Log likelihood	324.3308
Akaike information criterion	-13.74231
Schwarz criterion	-12.85022

Table 52

Pairwise Granger Causality Tests

Sample: 2000Q1 2010Q4
Lags: 5

Null Hypothesis:	Obs	F-Statistic	Prob.
PO does not Granger Cause EU	44	0.79731	0.5595
EU does not Granger Cause PO		0.87628	0.5077

Table 53

Chow Breakpoint Test: 2000Q1
Null Hypothesis: No breaks at specified breakpoints

Equation Sample: 1981Q2 2010Q4

F-statistic	4.058009	Prob. F(9,101)	0.0002
Log likelihood ratio	36.73101	Prob. Chi-Square(9)	0.0000
Wald Statistic	36.52208	Prob. Chi-Square(9)	0.0000

Table 54

GREECE

Null Hypothesis: EU has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic based on SIC, MAXLAG=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.932193	0.0025
Test critical values:	1% level	-3.486551	
	5% level	-2.886074	
	10% level	-2.579931	

Null Hypothesis: GR has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic based on SIC, MAXLAG=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.902977	0.0027
Test critical values:	1% level	-3.486551	
	5% level	-2.886074	
	10% level	-2.579931	

Table 55

GREECE

Vector Autoregression Estimates

Sample (adjusted): 1981Q2 1999Q4
Included observations: 75 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	EU	GR
EU(-1)	-0.173121	0.479753
	(0.07651)	(0.22742)
	[-2.26270]	[2.10955]
EU(-2)	-0.119897	0.242160
	(0.08028)	(0.23861)
	[-1.49355]	[1.01487]
EU(-3)	-0.122117	-0.080802
	(0.08140)	(0.24194)
	[-1.50030]	[-0.33398]
EU(-4)	0.762013	0.362382
	(0.07958)	(0.23653)
	[9.57573]	[1.53205]
GR(-1)	0.032208	-0.469433
	(0.04384)	(0.13031)
	[0.73467]	[-3.60242]
GR(-2)	-0.026456	-0.502838
	(0.04740)	(0.14088)
	[-0.55819]	[-3.56933]
GR(-3)	0.003099	-0.234103
	(0.04549)	(0.13523)
	[0.06812]	[-1.73117]
GR(-4)	0.023343	0.014046
	(0.04174)	(0.12406)
	[0.55928]	[0.11322]
C	0.003987	0.002823
	(0.00150)	(0.00446)

	[2.65696]	[0.63306]
R-squared	0.840365	0.446788
Adj. R-squared	0.821016	0.379732
Sum sq. resids	0.003701	0.032695
S.E. equation	0.007488	0.022257
F-statistic	43.43046	6.662914
Log likelihood	265.4579	183.7558
Akaike AIC	-6.838878	-4.660154
Schwarz SC	-6.560779	-4.382055
Mean dependent	0.006068	0.003884
S.D. dependent	0.017699	0.028260

Determinant resid covariance (dof adj.)	2.43E-08
Determinant resid covariance	1.88E-08
Log likelihood	454.2644
Akaike information criterion	-11.63372
Schwarz criterion	-11.07752

Table 56

Pairwise Granger Causality Tests

Sample: 1980Q1 1999Q4
Lags: 4

Null Hypothesis:	Obs	F-Statistic	Prob.
GR does not Granger Cause EU	75	0.53791	0.7084
EU does not Granger Cause GR		2.20014	0.0785

Table 57

GREECE

Vector Autoregression Estimates

Sample: 2000Q1 2010Q4
Included observations: 44
Standard errors in ( ) & t-statistics in [ ]

	EU	GR
EU(-1)	0.524020	0.104291
	(0.13663)	(0.13747)
	[3.83541]	[0.75865]
EU(-2)	-0.224996	0.009499
	(0.11304)	(0.11374)
	[-1.99034]	[0.08352]
EU(-3)	-0.175164	0.101975
	(0.11958)	(0.12031)
	[-1.46486]	[0.84757]
EU(-4)	0.641208	-0.079594
	(0.11188)	(0.11257)
	[5.73103]	[-0.70704]
EU(-5)	-0.677500	0.083113
	(0.14575)	(0.14665)
	[-4.64829]	[0.56674]
GR(-1)	-0.091898	0.279383
	(0.15953)	(0.16052)
	[-0.57604]	[1.74051]
GR(-2)	0.153803	0.337844
	(0.12422)	(0.12499)
	[1.23810]	[2.70296]
GR(-3)	0.059739	0.292098
	(0.12185)	(0.12260)

	[0.49027]	[2.38252]
GR(-4)	0.050531	-0.027220
	(0.12775)	(0.12854)
	[0.39555]	[-0.21177]
GR(-5)	0.041344	-0.005731
	(0.11441)	(0.11512)
	[0.36136]	[-0.04979]
C	0.000584	-0.000680
	(0.00160)	(0.00161)
	[0.36508]	[-0.42269]

R-squared	0.698477	0.629811
Adj. R-squared	0.607106	0.517632
Sum sq. resids	0.001429	0.001447
S.E. equation	0.006581	0.006622
F-statistic	7.644430	5.614360
Log likelihood	164.9323	164.6618
Akaike AIC	-6.996921	-6.984628
Schwarz SC	-6.550874	-6.538581
Mean dependent	0.002273	0.005635
S.D. dependent	0.010499	0.009534

Determinant resid covariance (dof adj.)	1.64E-09
Determinant resid covariance	9.21E-10
Log likelihood	332.8578
Akaike information criterion	-14.12990
Schwarz criterion	-13.23780

Table 58

Pairwise Granger Causality Tests

Sample: 2000Q1 2010Q4
Lags: 5

Null Hypothesis:	Obs	F-Statistic	Prob.
GR does not Granger Cause EU	44	0.56566	0.7256
EU does not Granger Cause GR		0.60209	0.6986

Table 59

Chow Breakpoint Test: 2000Q1
Null Hypothesis: No breaks at specified breakpoints

Equation Sample: 1981Q3 2010Q4

F-statistic	2.042247	Prob. F(11,96)	0.0323
Log likelihood ratio	24.81151	Prob. Chi-Square(11)	0.0097
Wald Statistic	22.46472	Prob. Chi-Square(11)	0.0210

Table 60

Null Hypothesis: EU has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic based on SIC, MAXLAG=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.943088	0.0024
Test critical values:	1% level	-3.486551	
	5% level	-2.886074	
	10% level	-2.579931	

Null Hypothesis: IR has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic based on SIC, MAXLAG=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.974648	0.0402
Test critical values:	1% level	-3.485586	
	5% level	-2.885654	
	10% level	-2.579708	

Table 61

IRELAND

Vector Autoregression Estimates

Sample (adjusted): 1981Q4 1999Q4
Included observations: 73 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	EU	IR
EU(-1)	0.005160	0.007361
	(0.12887)	(0.04118)
	[0.04004]	[0.17875]
EU(-2)	-0.134316	-0.032650
	(0.12632)	(0.04036)
	[-1.06334]	[-0.80894]
EU(-3)	-0.158656	-0.001330
	(0.07441)	(0.02378)
	[-2.13218]	[-0.05593]
EU(-4)	0.755533	0.003212
	(0.07457)	(0.02383)
	[10.1320]	[0.13480]
EU(-5)	-0.173948	-0.011788
	(0.12109)	(0.03869)
	[-1.43653]	[-0.30467]
EU(-6)	-0.022337	0.027608
	(0.12148)	(0.03882)
	[-0.18388]	[0.71124]
IR(-1)	0.040445	1.681055
	(0.36237)	(0.11579)
	[0.11161]	[14.5183]
IR(-2)	0.043992	-0.865890
	(0.61261)	(0.19575)
	[0.07181]	[-4.42343]
IR(-3)	-0.341415	0.255321
	(0.61459)	(0.19638)

	[-0.55552]	[1.30012]
IR(-4)	0.223147	-0.837232
	(0.61780)	(0.19741)
	[0.36120]	[-4.24111]
IR(-5)	0.490282	1.165224
	(0.61743)	(0.19729)
	[0.79407]	[5.90613]
IR(-6)	-0.410091	-0.460561
	(0.37211)	(0.11890)
	[-1.10207]	[-3.87346]
C	0.003788	0.000981
	(0.00212)	(0.00068)
	[1.78327]	[1.44539]

R-squared	0.850331	0.942775
Adj. R-squared	0.820398	0.931330
Sum sq. resids	0.003508	0.000358
S.E. equation	0.007646	0.002443
F-statistic	28.40712	82.37413
Log likelihood	259.3465	342.6314
Akaike AIC	-6.749219	-9.030998
Schwarz SC	-6.341329	-8.623108
Mean dependent	0.005864	0.013037
S.D. dependent	0.018042	0.009323

Determinant resid covariance (dof adj.)	3.48E-10
Determinant resid covariance	2.35E-10
Log likelihood	602.0985
Akaike information criterion	-15.78352
Schwarz criterion	-14.96774

Table 62

Pairwise Granger Causality Tests

Sample: 1980Q1 1999Q4
Lags: 6

Null Hypothesis:	Obs	F-Statistic	Prob.
IR does not Granger Cause EU	73	0.60422	0.7259
EU does not Granger Cause IR		0.14504	0.9894

Table 63

IRELAND

Vector Autoregression Estimates

Sample: 2000Q1 2010Q4
Included observations: 44
Standard errors in ( ) & t-statistics in [ ]

	EU	IR
EU (-1)	0.218718	0.441524
	(0.13372)	(0.48693)
	[1.63560]	[0.90674]
EU (-2)	-0.357276	-0.054669
	(0.11899)	(0.43328)
	[-3.00261]	[-0.12617]
EU (-3)	-0.233272	-0.205886
	(0.12766)	(0.46487)
	[-1.82723]	[-0.44289]
EU (-4)	0.507879	-0.077058
	(0.11328)	(0.41248)
	[4.48349]	[-0.18682]
EU (-5)	-0.422688	-0.453111
	(0.12941)	(0.47123)
	[-3.26628]	[-0.96156]
IR(-1)	0.126064	-0.154505
	(0.04997)	(0.18196)
	[2.52273]	[-0.84910]
IR(-2)	0.165167	0.209279
	(0.05506)	(0.20050)
	[2.99963]	[1.04377]
IR(-3)	0.089467	0.377366
	(0.05794)	(0.21098)
	[1.54410]	[1.78859]

IR(-4)	0.008897	0.104202
	(0.05834)	(0.21244)
	[0.15249]	[0.49050]
IR(-5)	-0.129236	0.114390
	(0.05585)	(0.20335)
	[-2.31418]	[0.56252]
C	0.001351	0.002246
	(0.00103)	(0.00376)
	[1.30941]	[0.59763]

R-squared	0.778593	0.243725
Adj. R-squared	0.711500	0.014550
Sum sq. resids	0.001034	0.013713
S.E. equation	0.005598	0.020385
F-statistic	11.60467	1.063491
Log likelihood	172.0494	115.1857
Akaike AIC	-7.320427	-4.735715
Schwarz SC	-6.874379	-4.289667
Mean dependent	0.002272	0.007096
S.D. dependent	0.010423	0.020535

Determinant resid covariance (dof adj.)	1.11E-08
Determinant resid covariance	6.27E-09
Log likelihood	290.6576
Akaike information criterion	-12.21171
Schwarz criterion	-11.31961

Table 64

Pairwise Granger Causality Tests

Sample: 2000Q1 2010Q4
Lags: 5

Null Hypothesis:	Obs	F-Statistic	Prob.
IR does not Granger Cause EU	44	3.62269	0.0101
EU does not Granger Cause IR		0.31539	0.9002

Table 65

Chow Breakpoint Test: 2000Q1
Null Hypothesis: No breaks at specified breakpoints

Equation Sample: 1981Q3 2010Q4

F-statistic	2.464372	Prob. F(11,96)	0.0092
Log likelihood ratio	29.34831	Prob. Chi-Square(11)	0.0020
Wald Statistic	27.10809	Prob. Chi-Square(11)	0.0044

Table 66

SPAIN

Null Hypothesis: EU has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic based on SIC, MAXLAG=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.900113	0.0028
Test critical values:	1% level	-3.486551	
	5% level	-2.886074	
	10% level	-2.579931	

Null Hypothesis: SP has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic based on SIC, MAXLAG=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.985702	0.0391
Test critical values:	1% level	-3.485586	
	5% level	-2.885654	
	10% level	-2.579708	

Table 67

SPAIN

Vector Autoregression Estimates

Sample (adjusted): 1981Q2 1999Q4
Included observations: 75 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	EU	SP
EU(-1)	-0.341157	0.052379
	(0.08149)	(0.09586)
	[-4.18672]	[0.54643]
EU(-2)	-0.331828	0.028286
	(0.08183)	(0.09626)
	[-4.05516]	[0.29385]
EU(-3)	-0.335537	0.061354
	(0.08138)	(0.09574)
	[-4.12288]	[0.64086]
EU(-4)	0.582104	0.062503
	(0.08026)	(0.09441)
	[7.25277]	[0.66201]
SP(-1)	0.202394	-0.181465
	(0.10349)	(0.12174)
	[1.95569]	[-1.49057]
SP(-2)	0.292183	0.368694
	(0.10619)	(0.12491)
	[2.75159]	[2.95158]
SP(-3)	0.258004	0.267971
	(0.11764)	(0.13839)
	[2.19318]	[1.93640]
SP(-4)	0.130412	-0.119857
	(0.11477)	(0.13502)
	[1.13625]	[-0.88773]
C	0.001534	0.003940
	(0.00144)	(0.00169)

	[1.06631]	[2.32892]
R-squared	0.871044	0.232727
Adj. R-squared	0.855413	0.139724
Sum sq. resids	0.003012	0.004169
S.E. equation	0.006756	0.007947
F-statistic	55.72526	2.502361
Log likelihood	273.1741	260.9922
Akaike AIC	-7.044642	-6.719792
Schwarz SC	-6.766543	-6.441694
Mean dependent	0.005562	0.007174
S.D. dependent	0.017767	0.008568

Determinant resid covariance (dof adj.)	2.88E-09
Determinant resid covariance	2.23E-09
Log likelihood	534.1846
Akaike information criterion	-13.76492
Schwarz criterion	-13.20873

Table 68

Pairwise Granger Causality Tests

Sample: 1980Q1 1999Q4
Lags: 4

Null Hypothesis:	Obs	F-Statistic	Prob.
SP does not Granger Cause EU	75	4.14634	0.0047
EU does not Granger Cause SP		0.18005	0.9480

Table 69

SPAIN

Vector Autoregression Estimates

Sample: 2000Q1 2010Q4
Included observations: 44
Standard errors in ( ) & t-statistics in [ ]

	EU	SP
EU(-1)	-0.311677	-0.132054
	(0.12126)	(0.06673)
	[-2.57035]	[-1.97893]
EU(-2)	-0.462459	-0.204453
	(0.11938)	(0.06570)
	[-3.87377]	[-3.11204]
EU(-3)	-0.316805	-0.185129
	(0.12334)	(0.06788)
	[-2.56856]	[-2.72748]
EU(-4)	0.495941	-0.168387
	(0.11115)	(0.06117)
	[4.46186]	[-2.75286]
SP(-1)	1.409735	1.031692
	(0.25112)	(0.13819)
	[5.61382]	[7.46553]
SP(-2)	0.060980	0.163592
	(0.35890)	(0.19751)
	[0.16991]	[0.82829]
SP(-3)	0.278614	0.562864
	(0.33959)	(0.18688)
	[0.82045]	[3.01190]
SP(-4)	-1.141646	-0.538476
	(0.24183)	(0.13308)
	[-4.72093]	[-4.04624]
C	0.000555	0.000102
	(0.00111)	(0.00061)

	[0.49942]	[0.16617]
R-squared	0.829328	0.873739
Adj. R-squared	0.790318	0.844880
Sum sq. resids	0.000766	0.000232
S.E. equation	0.004679	0.002575
F-statistic	21.25903	30.27549
Log likelihood	178.6498	204.9295
Akaike AIC	-7.711355	-8.905888
Schwarz SC	-7.346407	-8.540940
Mean dependent	0.001826	0.005351
S.D. dependent	0.010217	0.006537

Determinant resid covariance (dof adj.)	1.22E-10
Determinant resid covariance	7.70E-11
Log likelihood	387.4515
Akaike information criterion	-16.79325
Schwarz criterion	-16.06335

Table 70

Pairwise Granger Causality Tests

Sample: 2000Q1 2010Q4
Lags: 4

Null Hypothesis:	Obs	F-Statistic	Prob.
SP does not Granger Cause EU	44	16.0199	2.E-07
EU does not Granger Cause SP		2.94694	0.0337

Table 71

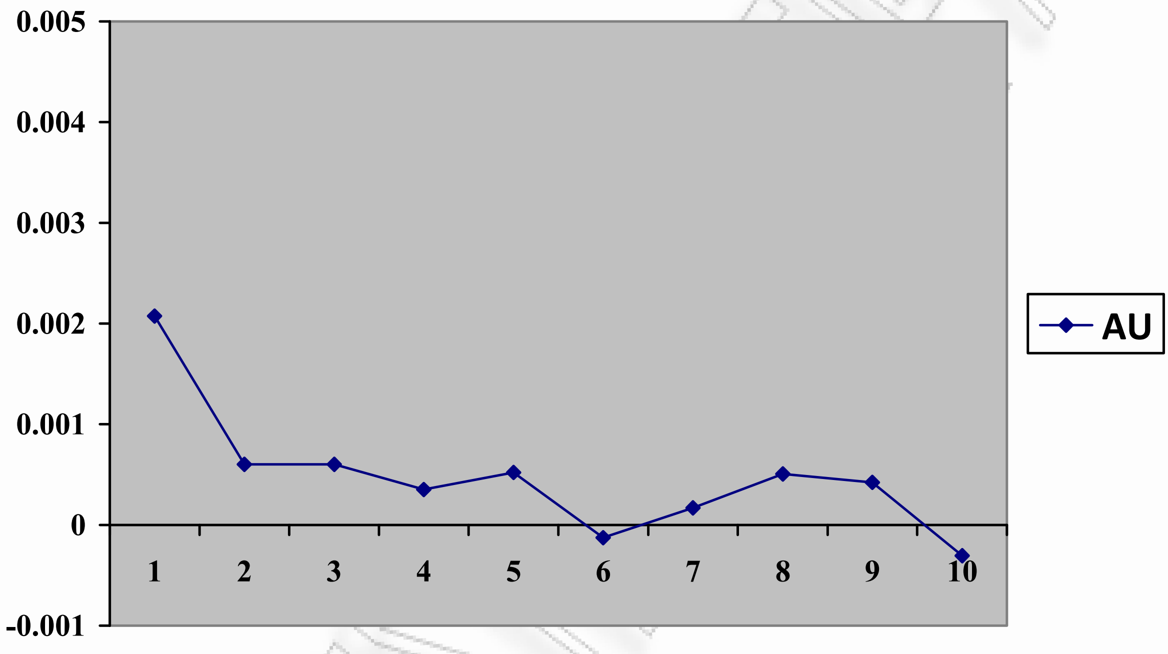
Chow Breakpoint Test: 2000Q1
Null Hypothesis: No breaks at specified breakpoints

Equation Sample: 1981Q3 2010Q4

F-statistic	2.622280	Prob. F(11,96)	0.0057
Log likelihood ratio	31.00160	Prob. Chi-Square(11)	0.0011
Wald Statistic	28.84508	Prob. Chi-Square(11)	0.0024

8. Diagrams

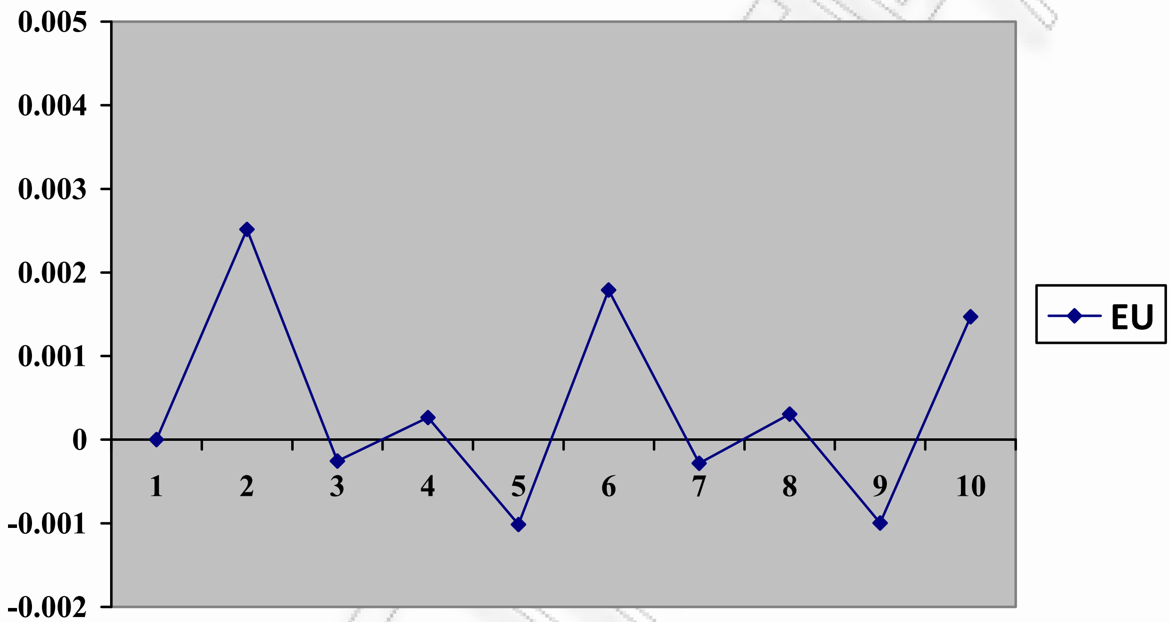
1.



Response of AU to EU shocks (1980-1999)

(Response to cholesky one s.d. innovations)

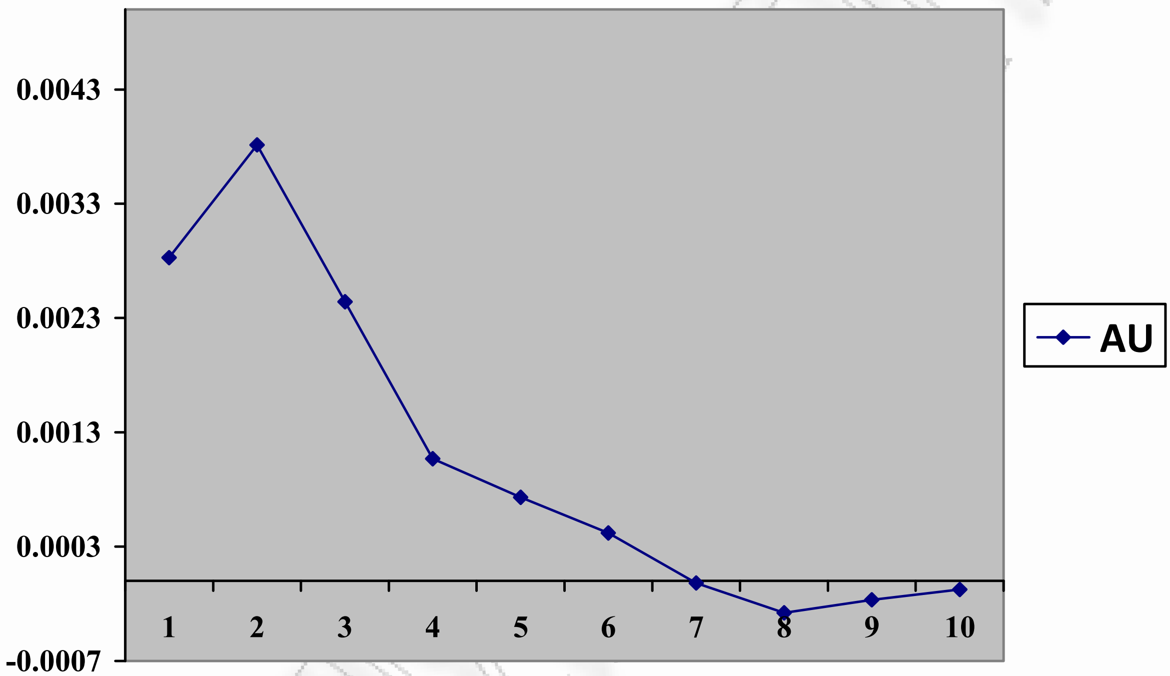
2.



Response of EU to AU shocks (1980-1999)

(Response to cholesky one s.d. innovations)

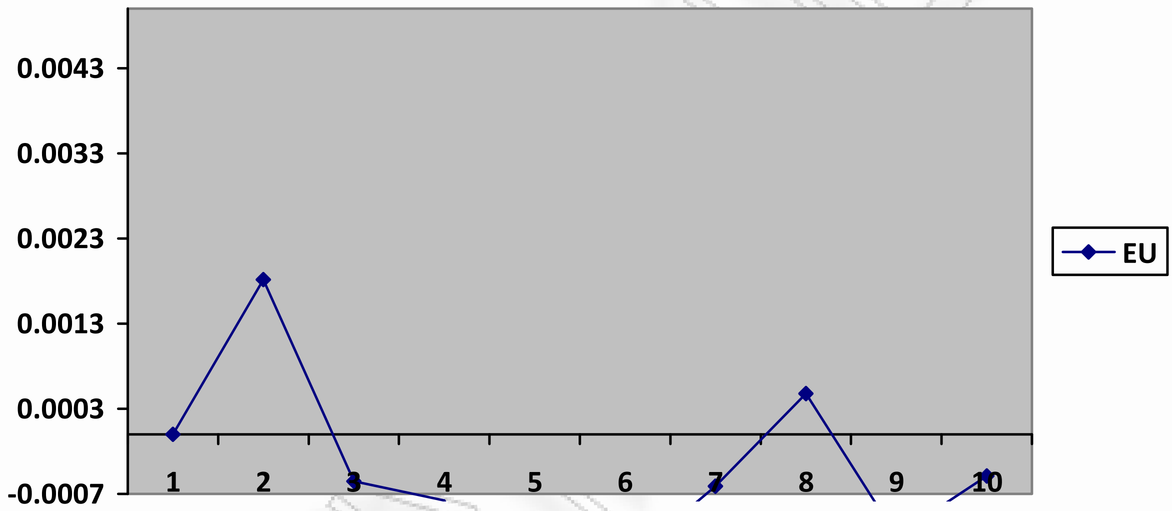
3.



Response of AU to EU shocks (2000-2010)

(Response to cholesky one s.d. innovations)

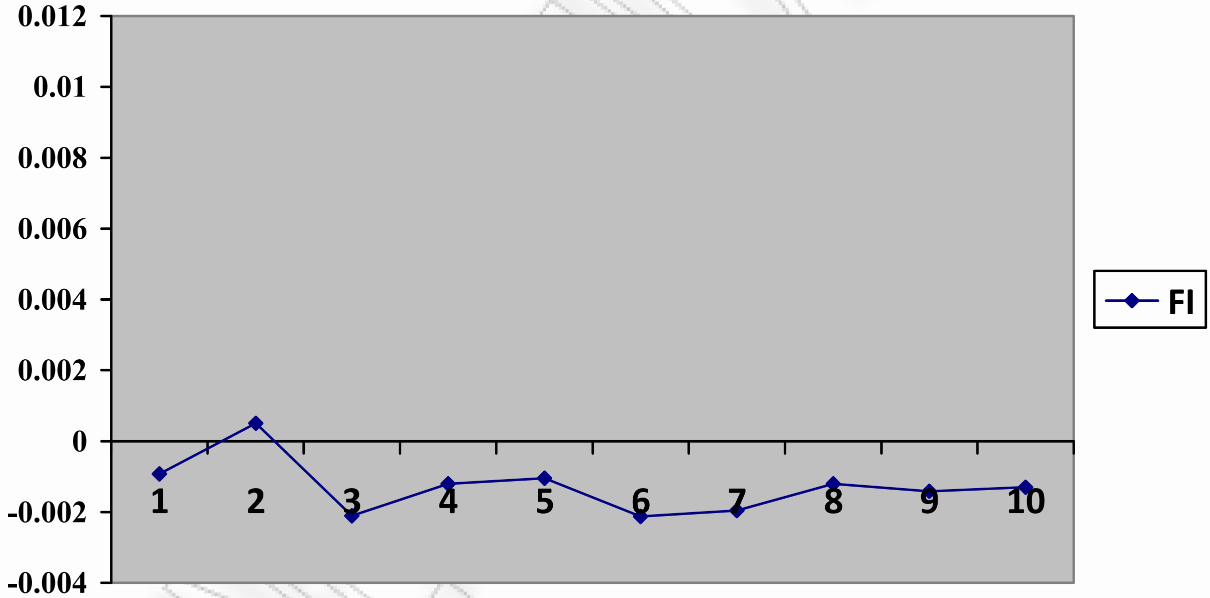
4.



Response of EU to AU shocks (2000-2010)

(Response to cholesky one s.d. innovations)

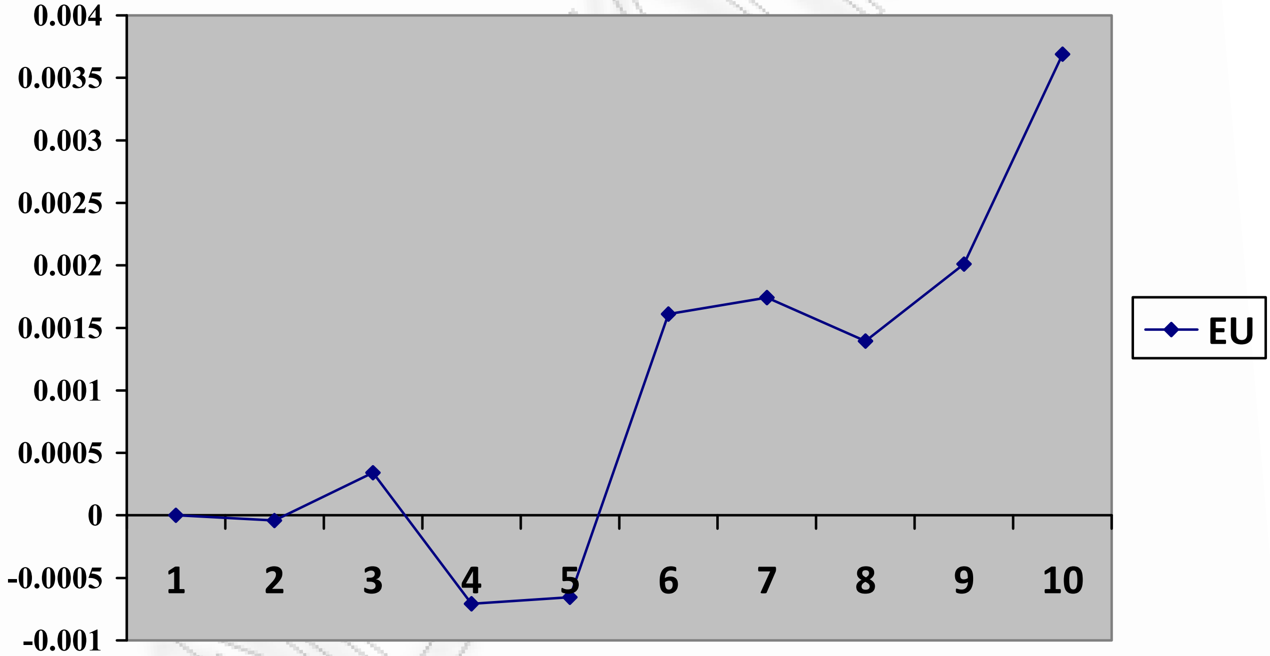
5.



Response of FI to EU shocks (1980-1999)

(Response to cholesky one s.d. innovations)

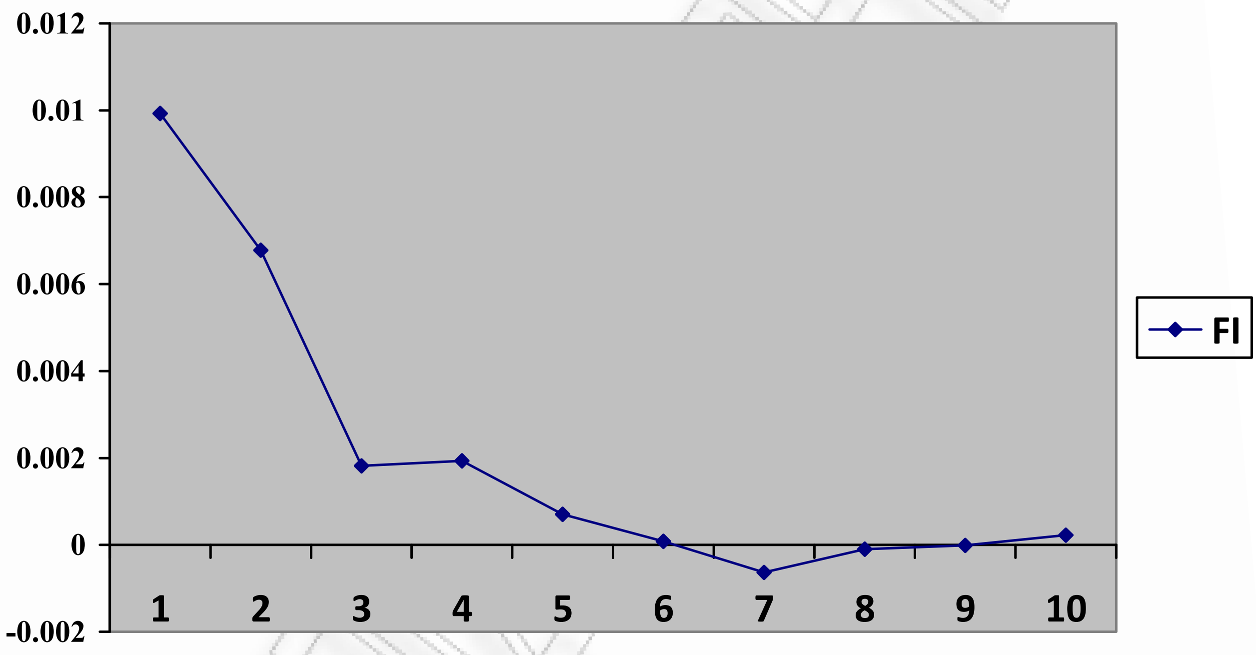
6.



Response of EU to FI shocks (1980-1999)

(Response to cholesky one s.d. innovations)

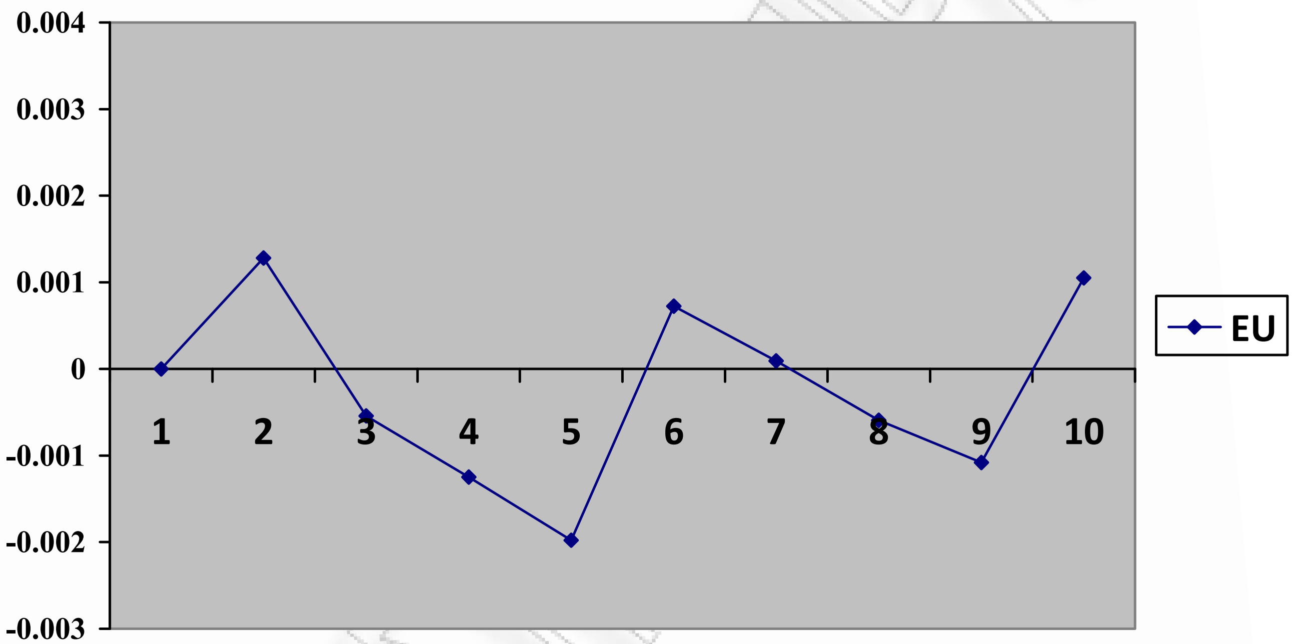
7.



Response of FI to EU shock (2000-2010)

(Response to cholesky one s.d. innovations)

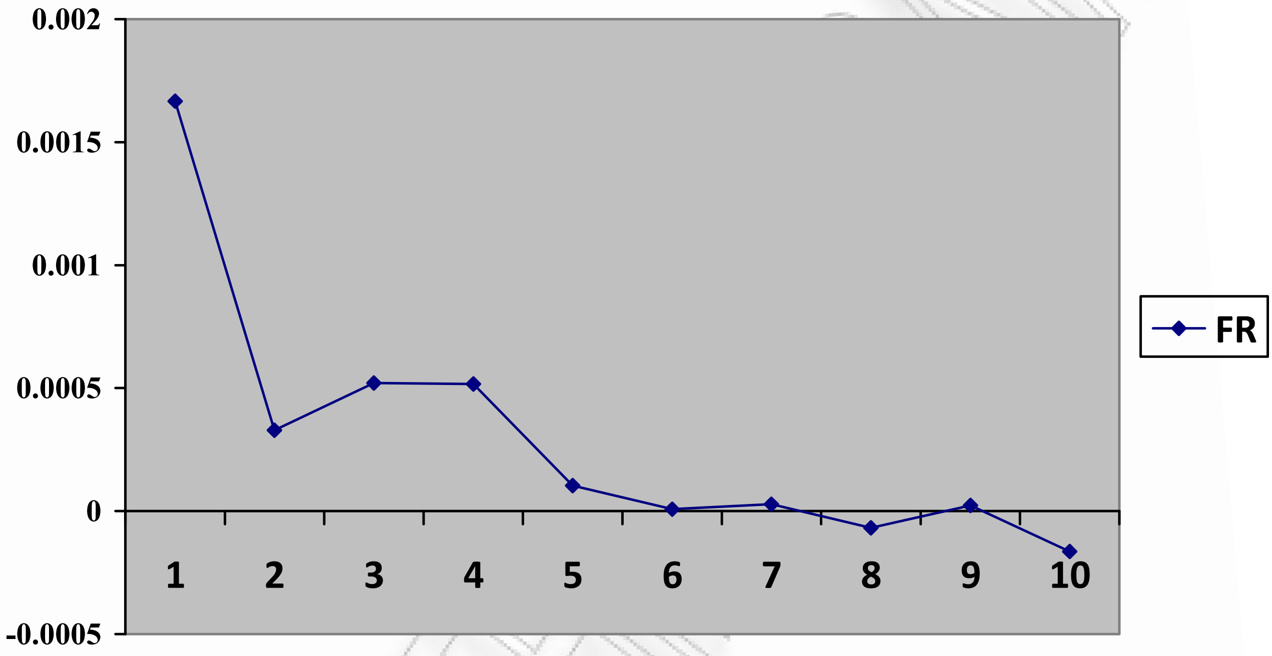
8.



Response of EU to FI shocks (2000-2010)

(Response to cholesky one s.d. innovations)

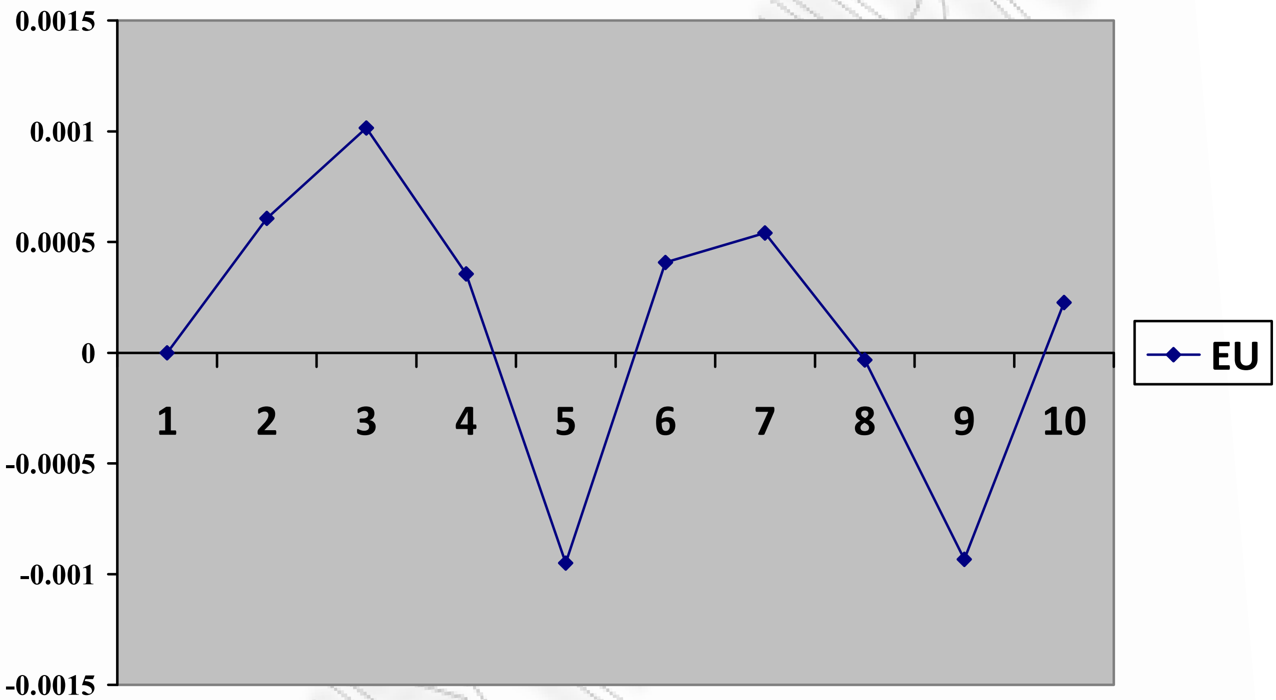
9.



Response of FR to EU shocks (1980-1999)

(Response to cholesky one s.d. innovations)

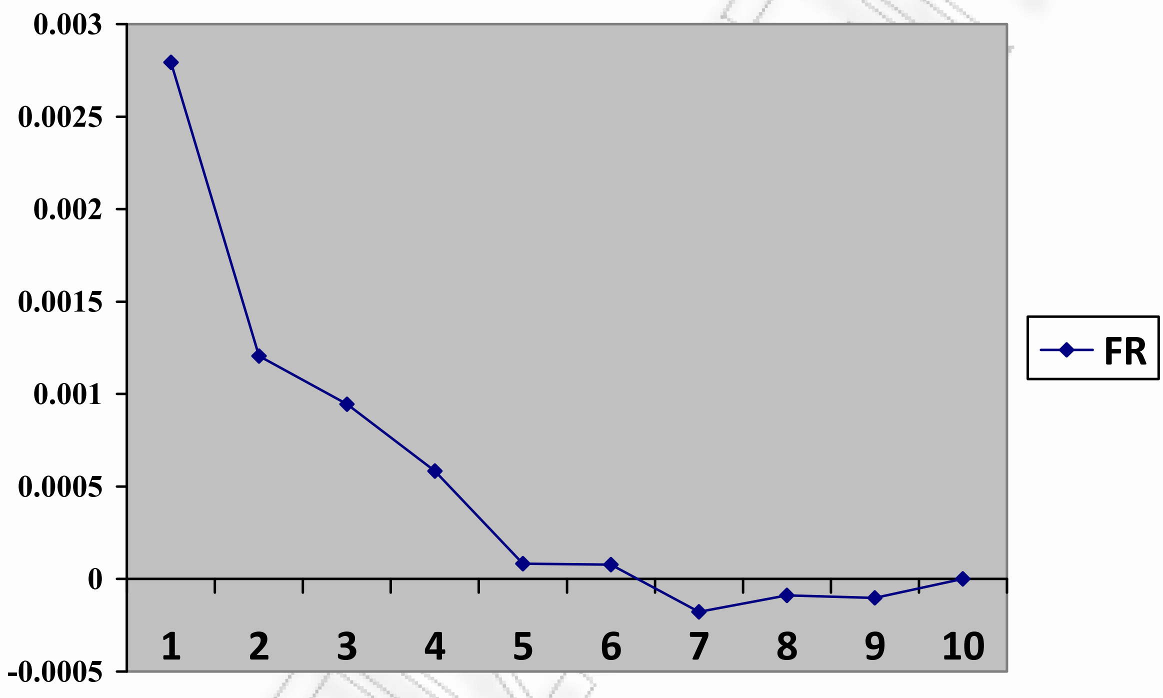
10.



Response of EU to FR shocks (1980-1999)

(Response to cholesky one s.d. innovations)

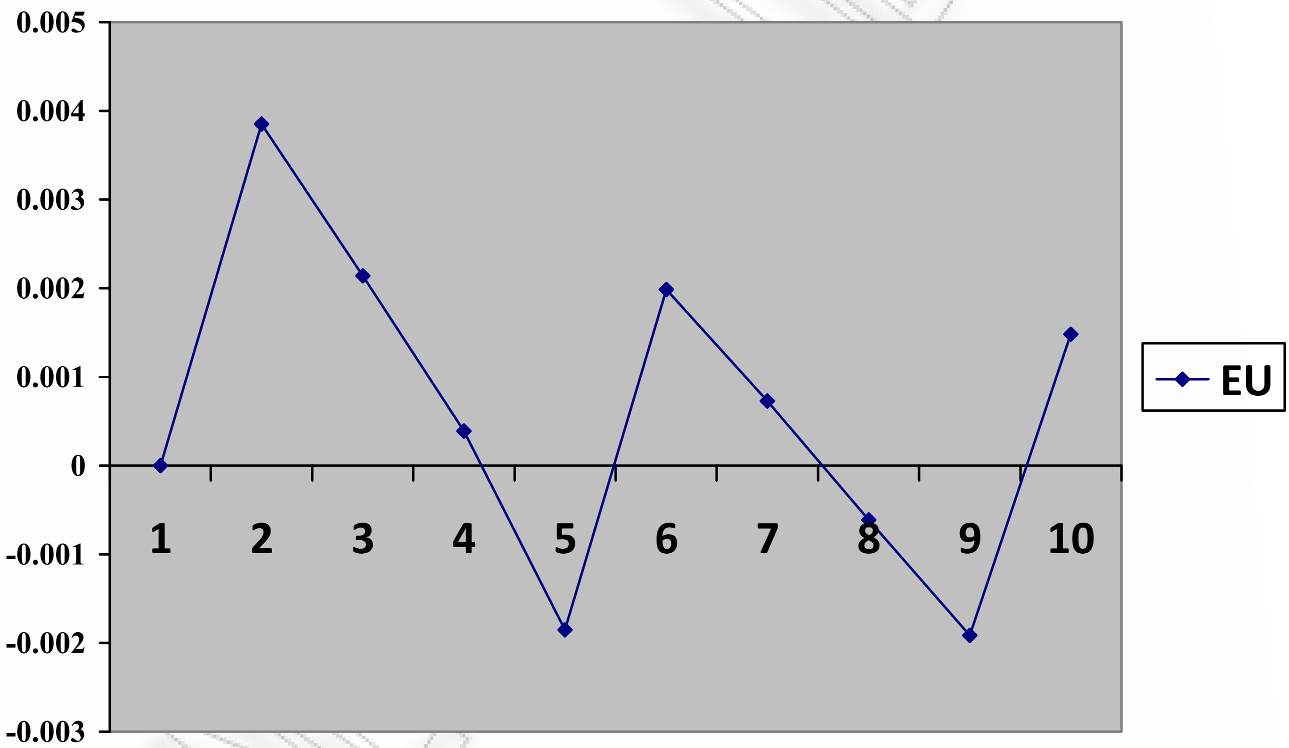
11.



Response of FR to EU shocks (2000-2010)

(Response to cholesky one s.d. innovations)

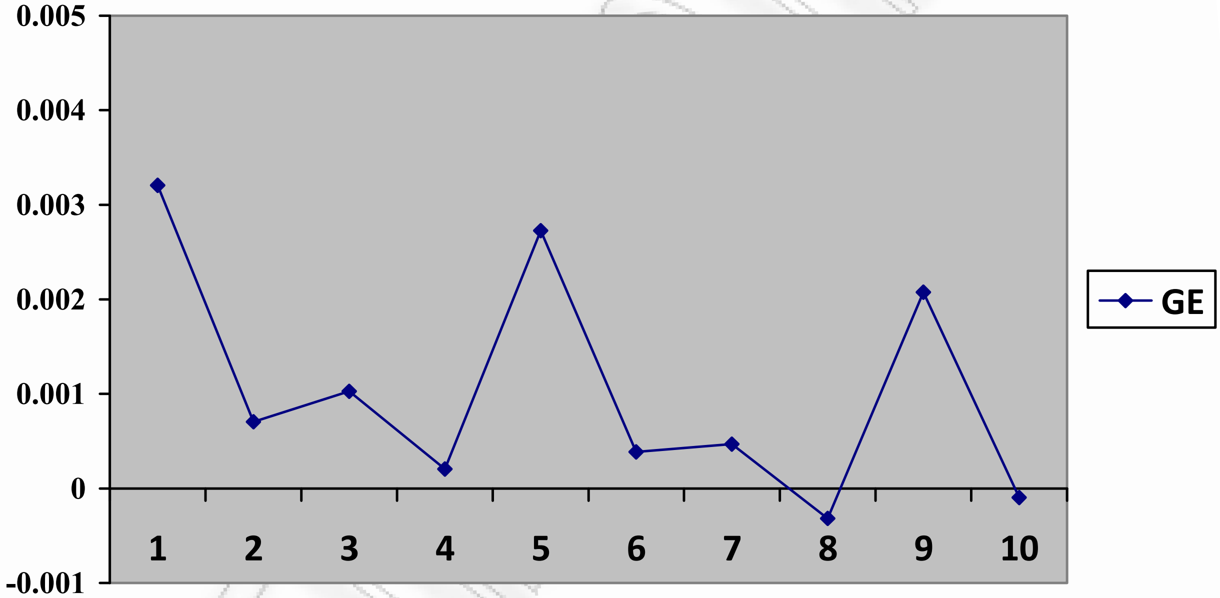
12.



Response of EU to FR shocks (2000-2010)

(Response to cholesky one s.d. innovations)

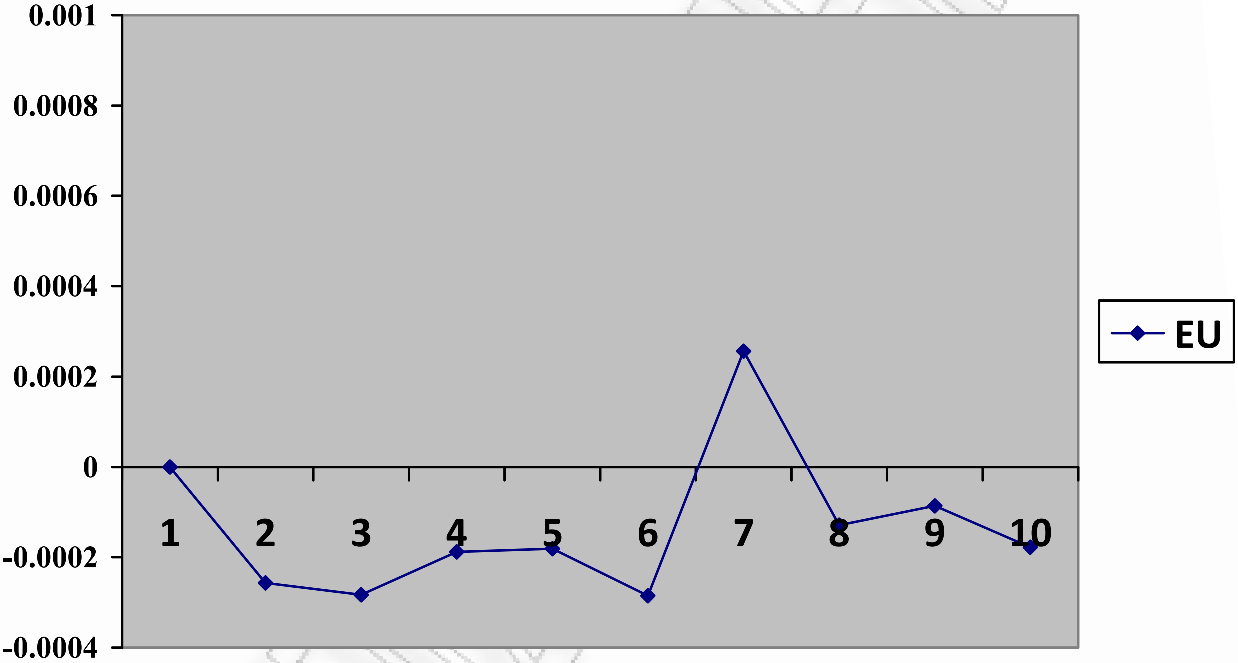
13.



Response of GE to EU shocks (1980-1999)

(Response to cholesky one s.d. innovations)

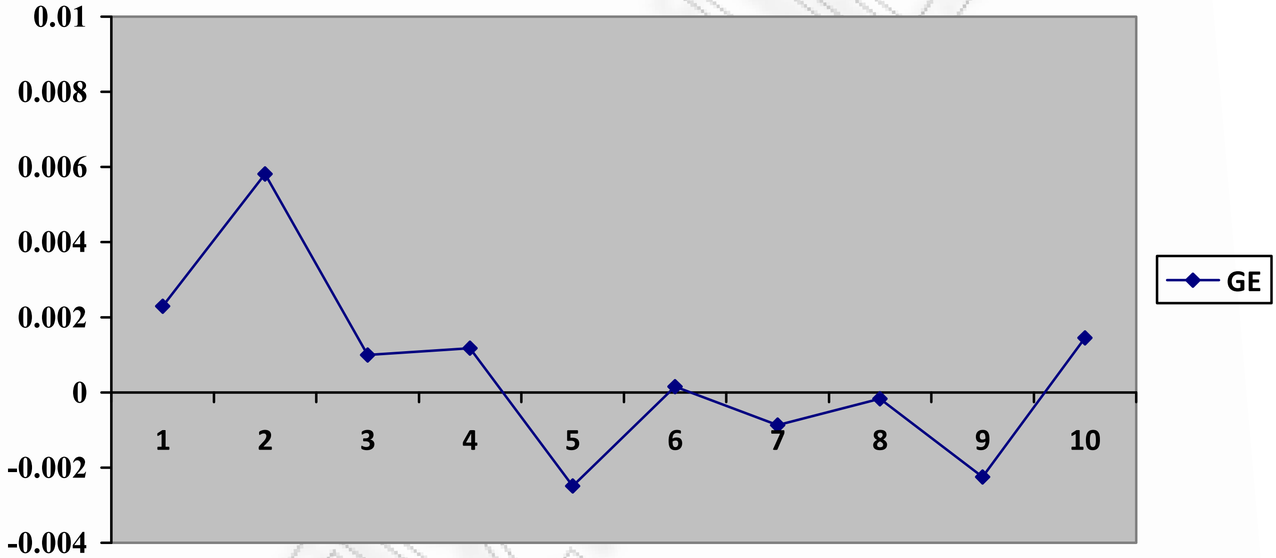
14.



Response of EU to GE shocks (1980-1999)

(Response to cholesky one s.d. innovations)

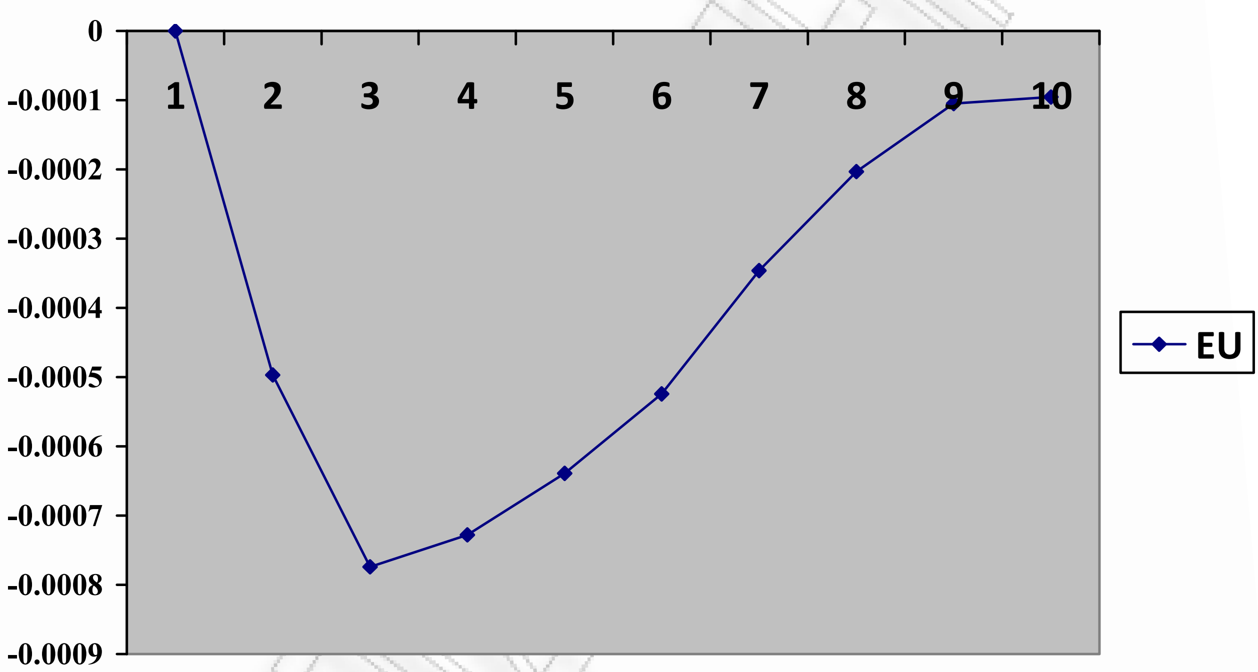
15.



Response of GE to EU shocks (2000-2010)

(Response to cholesky one s.d. innovations)

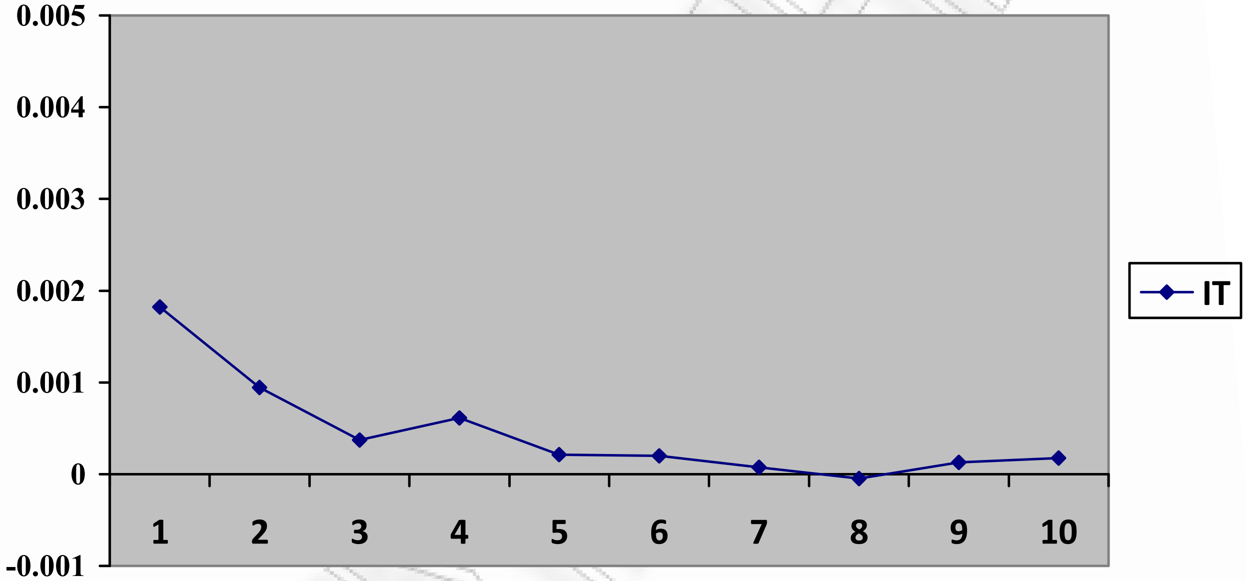
16.



Response of EU to GE shocks (2000-2010)

(Response to cholesky one s.d. innovations)

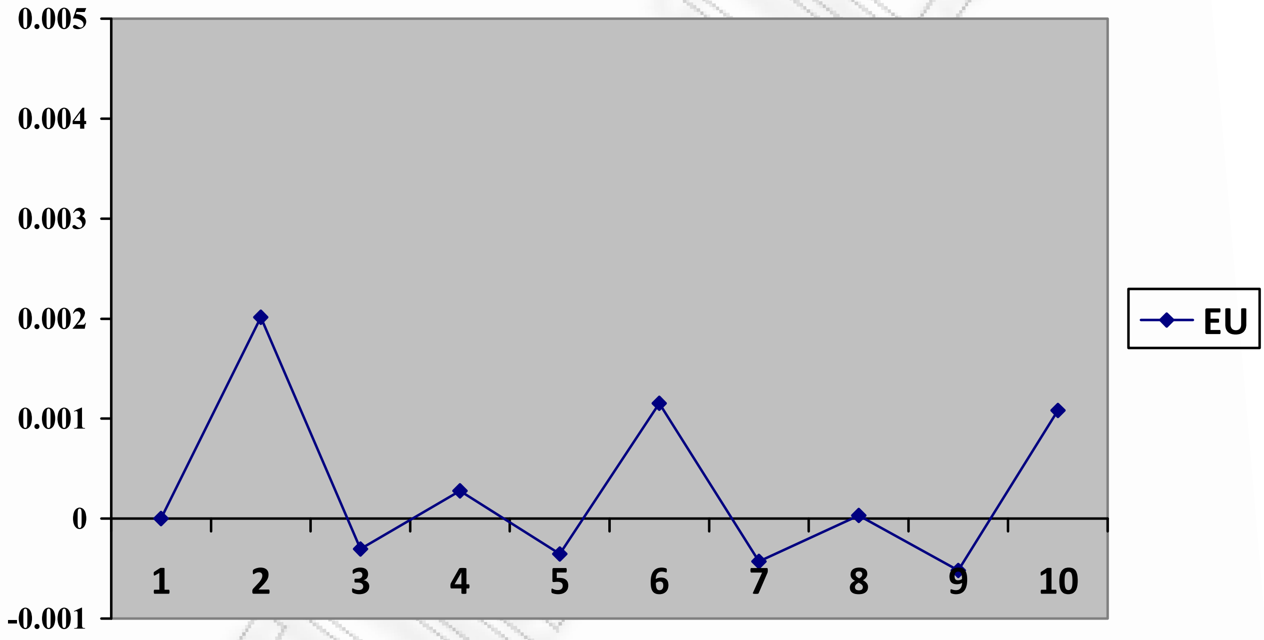
17.



Response of IT to EU shocks (1980-1999)

(Response to cholesky one s.d. innovations)

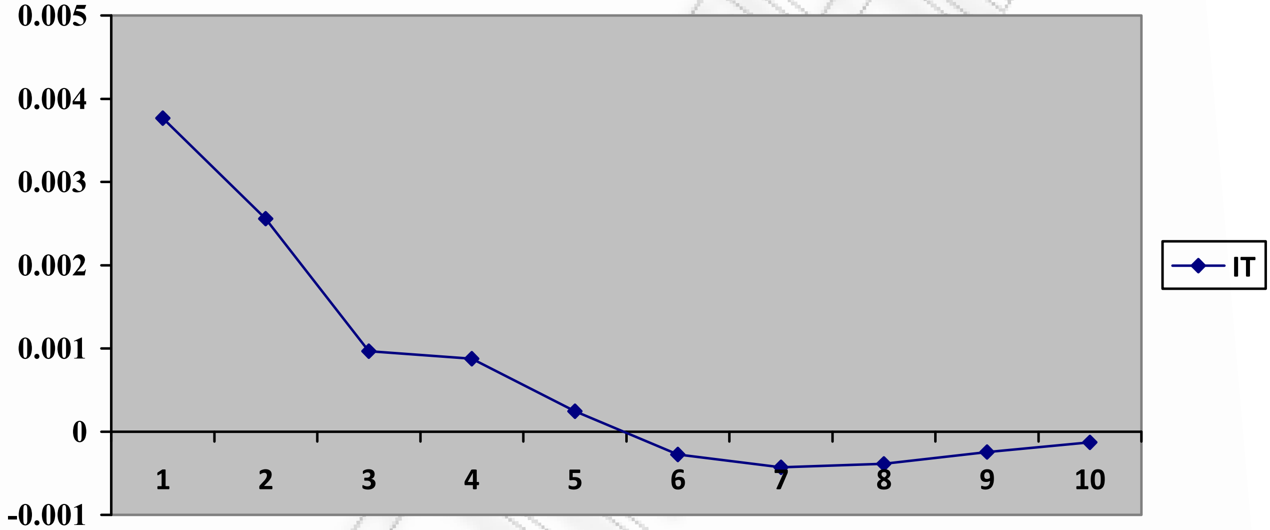
18.



Response of EU to IT shocks (1980-1999)

(Response to cholesky one s.d. innovations)

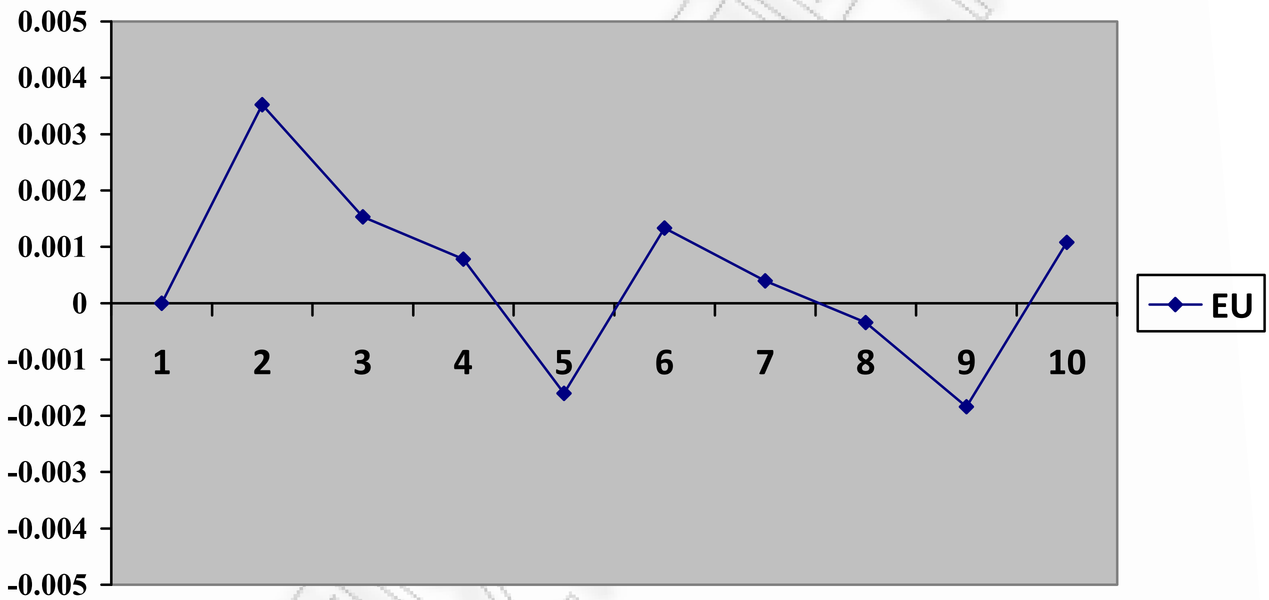
19.



Response of IT to EU shocks (2000-2010)

(Response to cholesky one s.d. innovations)

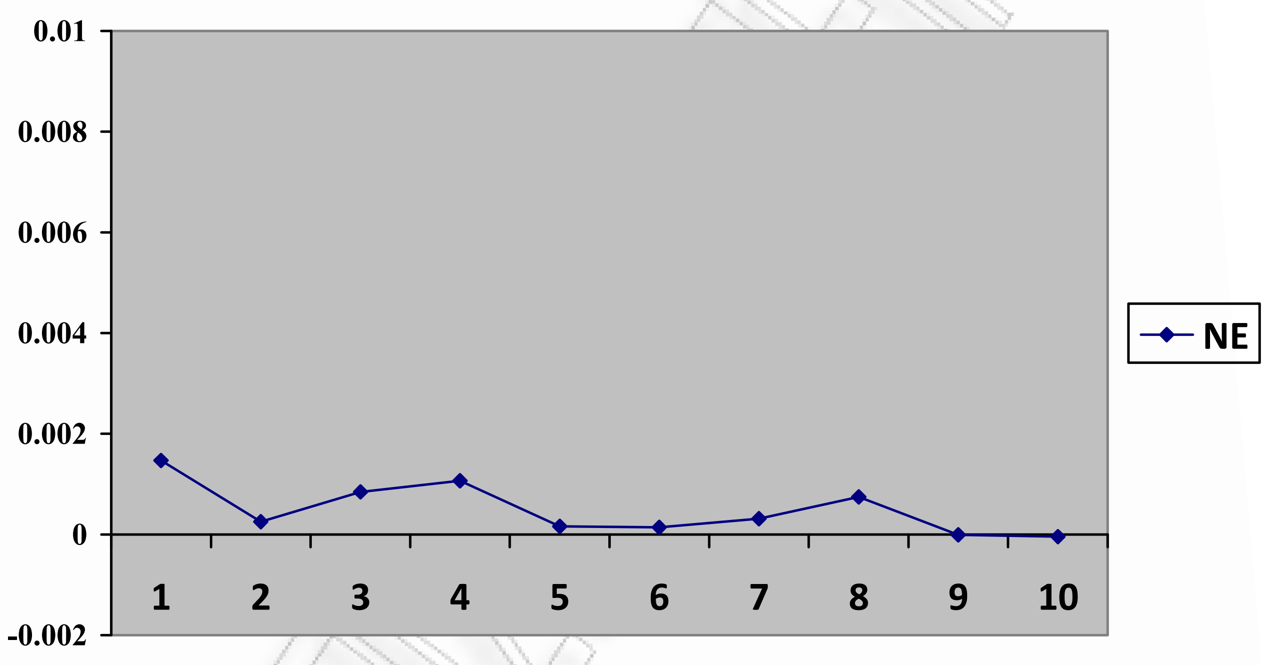
20.



Response of EU to IT shocks (2000-2010)

(Response to cholesky one s.d. innovations)

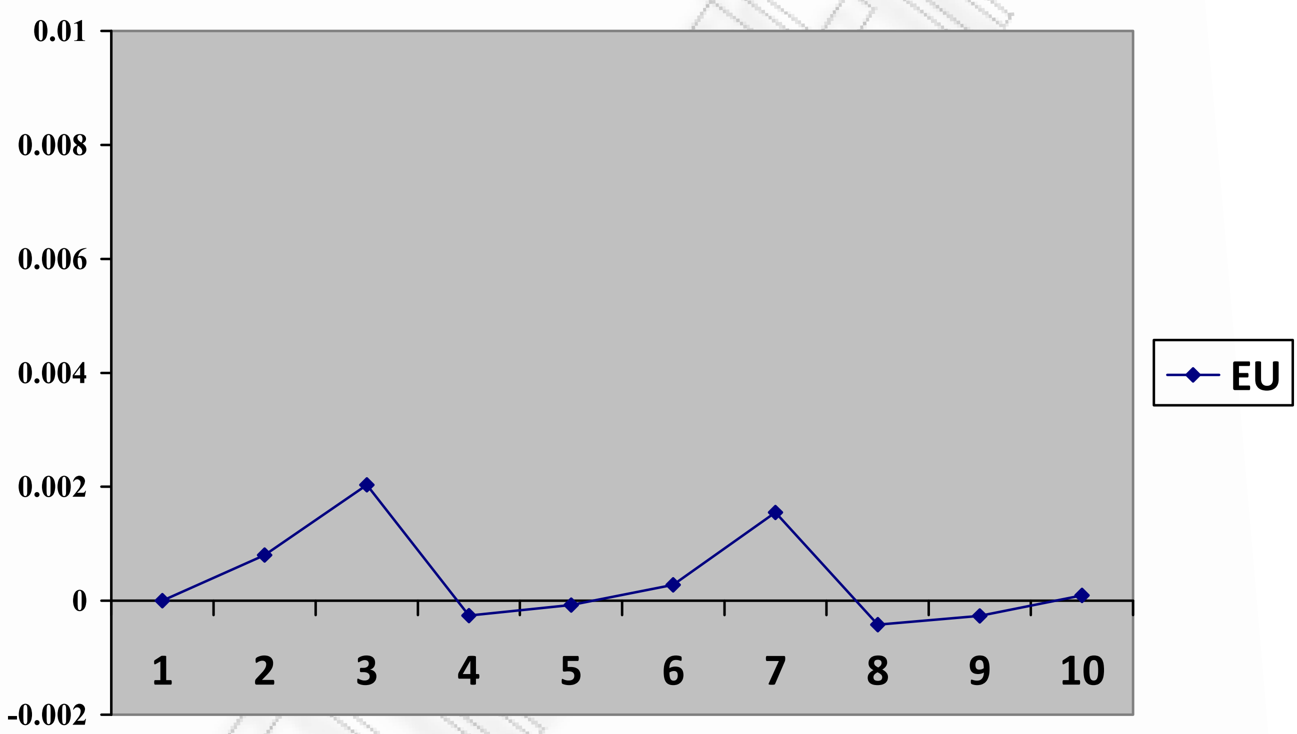
21.



Response of NE to EU shocks (1980-1999)

(Response to cholesky one s.d. innovations)

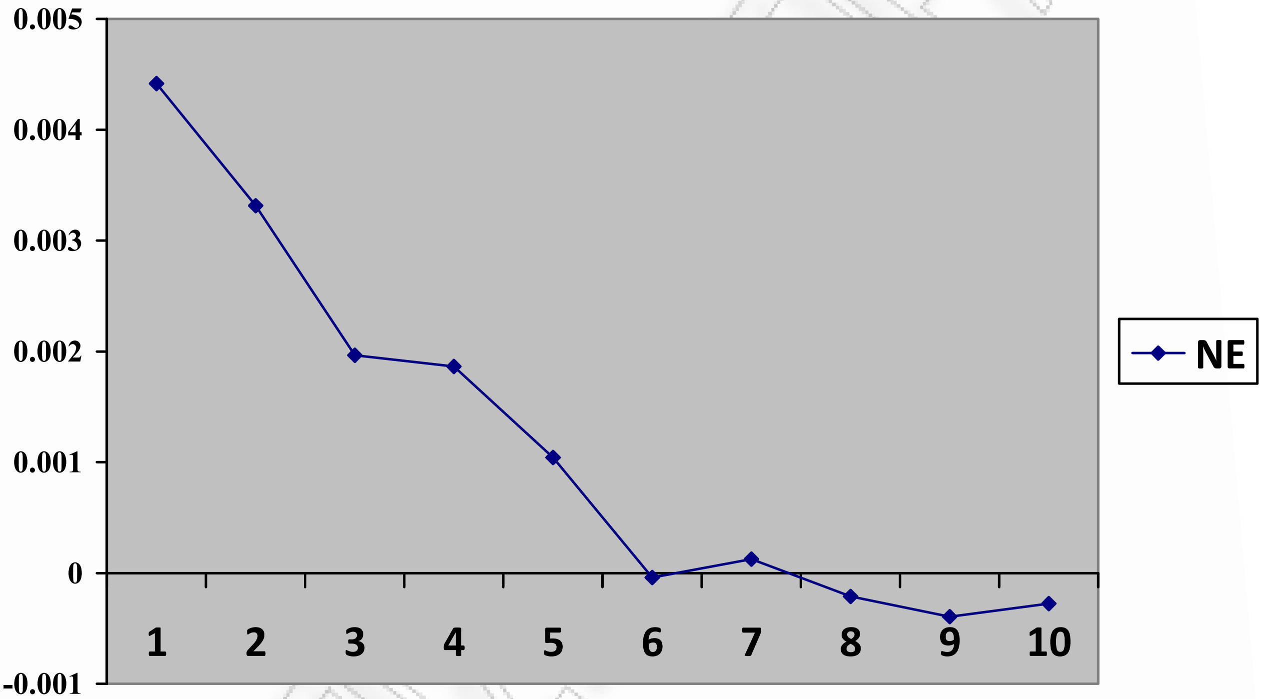
22.



Response of EU to NE shocks (1980-1999)

(Response to cholesky one s.d. innovations)

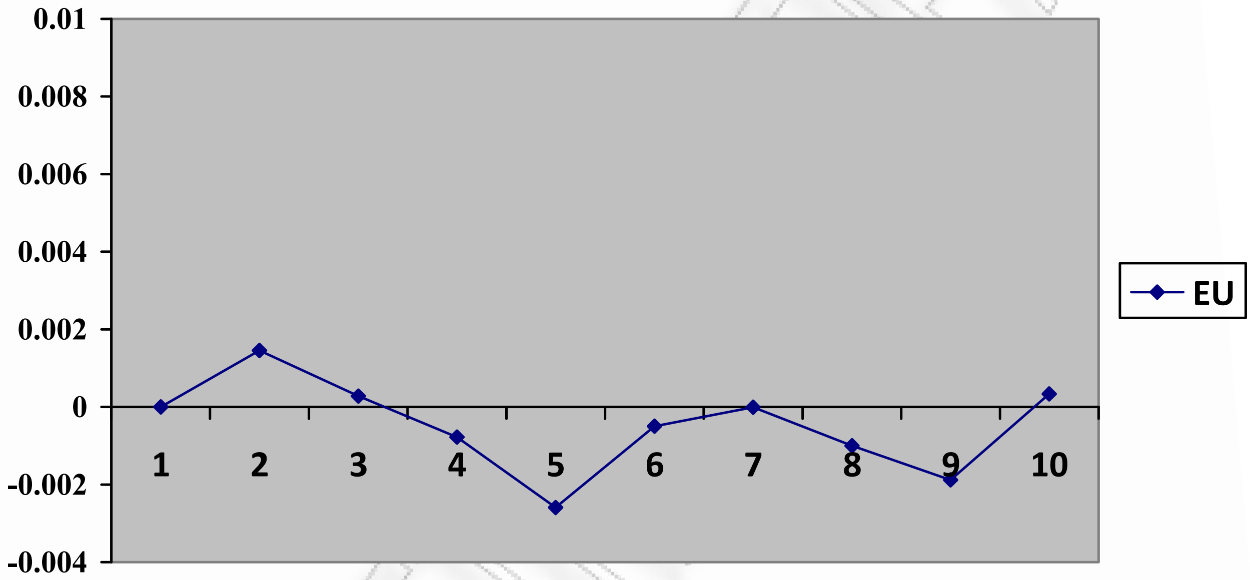
23.



Response of NE to EU shocks (2000-2010)

(Response to cholesky one s.d. innovations)

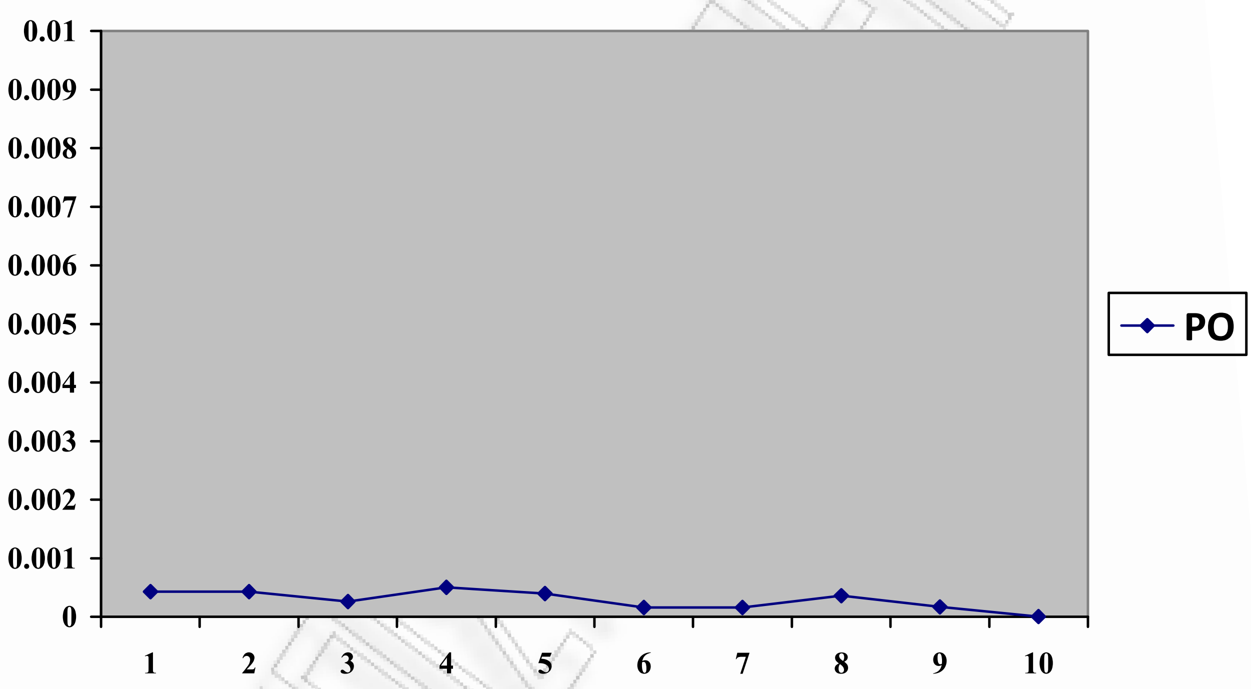
24.



Response of EU to NE shocks (2000-2010)

(Response to cholesky one s.d. innovations

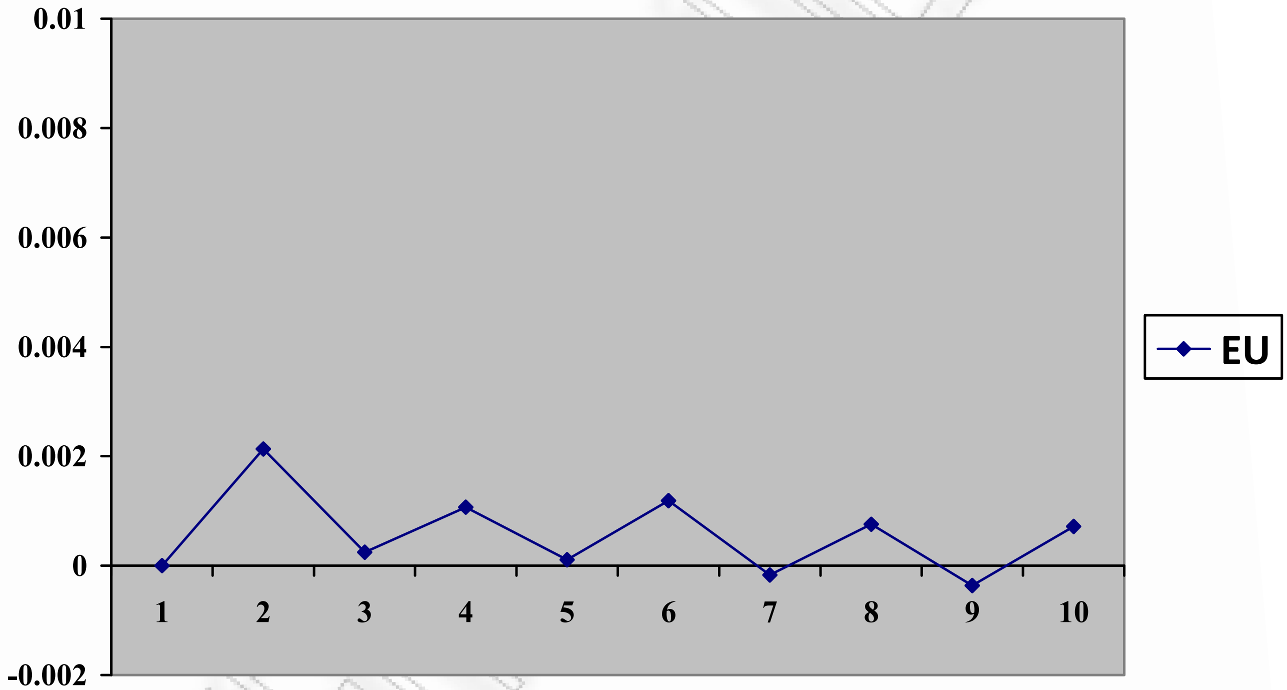
25.



Response of PO to EU shocks (1980-1999)

(Response to cholesky one s.d. innovations)

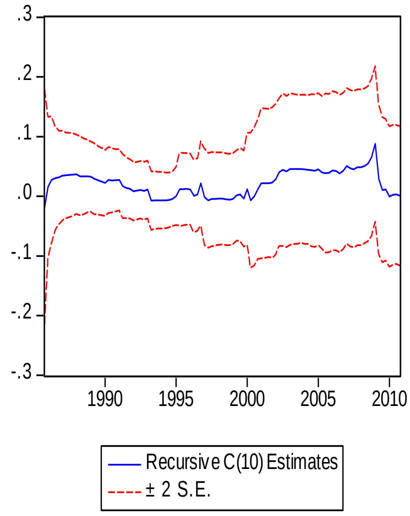
26.

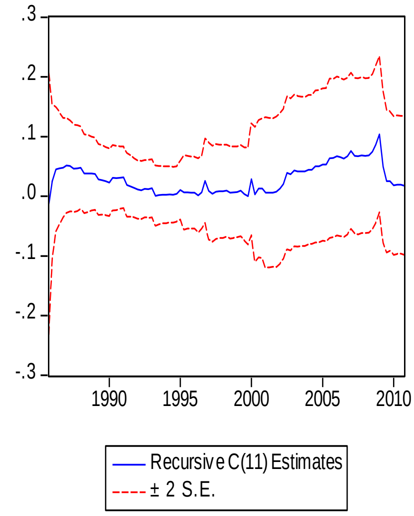


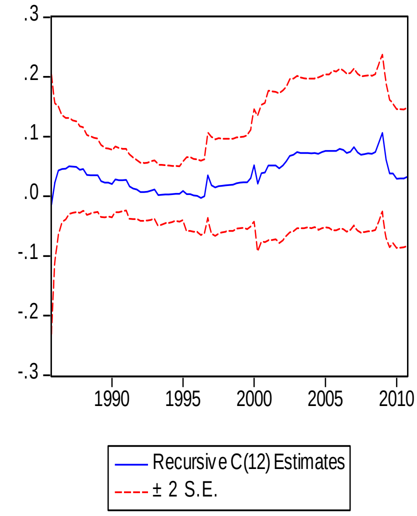
Response of EU to PO shocks (1980-1999)

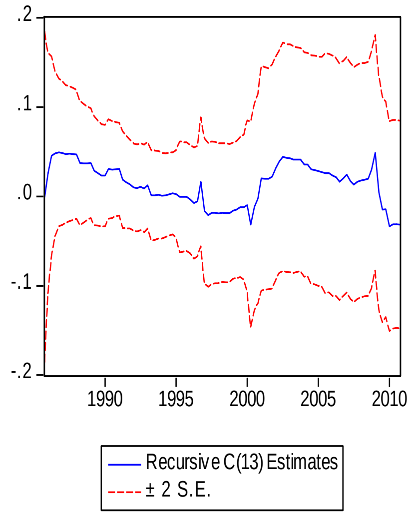
(Response to cholesky one s.d. innovations)

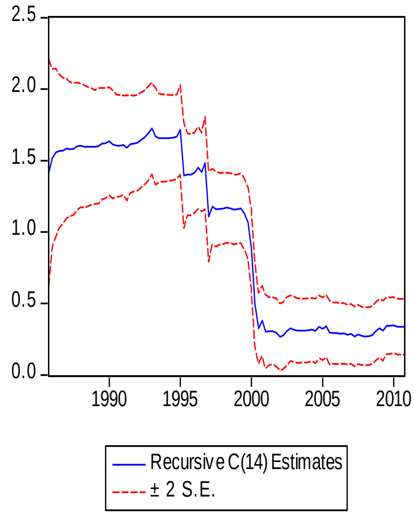
27.

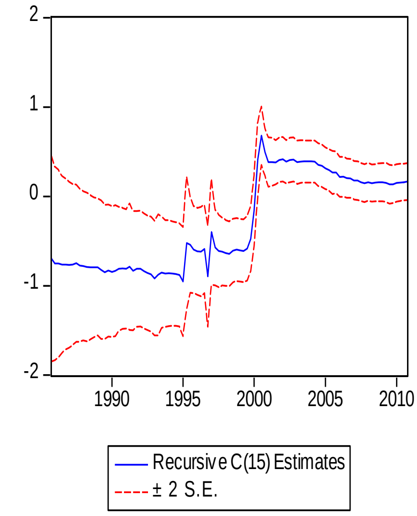

Recursive C(10) Estimates
± 2 S.E.

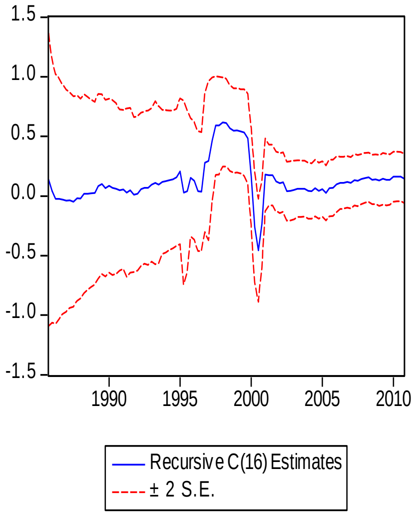

Recursive C(11) Estimates
± 2 S.E.

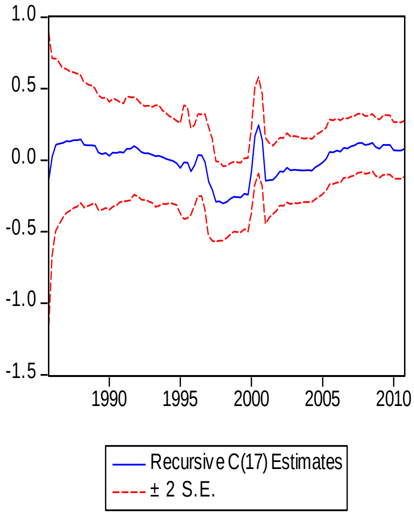

Recursive C(12) Estimates
± 2 S.E.

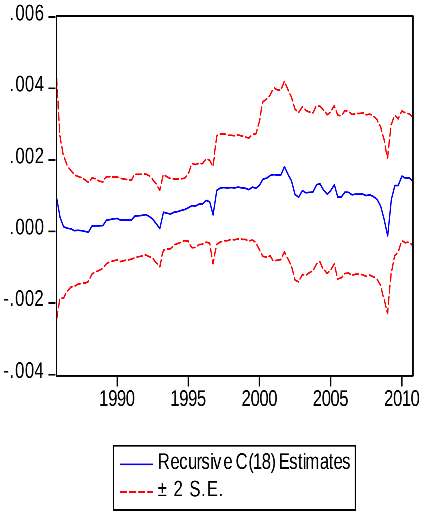

Recursive C(13) Estimates
± 2 S.E.


Recursive C(14) Estimates
± 2 S.E.

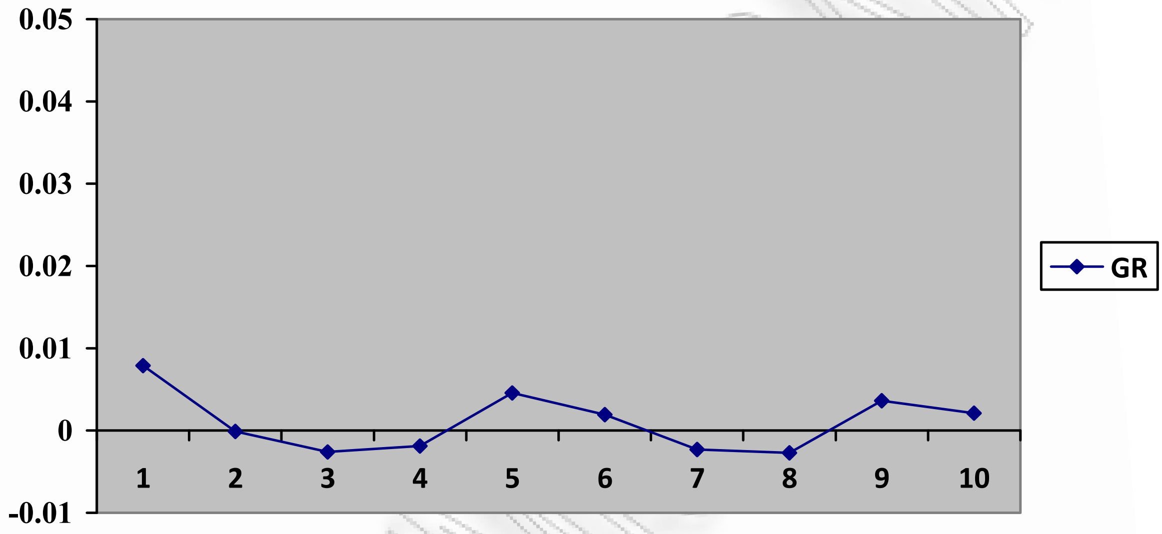

Recursive C(15) Estimates
± 2 S.E.


Recursive C(16) Estimates
± 2 S.E.


Recursive C(17) Estimates
± 2 S.E.


Recursive C(18) Estimates
± 2 S.E.

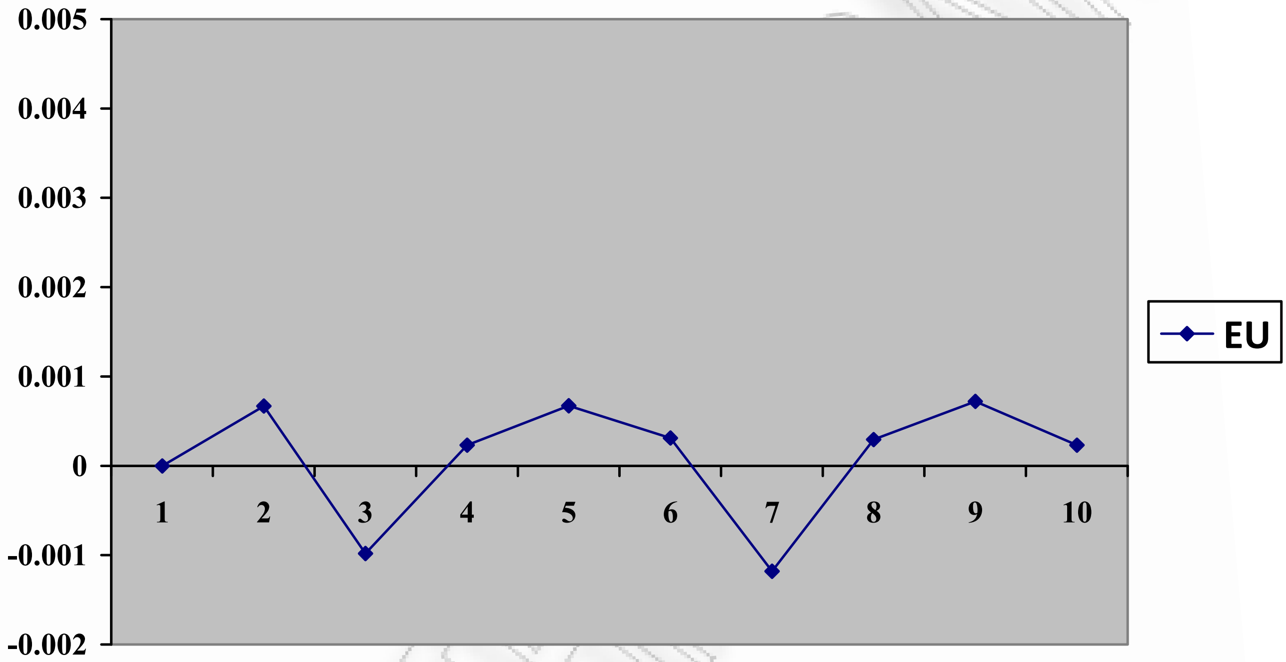
28.



Response of GR to EU shocks (1980-1999)

(Response to cholesky one s.d. innovations)

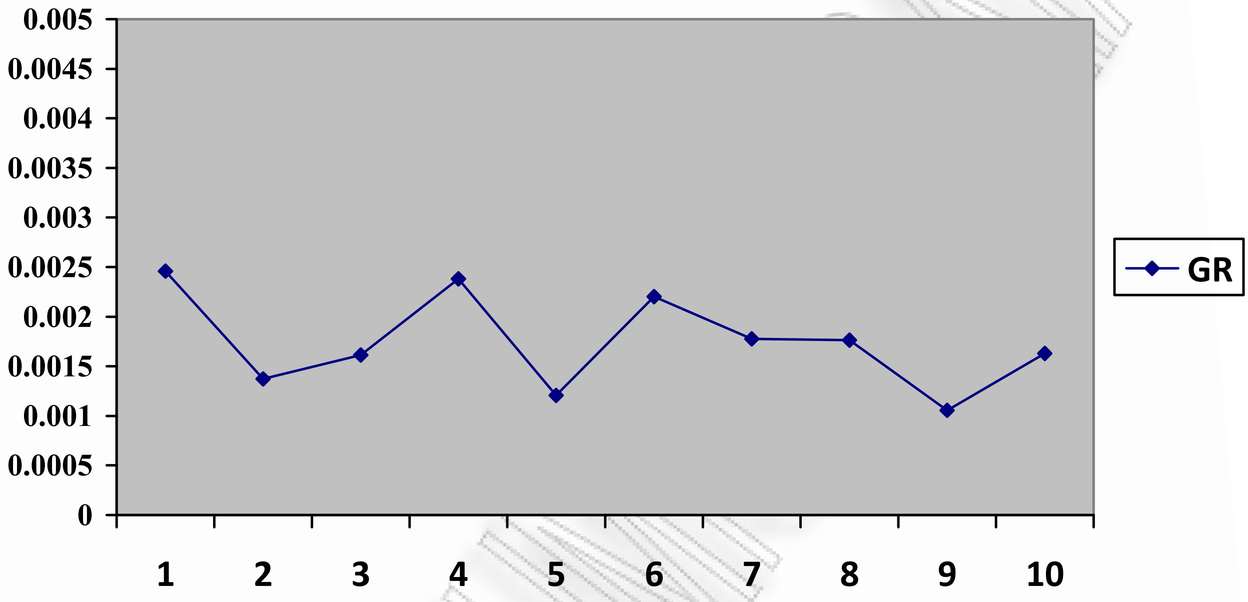
29.



Response of EU to GR shocks (1980-1999)

(Response to cholesky one s.d. innovations)

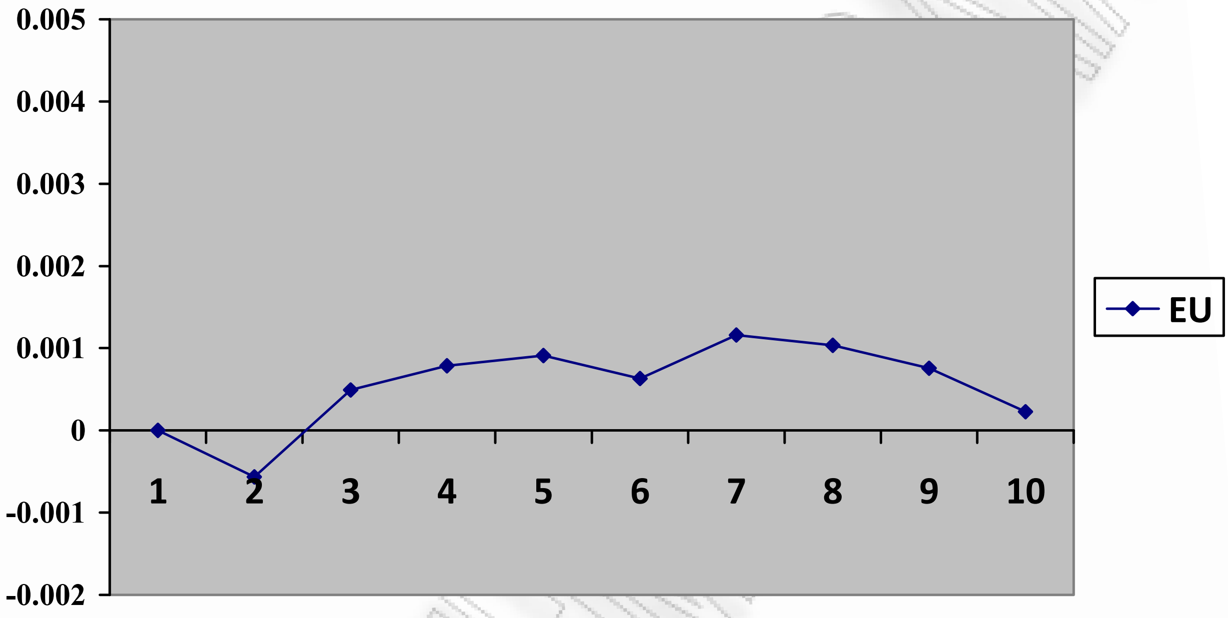
30.



Response of GR to EU shocks (2000-2010)

(Response to cholesky one s.d. innovations)

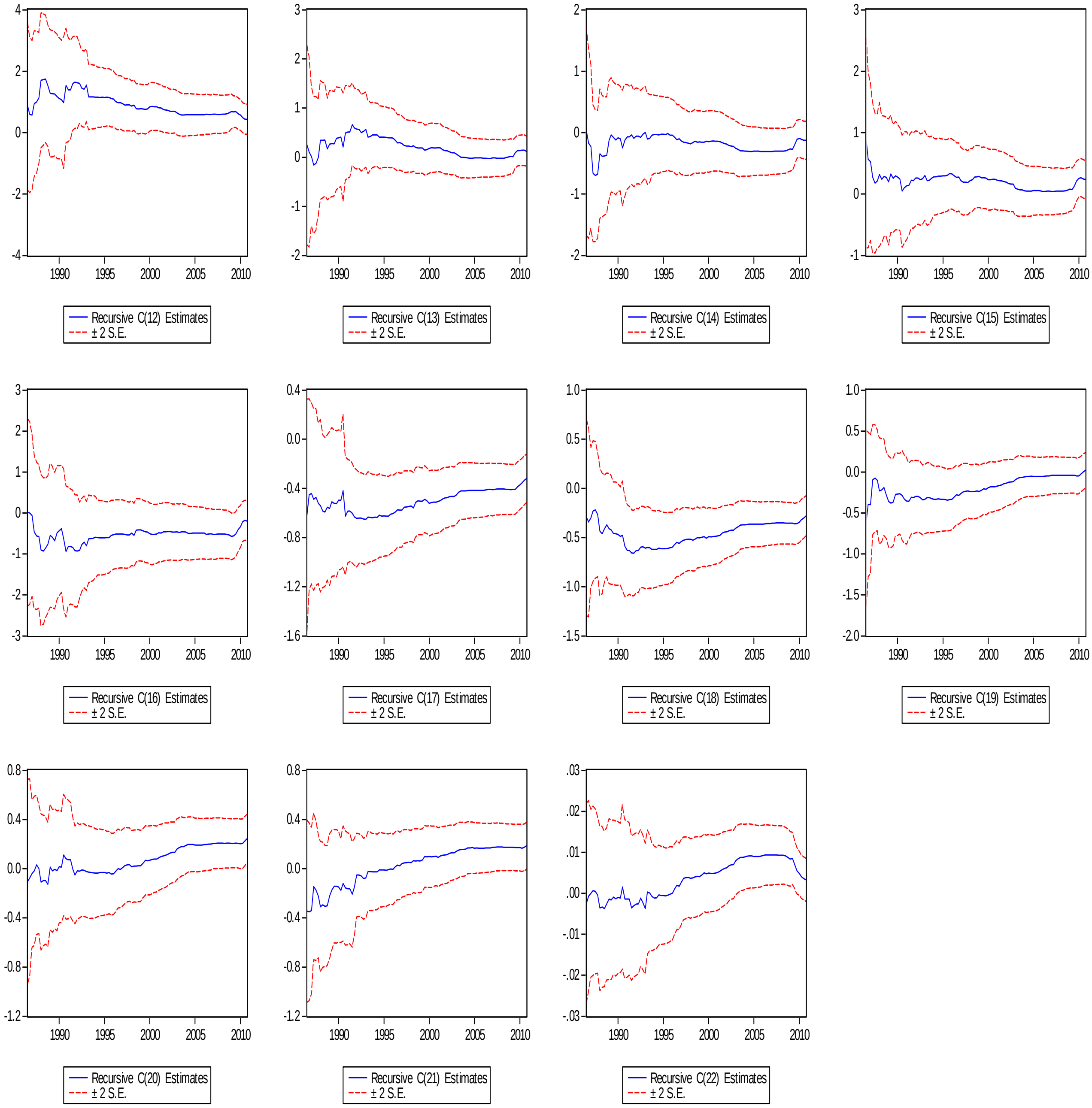
31.



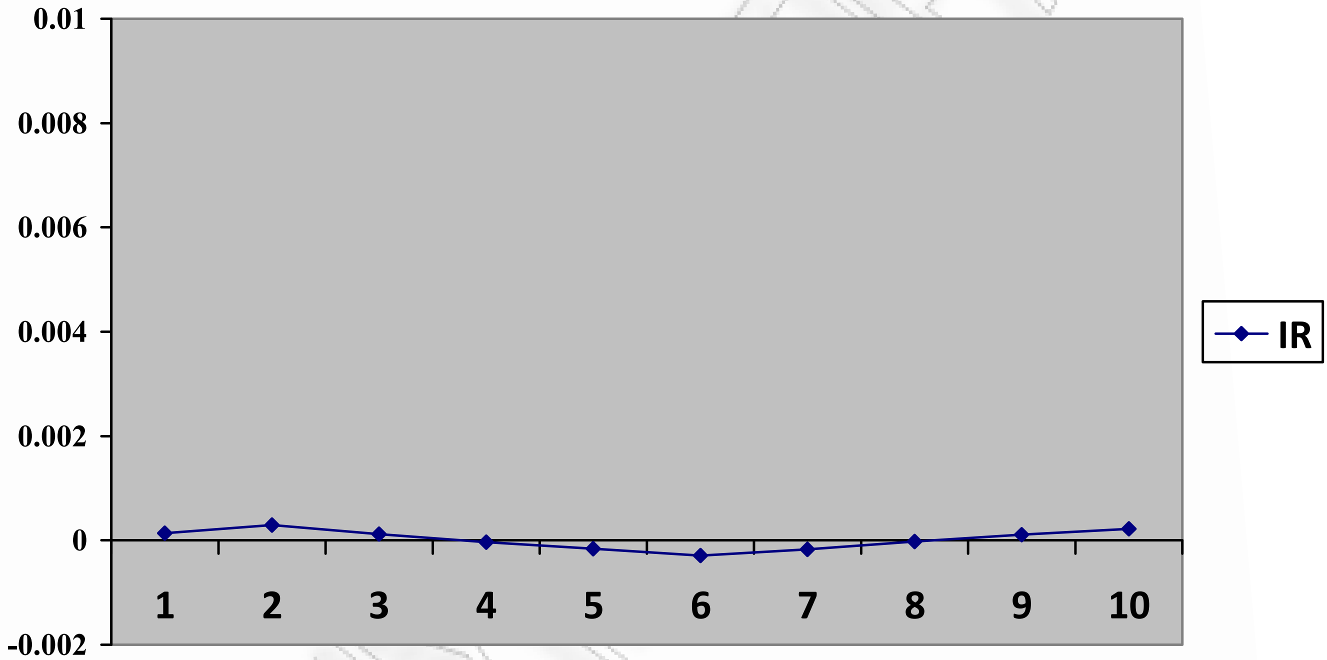
Response of EU to GR shocks (2000-2010)

(Response to cholesky one s.d. innovations)

32.


Recursive C(12) Estimates
± 2 S.E.
Recursive C(13) Estimates
± 2 S.E.
Recursive C(14) Estimates
± 2 S.E.
Recursive C(15) Estimates
± 2 S.E.
Recursive C(16) Estimates
± 2 S.E.
Recursive C(17) Estimates
± 2 S.E.
Recursive C(18) Estimates
± 2 S.E.
Recursive C(19) Estimates
± 2 S.E.
Recursive C(20) Estimates
± 2 S.E.
Recursive C(21) Estimates
± 2 S.E.
Recursive C(22) Estimates
± 2 S.E.
1990
1995
2000
2005
2010

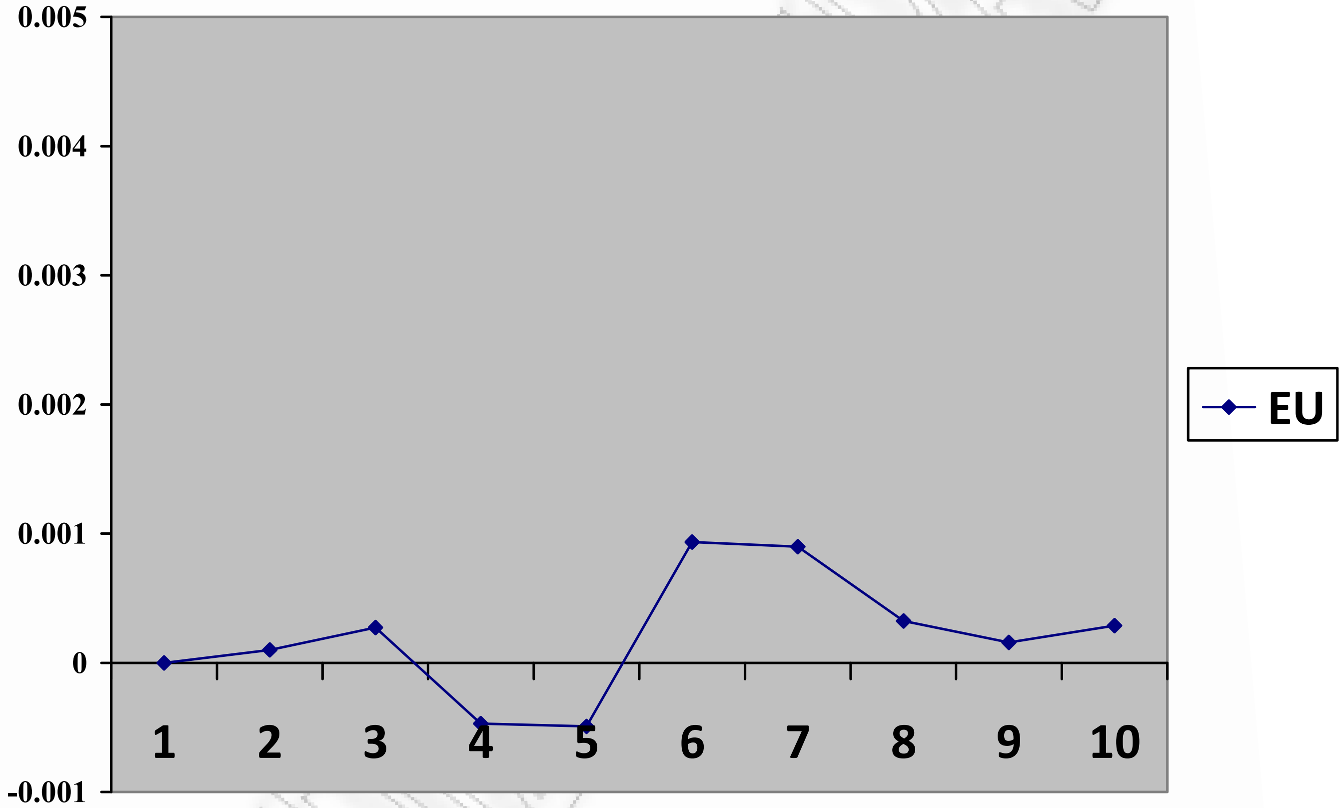
35.



Response of IR to EU shocks (1980-1999)

(Response to cholesky one s.d. innovations)

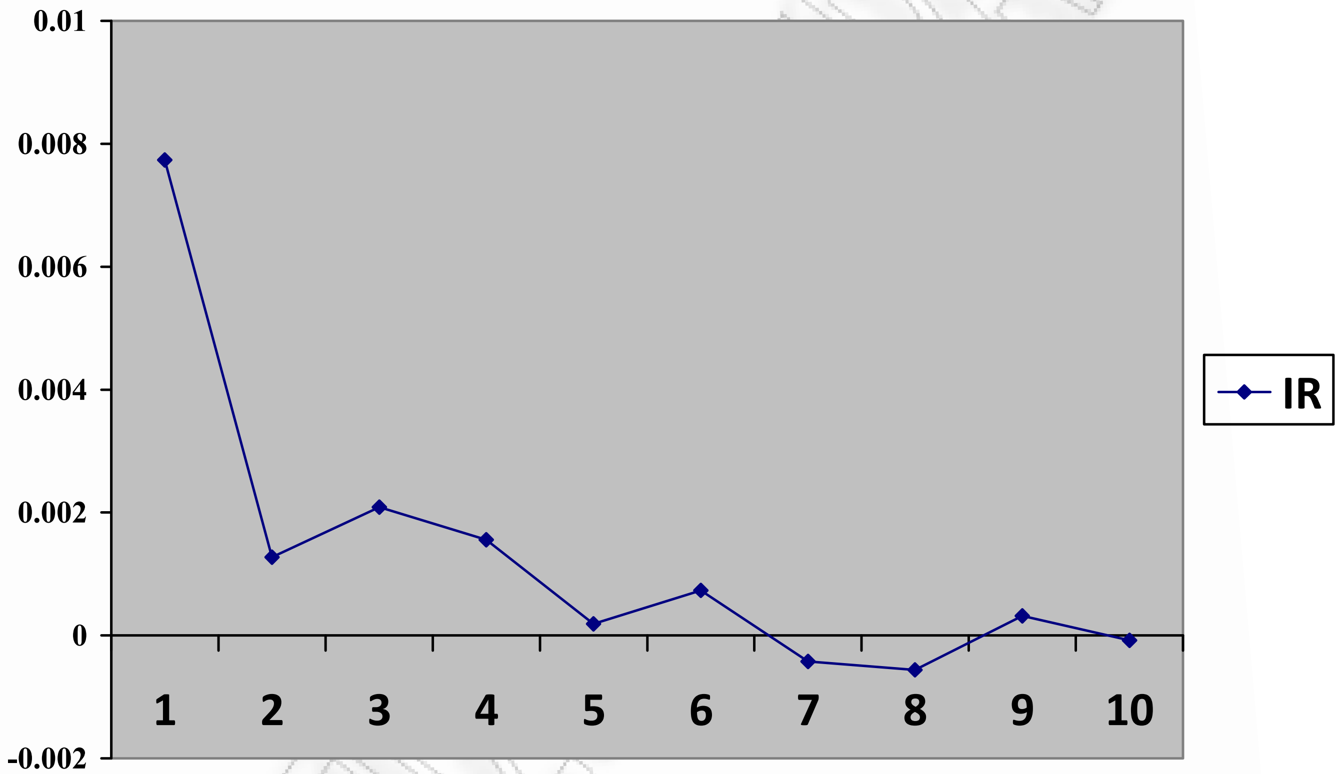
34.



Response of EU to IR shocks (1980-1999)

(Response to cholesky one s.d. innovations)

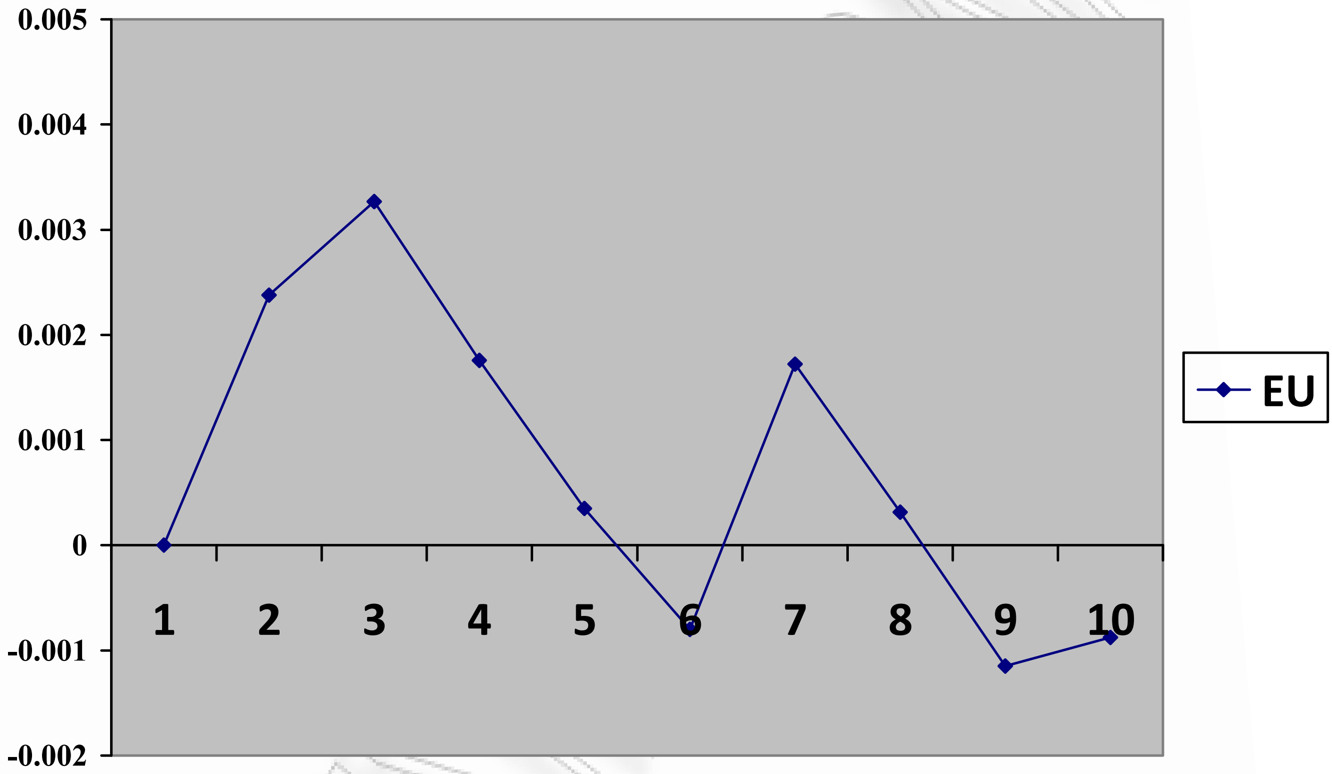
35.



Response of IR to EU shocks (2000-2010)

(Response to cholesky one s.d. innovations)

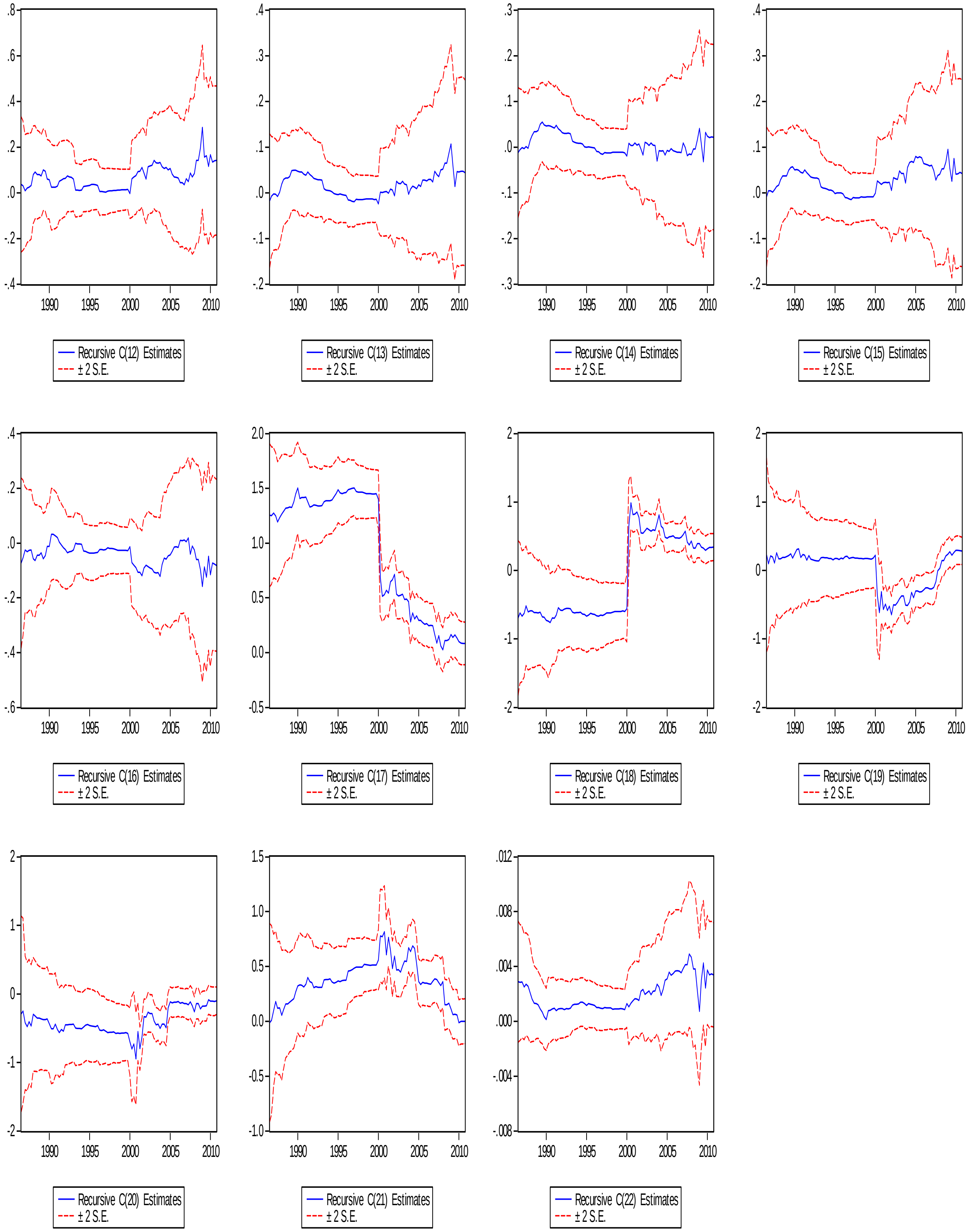
36.



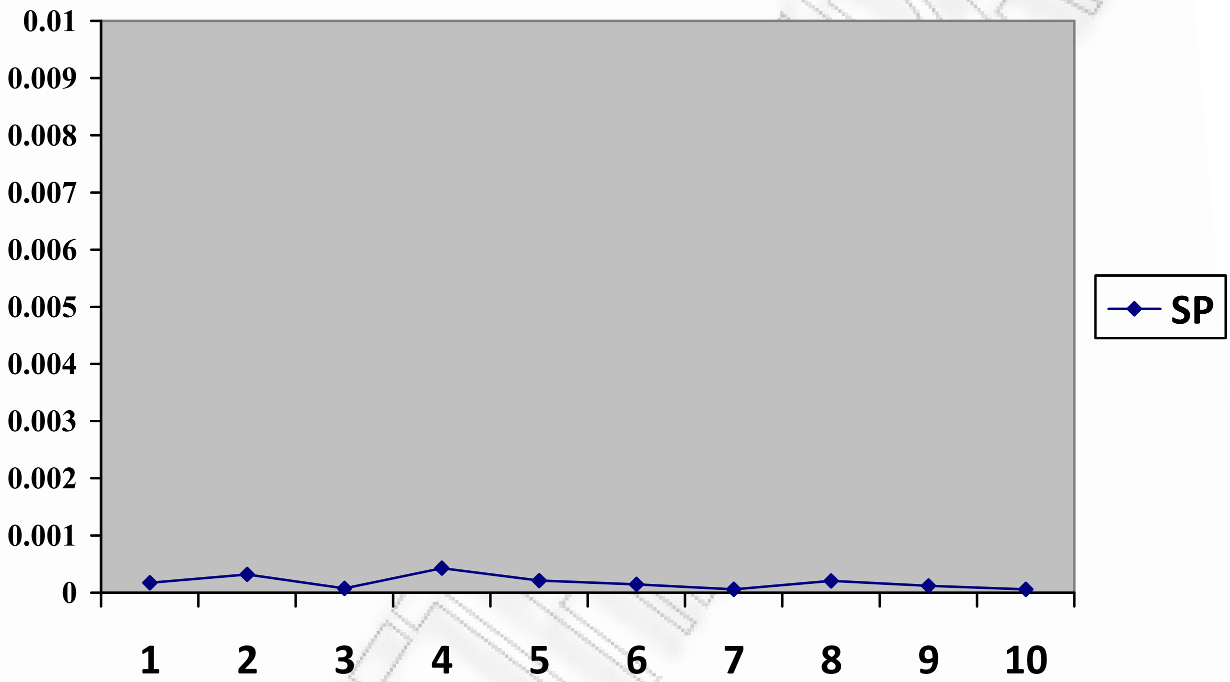
Response of EU to IR shocks (2000-2010)

(Response to cholesky one s.d. innovations)

37.


Recursive C(12) Estimates
± 2 S.E.
Recursive C(13) Estimates
± 2 S.E.
Recursive C(14) Estimates
± 2 S.E.
Recursive C(15) Estimates
± 2 S.E.
Recursive C(16) Estimates
± 2 S.E.
Recursive C(17) Estimates
± 2 S.E.
Recursive C(18) Estimates
± 2 S.E.
Recursive C(19) Estimates
± 2 S.E.
Recursive C(20) Estimates
± 2 S.E.
Recursive C(21) Estimates
± 2 S.E.
Recursive C(22) Estimates
± 2 S.E.

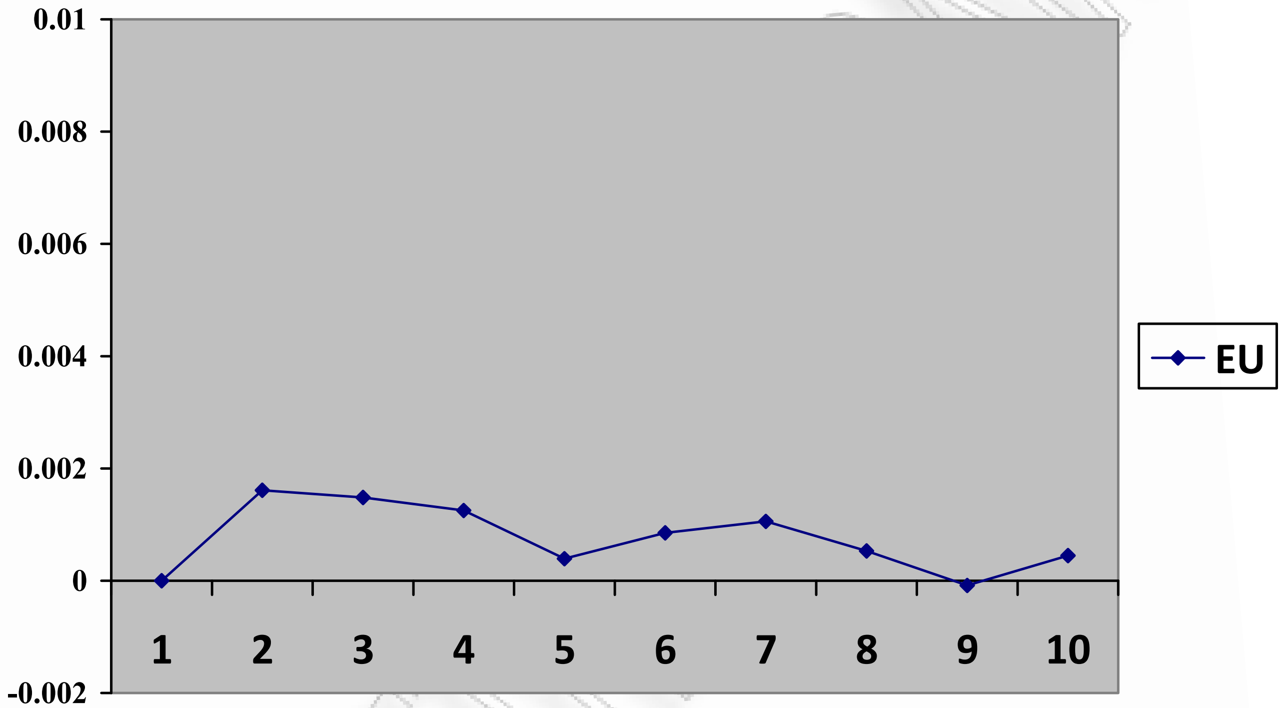
38.



Response of SP to EU shocks (1980-1999)

(Response to cholesky one s.d. innovations)

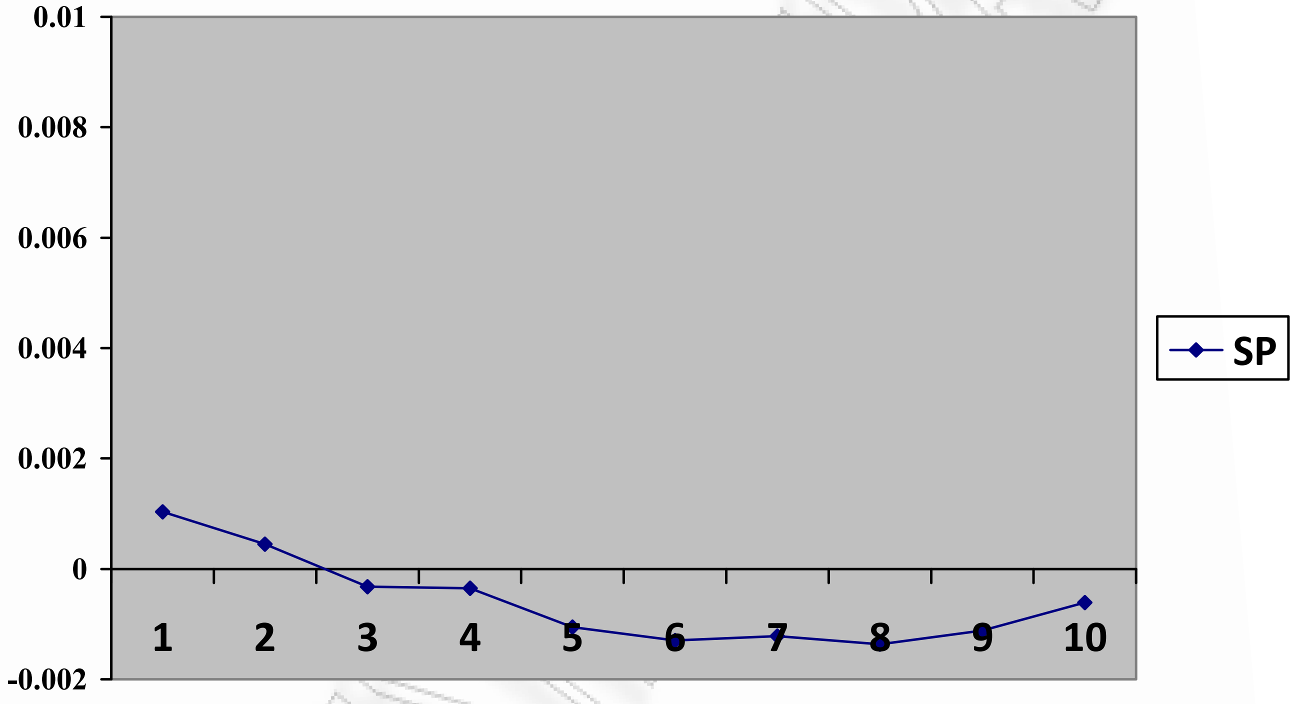
39.



Response of EU to SP shocks (1980-1999)

(Response to cholesky one s.d. innovations)

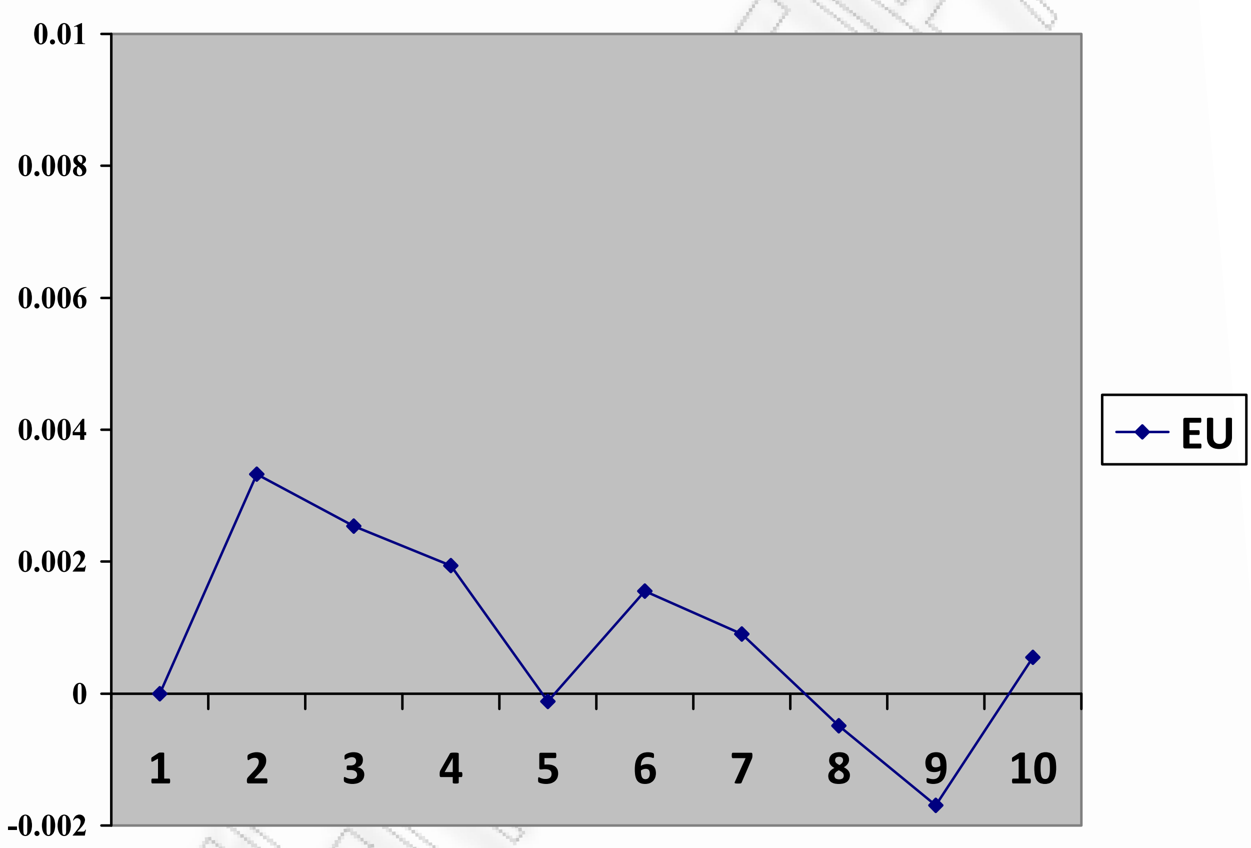
40.



Response of SP to EU shocks (2000-2010)

(Response to cholesky one s.d. innovations)

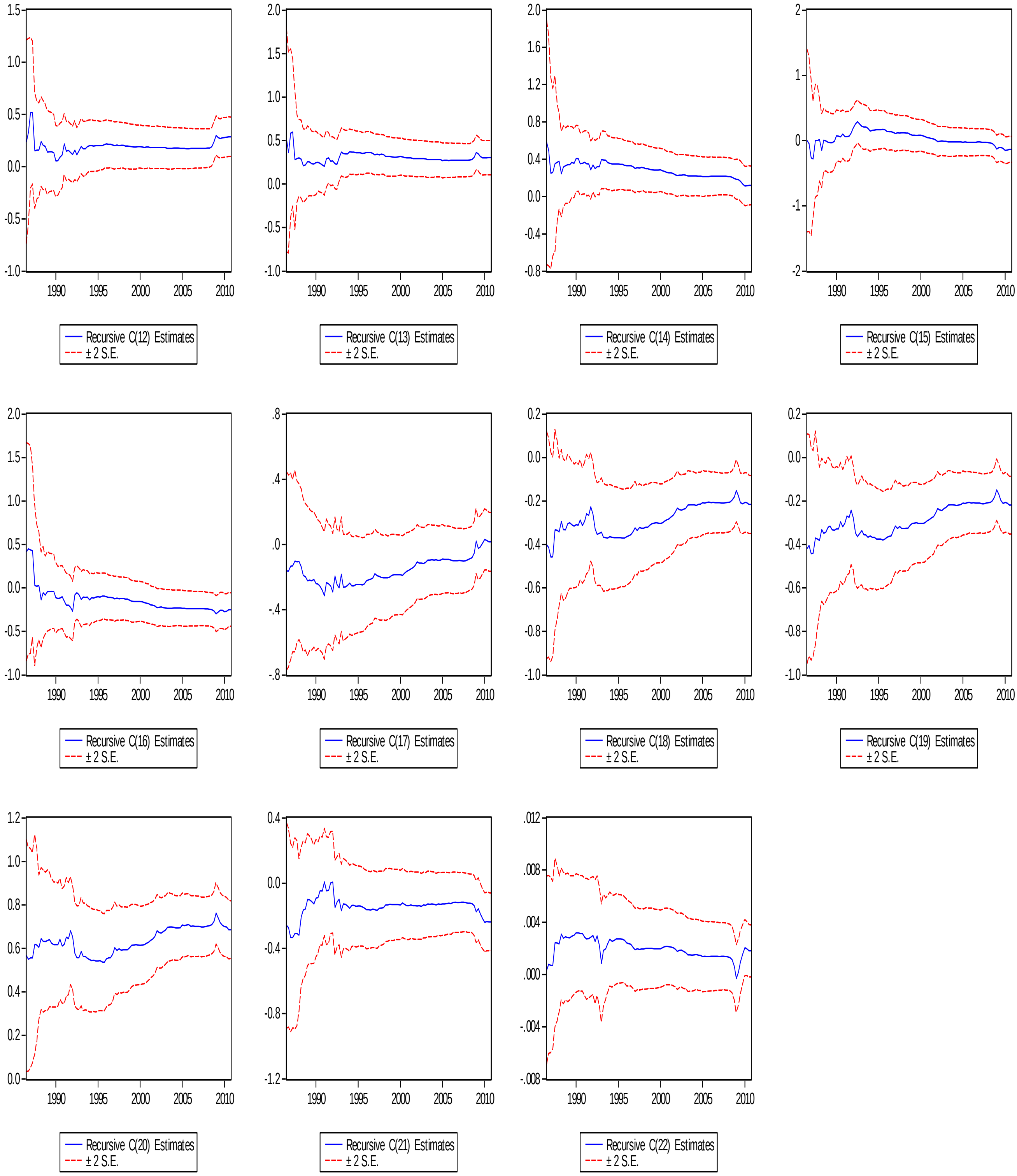
41.



Response of EU to SP shocks (2000-2010)

(Response to cholesky one s.d. innovations)

42.


Recursive C(12) Estimates
± 2 S.E.
Recursive C(13) Estimates
± 2 S.E.
Recursive C(14) Estimates
± 2 S.E.
Recursive C(15) Estimates
± 2 S.E.
Recursive C(16) Estimates
± 2 S.E.
Recursive C(17) Estimates
± 2 S.E.
Recursive C(18) Estimates
± 2 S.E.
Recursive C(19) Estimates
± 2 S.E.
Recursive C(20) Estimates
± 2 S.E.
Recursive C(21) Estimates
± 2 S.E.
Recursive C(22) Estimates
± 2 S.E.