Università degli Studi di Padova

Dipartimento di Scienze Statistiche

Corso di Laurea Triennale in Statistica Economia e Finanza

RELAZIONE FINALE

“On the impact of economic policy uncertainty shocks on macroeconomic expectations in the United States"

Relatore: Prof. Efrem Castelnuovo

Dipartimento di Scienze Economiche e Aziendali ‘Marco Fanno’

Laureanda**:** Lovato Clara

Matricola: 1010635

ANNO ACCADEMICO 2012/13

Alla mia famiglia che c'è sempre…

A papà e i nostri silenzi

A mamma e la sua tenacia

A Camilla e la sua dolcezza

A Edoardo e la nostra complicità

« L'incertezza è l'habitat naturale della vita umana, sebbene la speranza di sfuggire ad essa sia il motore delle attività umane. Sfuggire all'incertezza è un ingrediente fondamentale, o almeno il tacito presupposto, di qualsiasi immagine composita della felicità. È per questo che una felicità autentica, adeguata e totale sembra rimanere costantemente ad una certa distanza da noi: come un orizzonte che, come tutti gli orizzonti, si allontana ogni volta che cerchiamo di avvicinarsi a esso. »

Zygmunt Bauman

INDEX

Section 3: my **ANALYSIS** reporting mostly focus on estimates for the **dynamic responses** of aggregate economic outcomes for the baseline model to policy-related uncertainty shocks.

Section 4: considers several **ROBUSTNESS TESTS** and comparisons for my VAR model to find accordance and persistence with macroeconomic theory.

INTRODUCTION

"The economy, you know, is a dismal science. A science in which the forecasts have the power to determine the facts, and this happens with even greater consequences, even in cases where their predictions are impossible to formulate, and the market is groping in the darkness of uncertainty. Uncertainty is exactly what seems to be ailing the world economy today. What we are witnessing is the overlapping of a financial and economic instability, which are interwoven in an unstable geopolitical scenario, making the situation more and more difficult to decipher." Attilio di Battista, Junior Consultant - Economic Research at International Trade Centre

"L'economia, si sa, è una scienza triste. Una scienza in cui le previsioni hanno il potere di determinare i fatti; ciò vale, con conseguenze anche maggiori, anche nei casi in cui proprio le previsioni sono impossibili da formulare, ed il mercato brancola nel buio dell'incertezza. Proprio di questo sembra essere malata oggi l'economia mondiale: di incertezza. Ciò a cui oggi assistiamo è il sovrapporsi di un'instabilità economica e di una finanziaria, che si intrecciano in uno scenario geopolitico instabile, rendendo la situazione sempre più difficile da decifrare."

We officially entered the global economic crisis in the first quarter of 2008; this crisis continues to be a burden on the world economy to this day. The causes, that trigger this world economy's condition, are to be found largely in the financial crisis that hit the United States in the third quarter of 2007. The challenging problem of subprime, loans made by U.S. banks to risky borrowers who were unable to meet their mortgage repayments. In addition to this there have been a series of price increases, starting from raw materials, primarily oil, followed by the other fossil fuels, up to food including wheat and rice. Global inflation increased considerably too and a credit crisis developed causing a lack of trust in the financial markets.

In 2009 the industrial crisis made the GDP, of many countries (mainly Western), fell dramatically causing their entrance into recession. A rapid succession of negative concatenated events followed this situation, from which still nowadays the global economy is trying to come out with great difficulty. It triggered a search of Scott Baker, Nick Bloom and Steven J. Davis (2013) to understand the difficulties of an economic recovery in the USA. They identified a factor known as the uncertainty of economic policy, which concerns how managing difficult choices to make expenditures, loans and investments especially, for economic subjects, families and businesses, without economic certainties. This uncertainty is due to politicians' misguided or unsafe choices in terms of health care, taxation, commercial and financial operations, pushing more and more towards a risk-averse mentality. According to their idea, the lack of security in the micro and macro-economic world causes a vicious cycle where fewer resources are invested in innovation production, less business staff recruited that increases unemployment, and in addition more and more families have turned to 'hiding their money under the mattress'. This prevents from laying the groundwork for an effective growth and it does not concern only the present but also the long run. With their study, the three researchers have created an index that is able to measure the uncertainty of U.S. economic policy in order to understand the significant impact on the economic cycle and maybe be able to predict the effects and changes.

I am interested in how aggregate of output, interest rate, inflation and stock-market index respond to movements in policy-related economic uncertainty. Here I adopt a simple empirical approach to this question, using Vector Auto Regressions (VAR) and simple identifying assumption to estimate the effects of policy uncertainty on aggregate outcomes. I fit a VAR and recover orthogonal shock using Cholesky decomposition with the following ordering: the log of the S&P 500 index, the policy uncertainty index, the consumer price index to control the inflation, the real gross domestic product, the federal funds rate to control the interest rates. In my baseline specification, I run the VAR on quarterly-grow-rate data with four quarterly lags. This approach identifies dynamic relationships among the variables using the Cholesky ordering and differences in timing of movements in the variables.

The estimated effects of political uncertainty on output, inflation and interest rate and stock-market are robust to several modifications to the baseline VAR specification: a VAR(4) with 4 growth-rate variables. In the first robustness check I consider a VAR(4) with log variables comparing it with the baseline one. As a second robustness test I try to consider exogenous the FFR variable instead of endogenous focusing the attention on the possible variations and reactions of the growth-rate of GDP. Its controls what it will happen if the Fed decides to not react turning down the interest rate. As a third test I consider two models VAR(4) with an added variable; the stock-market index S&P500. These models differ for the variable FFR, firstly it is considered exogenous and secondly endogenous.

Therefore, I conduct a VAR analysis, using Cholesky orderings to construct orthogonal shocks and the policy-related uncertainty index to investigate its role as one potential driver of the real economic variables such as inflation, interest rate and GDP. I find that a policy uncertainty shock foreshadows drops of 10% in interest rate after 40 quarters (10 years) and GDP reductions of 16% within 40 quarters. These findings reinforce concerns that policy-related economic uncertainty played a role in the slow growth and fitful recovery of recent years, and they invite further research into the effect of policy-related uncertainty on economic performance.

Section 1: DATA AND VARIABLES

The time series, that make up the vector autoregressive model, have quarterly frequency and cover the following macroeconomic variables USA:

1. **S&P500**
2. Economics Policy uncertainty index **EPU**
3. Consumer price index for all urban consumer, all items **CPI**ASUCSL
4. Real gross domestic product **GDP**C1
5. Effective federal funds rate **FFR**

They cover this time range: 1985-01-01 to 2008-04-01. From the first quarter of 1985 to the second of 2008 , when the economic crisis was exploding.

1.1 S&P500

Widely regarded as the best single gauge of the U.S. equities market, this world-renowned index includes 500 leading companies in leading industries of the U.S. economy. Although the S&P 500® focuses on the large cap segment of the market, with approximately 75% coverage of U.S. equities, it is also an ideal proxy for the total market. S&P 500 is part of a series of S&P U.S. indices that can be used as building blocks for portfolio construction.

The S&P 500 was built by Standard & Poor's in 1957 and follows the trend of a stock basket formed by the 500 U.S. companies with the largest capitalization. The weight given to each company is directly proportional to the market value of the same. This index is the most widely used to measure the performance of the U.S. equity market and is now recognized as a benchmark for the performance of the portfolio. The Future on S&P 500 introduced in 1982, is the main tool used by managers to follow the index or to hedge the U.S. market. It is contracted at the CME (Chicago Mercantile Exchange).

1.2 Economic Policy Uncertainty index EPU

Uncertainty about tax, spending, monetary and regulatory policy slowed the recovery from the 2007-2009 recession. To measure policy-related economic uncertainty and to estimate the dynamic relationship between output, investment and employment this EPU index was built from three types of components. One component quantifies newspaper coverage of policy-related economic uncertainty. A second component reflects the number of federal tax code provisions set to expire in future years. The third component uses disagreement among economic forecasters over a future federal government purchases and the future CPI price level as a proxy for uncertainty.

Firstly, EPU index is a new measure and a good proxy for actual policy uncertainty and we can have its evolution since 1985. Secondly, as my thesis's aim, I estimate the dynamic response to policy-related uncertainty shocks on economic activity in simple vector autoregressive (VAR) models. The VAR estimates show that an innovation (shock) in policy uncertainty is followed by a decline of about 16% in real GDP (from variance decomposition of my baseline VAR model) within 40 quarters. However, the VAR results show that increases in our policy-related economic uncertainty index foreshadow declines in output, investment and employment. Many measures of uncertainty rise in recession and fall in recoveries, suggesting that uncertainty could play an important role in driving business shocks. It spikes near consequential presidential elections and major events such as the Gulf wars and the 9/11 attack. It also rises steeply from 2008 onward, as we can see from ***Figure 1***.

Some intuitions behind the depressing effect of uncertainty goes back at least to Bernanke (1983). He points out that an high uncertainty gives firms an incentive to delay investment and employment decisions. If every firm waits to invest or hire, the economy contracts generating a recession. When uncertainty falls back down, firms start hiring and investing again to address pent-up demand.

Recently, many commentators have argued that policy-related uncertainty has been a key factor slowing the recovery from the recession of 2007-2009. The claim is that businesses and households are uncertain about the future taxes, spending levels, regulations, health-care reform, and interest rates. In turn, this uncertainty leads them to postpone spending on investment and goods' consumption and to slow hiring, impeding the recovery.

Nowadays the world's stock markets do not react to news that comes from the economic world, but they look more at the political sphere. That, unfortunately, is not able to give certainty to the markets neither in the United States nor in Europe. And this not only slows down the recovery today, but also weakens the long-term growth. The most striking feature of the current stock market volatility is that the politicians are making news. Their actions and statements regarding bailouts, budget and reforms of the regulatory framework determine the fluctuations of the markets.

This is not normal. Before the financial crisis of 2008, the economic news influenced the financial markets 'performance. A growth in GDP and positive data about employment blew the markets. Negative corporate results caused the stock market crash. Today, unfortunately, the politicians fail to agree generating a broad economic uncertainty. According to our new index, in the 2012 the political uncertainty was close to its all-time highs (Figure 1). Uncertainty is one of the main factors that slow the recovery and threatens to cause a new recession.

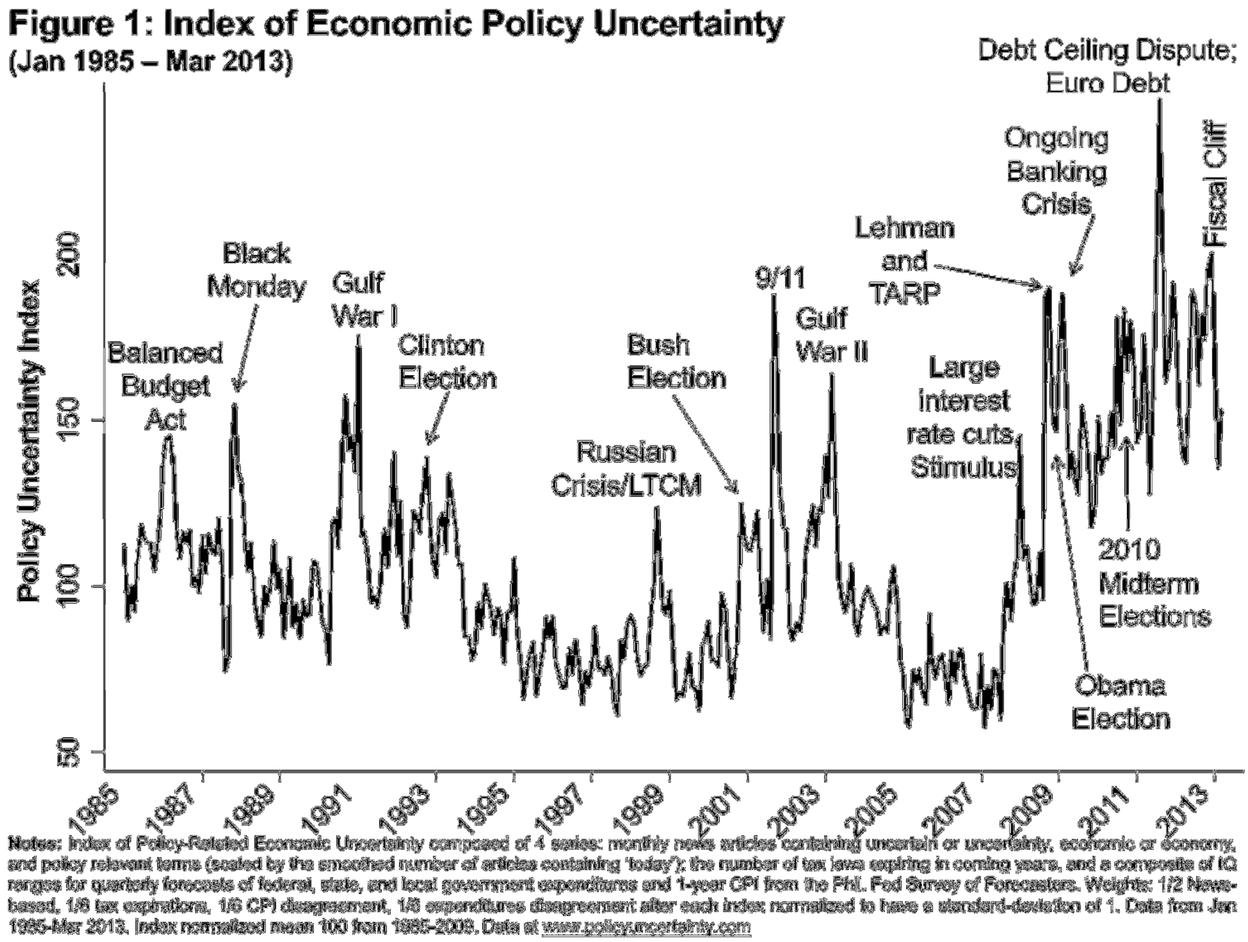


Figure 1. Economic policy uncertainty index in United States. Source: Baker, Bloom e Davis (2011), "Measuring Economic Policy Uncertainty", Chicago & Stanford mimeo.

This graph displays the Policy-Related Economic Uncertainty index: EPU. We can find spikes in uncertainty corresponding to several well-known prominent events and a substantially higher level of uncertainty since the onset of the Great Recession in 2007. In particular, we find spikes associated with consequential presidential elections, wars, 9/11 attack, contentious budget battles, and a number of spikes during and after the Great Recession. The average index value is 109 in 2006 (the last year before the current crisis) and 233 in the first eight months of 2011 (all-time high); a difference of 124. Uncertainty is considerably higher in the past 10 years than in the previous 15 years.

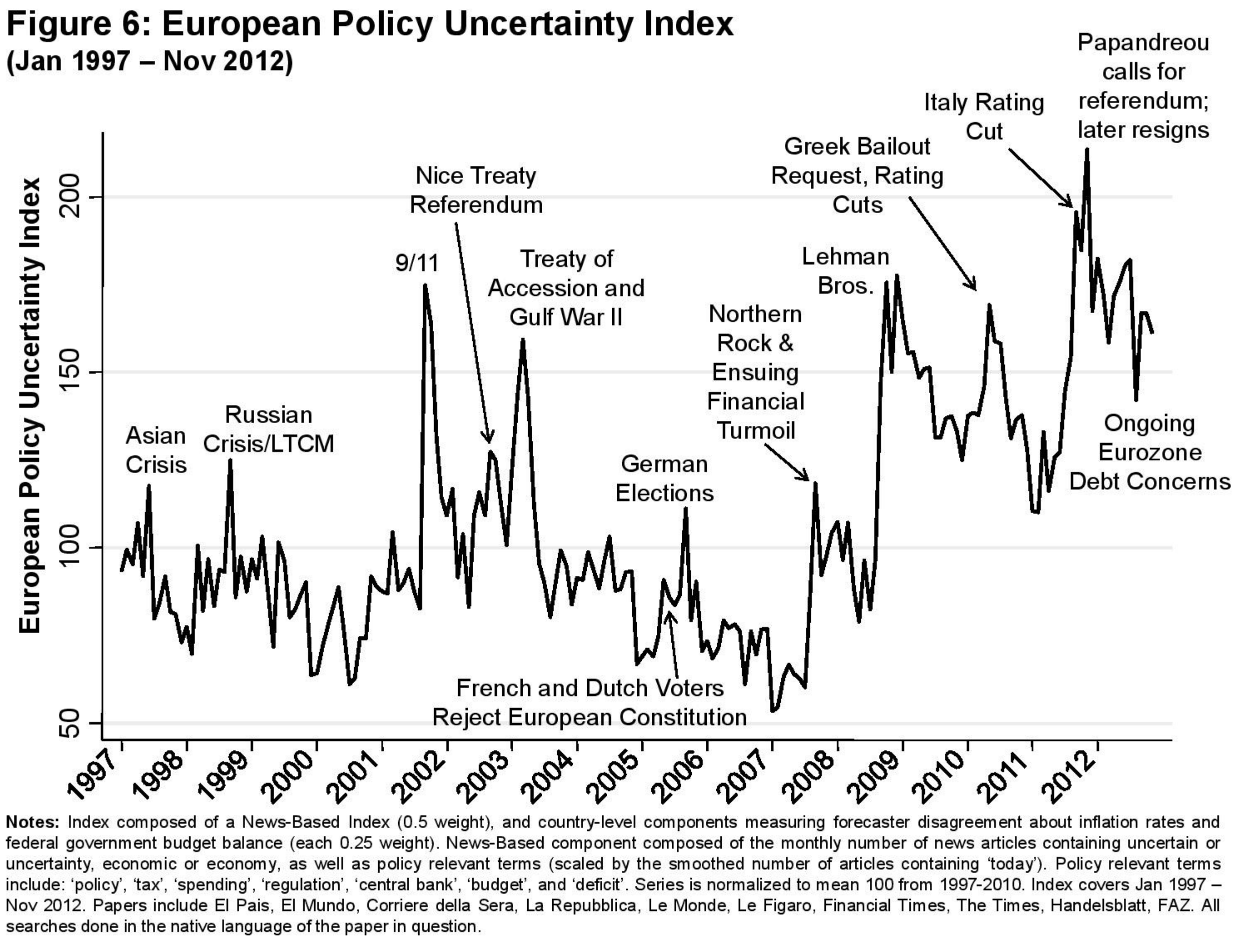


Figure 1. Economic policy uncertainty index in Europe.

From this figure we can compare the USA policy uncertainty index (*Figure 1*) with the European one (*Figure 6*); discovering that some peaks are common for both countries, while others are typical of Europe and its major financial and political events.

HOW TO MEASURE POLICY UNCERTAINTY?

Baker, Bloom and Davis have constructed an index of political uncertainty using three types of information: the frequency of newspaper articles about the economic uncertainty and the role of policy, the number of federal provisions in the tax due in the next years and the extent of disagreement between economic forecasts regarding the expected inflation and the purchase of goods and services by the government. Their index shows peaks during the period of uncertainty around major elections, wars and terrorist attacks of September 11. More recently, it peaked after the failure of Lehman Brothers in September 2008, following the approval of the package Tarp. It remained a high value from that moment onwards. Obviously, it is possible that the strong political uncertainty is a consequence of the economic uncertainty. To test this possibility, they use the lists of Google News to build a broad index of economic uncertainty *(red line in the Figure 2 below)* and a smaller index *(blue line)*, which focuses exclusively on the uncertainty policy. Comparing the two indices (*Figure*

2) we can notice the presence of high peaks of economic uncertainty that do not correspond to peaks of political uncertainty. Some examples are: the financial crisis in Asia in 1997 and some periods when it was feared a recession in the second half of the eighties. In summary, the data refute the thesis that economic uncertainty necessarily encourages political uncertainty.

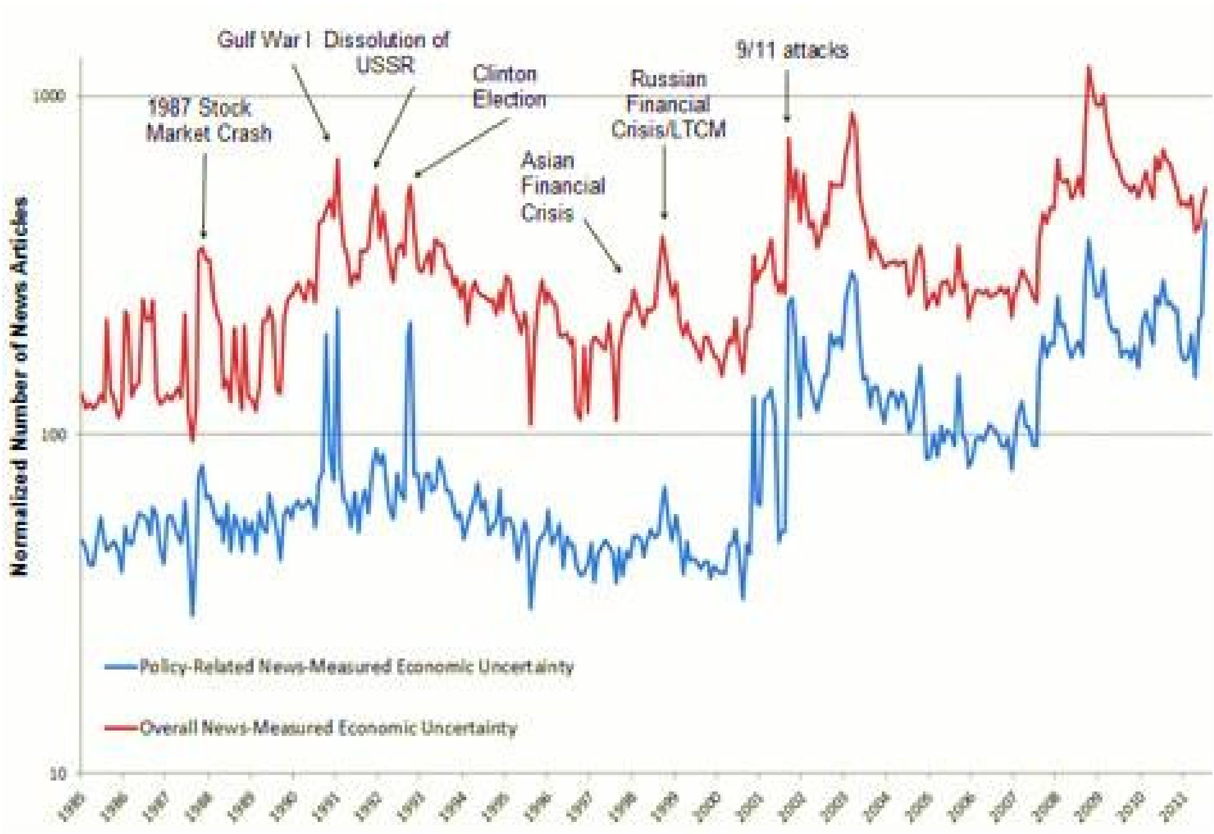


Figure 2. Policy Uncertainty and Economic Policy Uncertainty (overall Economic). Sources: Baker, Bloom e Davis (2011).

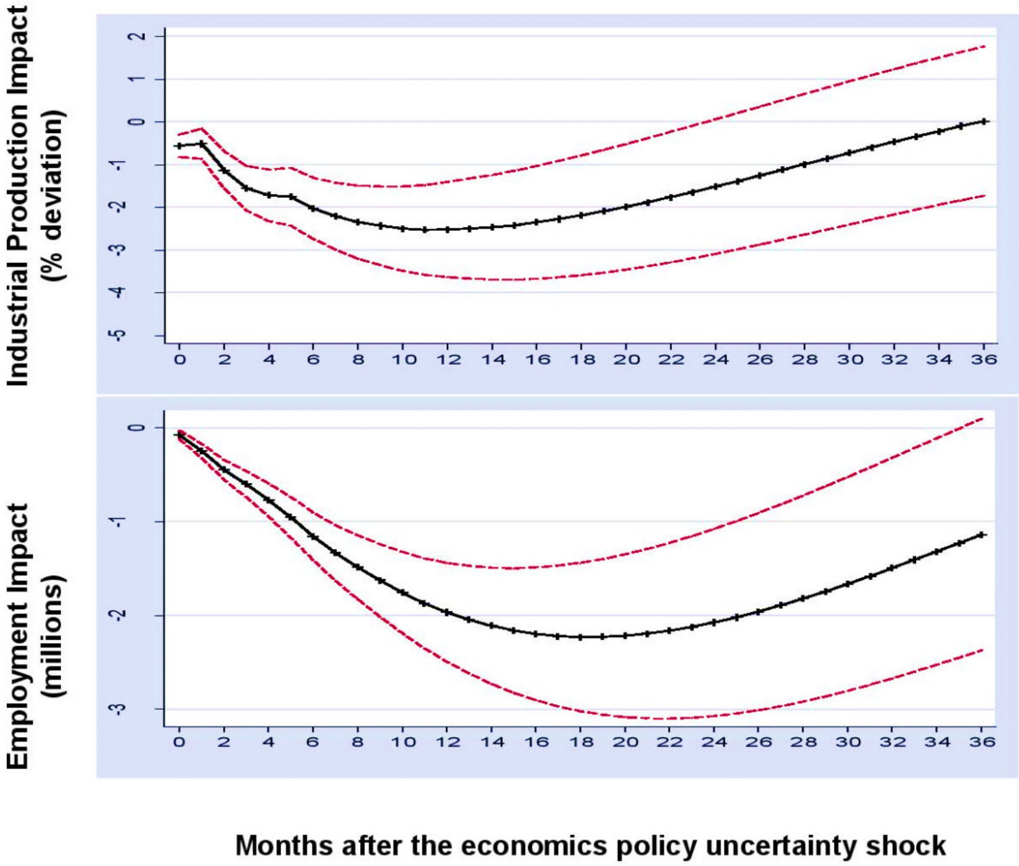
WHY THE POLITICY UNCERTAINTY IS SO HIGH?

To identify the reasons for the policy uncertainty, they have deepened the lists of Google News and quantified the mix of factors. Many factors determine the high levels of political uncertainty of 2010-2011, but the monetary and fiscal aspects are the most important. An example is ***the tax cuts introduced by George W. Bush about the income**, which originally were supposed to expire at the end of 2010. Democrats and Republicans have taken opposing positions on the need to eliminate them or not. Instead of taking a decision in advance of the deadline and eliminate the uncertainty, Congress waited until the last minute to decide to extend the tax breaks. The recent decisions of the Senate on ***raising tariffs on imports from China** are likely to trigger a trade war. In Europe, the ongoing discussions about ***possible bailouts of countries and banks** feed the climate of political uncertainty.

WHY THE POLITICAL UNCERTAINTY IS DANGEROUS?

When companies do not have certainty on taxes, health care costs and the framework of rules assume a cautious position. Making mistakes on investment and hiring are expensive, so many companies expect quieter moments to expand. If too many businesses wait, the recovery does not take off. And low capital investment, product development and training of staff weaken the long-term growth. Baker, Bloom and Davis might expect some improvement in the short term by a stable political system, which was able to increase the certainties? They use simple assumptions and identification vectors of auto regression (for which Sims won the Nobel Prize this year) to estimate the effects of political uncertainty. Their Var for the United States (Figure 12) suggests that bringing political uncertainty to 2006 levels could increase industrial production by 4 percent and create 2.5 million jobs in eighteen months. It is not enough to trigger an economic boom, but it would be a big step forward.

Figure 12: Estimated Industrial Production and Employment after a Policy Uncertainty Shock



Notes: This shows the impulse response function for Industrial Production and employment to an 102 unit increase in the policy-related uncertainty index, the increase from 2006 (the year before the current crisis) to 2011. The central (black) solid line is the mean estimate while the dashed (red) outer lines are the one-standard-error bands. Estimated using a monthly Cholesky Vector Auto Regression (VAR) on the EPU index, log(S&P 500 index), federal reserve funds rate, log employment, log industrial production and linear time trend. Fit to data from 1985 to 2011.

1.3 Consumer Price Index for All Urban Consumers: CPI and INFLATION RATE

The Consumer Price Index (CPI) is a measure of the average change over time in the prices of consumer items goods and services that people buy for day-to-day living. Firstly you have to decide what goods and services included in the average, the CPI follows only the trend of the consumer prices, not taking into account the goods and services not directly purchased by consumers. The CPI is a complex construct that combines economic theory with sampling and other statistical techniques and uses data from several surveys to produce a timely and precise measure of average price change for the consumption sector of the American economy. Production of the CPI requires the skills of many professionals, including economists, statisticians, computer scientists, data collectors, and others. The CPI's surveys rely on the voluntary cooperation of many people and establishments throughout the country who, without compulsion or compensation, supply data to the Government's data collection staff.

The Bureau of Labor Statistics (BLS) publishes CPI data every month. The three main CPI series are:

- CPI for All Urban Consumers (CPI-U)
- Chained CPI for All Urban Consumers (C-CPI-U)
- CPI for Urban Wage Earners and Clerical Workers (CPI-W)

The CPI for All Urban Consumers, or CPI-U, which BLS began publishing in January 1978, represents the buying habits of the residents of urban or metropolitan areas in the United States. Each month's index value displays the average change in the prices of consumer goods and services since a base period, which currently is 1982-84 for most indexes. For example, the CPI-U for March 2002 was 178.8. One interpretation of this is that a representative set of consumer items that cost $100 in 1982-84 would have cost $178.80 in March 2002. The CPI provides an estimate of the price change between any two periods. The percent change between the CPIs for two periods indicates the degree to which prices changed between them. The CPI follows the prices of a sample of items in various categories of consumer spending—such as food, clothing, shelter, and medical services—that people buy for day-to-day living.

The inflation rate, an indicator of the relative change (in time) of the general price level, allows you to see the change in the purchasing power of the currency. It is usually expressed in terms of percentages. Central banks today consider that their main mission is to ensure price stability with the intent to hold the inflation rate low enough, so that there is any abundant concern for anyone.

The causes of inflation may be different; one of them is determined by the degree to which the increase in the money supply exceeds demand (expansionary monetary policy) that stimulates demand for goods and services and investments. This is a reason that economists have found for price increases in the long run. Other causes can be found in the increase in prices of goods and the increasing cost of imported inputs and intermediate goods. Moreover the increase in cost of inputs also plays a role important to the rising cost of labor.

- INFLATION FROM EXCESS OF CURRENCY

This is the monetarist explanation, which identifies the cause of inflation in the excess of monetary emission with respect to the level required by the volume of transactions. Since the system, according to the monetarists, tends to equilibrium at full employment, any excess money will necessarily release on prices. For monetarists, inflation is due to the errors of the central banks that overly expand the money supply and to excessive government spending.

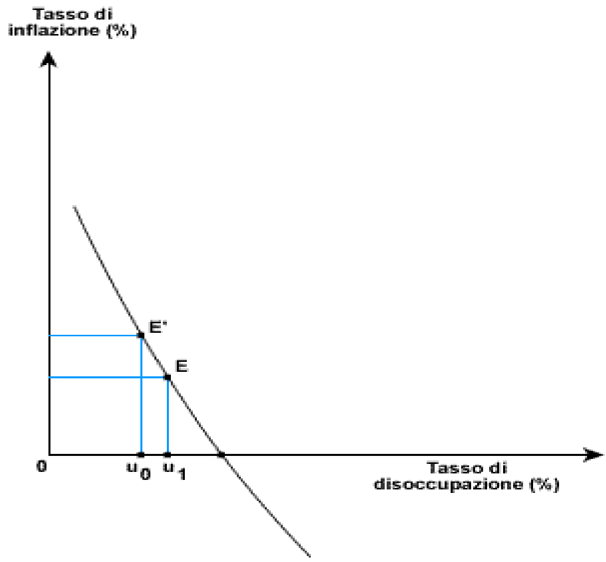
- DEMAND-PULL INFLATION

This is the Keynesian explanation, which considers the inflation caused by an excess of global demand on global supply. This type of inflation is typical of economies under conditions of full employment. When the inputs are fully employed, an excess of demand over supply causes a general increase in prices, as businesses, searching for workers and raw materials, offer higher wages and prices, spreading in the system the upward pressure on prices. This increase is higher if the difference between aggregate demand and aggregate supply is higher.

- COST-PUSH INFLATION

This explanation, which reflects the conflict between the different social groups in the distribution of income, traces the inflation rise in prices caused by rising production costs, especially those related to labor and raw materials. If costs rise, employers respond by raising prices in order to protect their profits. Of course, the possibility of raising the prices depend on the market regime in which the companies operate. If firms operate under perfect competition, the selling prices cannot be increased, and if they operate in an oligopolistic market, companies can increase selling prices, applying the principle of full cost or mark-up.

An explanation of inflation, regarding the category of cost inflation, was proposed in 1958 by the English economist A.W. Philips, who examined the relationship between inflation and unemployment in Britain in the period 1861-1957. The graphical representation of the trade-off between inflation and unemployment is called the Phillips curve. It is a graph that connects the rate of change of money wages (S) and the unemployment rate (D); the unemployed labor force as a percentage of the total.



The <u>effects</u> of inflation are negative for the whole economic system. There are damages for **workers**, since, during inflation, the individual prices do not increase uniformly but have a great variability with serious consequences in distribution of income. However, you can limit the damage on workers by automatic indexing mechanisms that allow you to increase wages in relation to the increase in cost of living. The damages are not just for **savers** but also for the **creditors**, while the debtors are favored by inflation. The underwriters of government bonds, small investors, holders of insurance or not indexed annuities perceive income that remains nominally unchanged and do not follow the decrease in the purchasing power of the currency. This definitely damages to **companies and firms**. **Entrepreneurs**, at least at first, can benefit from the presence of inflationary pressures, it is called annuity by inflation. This advantage does not last because, after a first moment, industrial investments are discouraged since interest rates grow, the difficulty of forecasting and planning inevitably increases, the loss of value of money discourages savings and slows down investments and the formation of new capital. In this area there is also the damage to **public finances** since, because of inflation, instability tends to spread in the tax system that is not able to obtain immediately the appropriate revenues to public expenditure inflated by the inflation. Inflation then causes damage to the entire system by reducing the **export competitiveness**. In fact, if prices increase, production costs increase in line with these price increases and this ultimately results in a reduction in exports.

The most common <u>remedy</u> is indexing: wages, mortgages, bonds, contracts supply.

Inflation is <u>measured</u> in two ways: by means of the **Consumer Price Index** (**CPI**), or through the construction of an index of consumer prices. It is one statistical tool that measures changes over time in the prices of a set of goods and services, called the basket, representative of the actual consumption families in a specific year. Another measurement tool is the **GDP deflator**. The GDP deflator is a tool that allows you to "purify" the growth of GDP by rising prices. Since the Gross Domestic Product is the product, price for quantity, we should know if the growth from one year to another is given by the quantity or produced by rising prices. The deflator is then given by the ratio of Nominal GDP(amount for current prices) and real GDP (constant prices for quantity). Since the value of real GDP is independent of the price dynamics, its changes in value reflect only changes in production economy. Therefore, the GDP is a measure of the production of goods and services. The two indices are moving in the same direction and differ by less than a point percentage.

1.4 Real gross domestic product GDPC1

Gross domestic product (GDP) is the inflation-adjusted measure of the market value of all goods/services produced within the geographical boundaries of the Unites States, regardless of whether the workers/owners are US citizens or not.

GDP is measured as the sum of personal consumption expenditures, gross private domestic investment, net exports of goods and services (exports less imports), and government consumption expenditures and gross investment; GDP = C + I + G + (EX - IMP).

GDP excludes intermediate purchases of goods and services by business.

Real income is the main measure for the material well-being and economic productivity. In my analysis, I use a logarithmic transformation 100 * log(GDP).

1.5 INTEREST RATE and Effective federal funds rate FEDFUNDS/ FFR

The interest rate shows concretely the theoretical price paid by those who receive capital and collected by who offers them. The debtor, receiving a sum of money, agrees to pay a sum greater than the one received. The difference is the interest, which is usually calculated as a percentage of the amount lent. This is the percentage interest rate. The interest rate is variable even in function of the reference currency, the risk related to the solvency of the debtor and the length of the reference period. The data, which I use in my paper, refer to the rate of short-term interest set by the Fed (Federal Reserve, that is the Central Bank of the United States of America), therefore also called the Federal Funds Rate; FFR.

The Federal funds rate is the interest rate at which banks loan each other overnight funds from their balances with the Federal Reserve.

Expanded Definition: The Federal funds rate is a target rate set by the Federal Reserve for overnight loans between banks. These overnight loans enable banks to maintain enough reserves to meet federal requirements.

The target interest rate does not determine how much it costs to borrow funds overnight; the actual rates are set by the open market. The weighted average of all of these transactions determines the effective rate, which is usually slightly higher than the nominal or target rate. Because of this relationship between the target and the effective rates, changing the Federal funds rate either encourages or discourages banks from raising capital through borrowing. In this way, the Federal Reserve affects how freely the economy operates. The rate of interest on overnight loans of excess reserves made among commercial banks.

Because the Federal Reserve has significant control over the availability of federal funds, the rate is considered an important indicator of Federal Reserve monetary policy and the future direction of other interest rates. A declining federal funds rate may indicate that the Federal Reserve has decided to stimulate the economy by releasing reserves into the banking system.

Case Study: The Federal Reserve announced in early December 2001 it was lowering its target federal funds rate from 2.00% to 1.75%, the lowest level in 40 years. The quarter-point decline represented the 11th reduction in the benchmark short-term interest rate since the beginning of the year and established a target rate lower than the rate of inflation. The federal funds rate represents the rate that banks pay to borrow reserves from other banks. This rate influences other short-term rates, including the prime rate and the interest rate on U.S. Treasury bills. The aggressive Federal Reserve policy toward reducing interest rates was intended to stimulate a weak economy that had produced rising unemployment and business failures, especially following the September 11 terrorist attacks in New York City and Washington, D.C.

The Federal Reserve has tools available to affect short-term interest rates but not long-term rates, which are influenced by inflation expectations of lenders and borrowers. Thus, an aggressive policy by the Federal Reserve that reduces interest rates is the main way for the central Bank to stimulate the economy's recovery. Making the dollar more expensive (increasing the rate of interest) causes a reduction in the currency demand by the banking system and thus placing less liquidity in the production system. By doing this, you can keep inflation under control in the growth phase. But now, in times of economic crisis and recession, this would definitely be a suicidal maneuver.

The Federal Reserve Act specifies that the FOMC (Federal Open Market Commitee) should seek "to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates." At each meeting, the FOMC closely examines a number of indicators of current and prospective economic developments. Then, cognizant that its actions affect economic activity with a lag, it must decide whether to alter the federal funds rate. A decrease in the federal funds interest rate stimulates economic growth, but an excessively high level of economic activity can cause inflation pressures to build to a point that ultimately undermines the sustainability of economic expansion. An increase in the federal funds interest rate will curb economic growth and help contain inflation pressures, and thus can promote the sustainability of an economic expansion, but too large an increase could retard economic growth too much. The Committee's actions on interest rates are undertaken to achieve the maximum rate of economic growth consistent with price stability and moderate long-term interest rates.

The interest rate that banks charge each other for the use of Fed funds. It changes daily and is a sensitive indicator of general interest rate trends. The Fed funds rate is one of the two interest rates set by the Fed, the other being the discount rate. While the Fed can't directly affect this rate, it effectively controls it in the way it buys and sells Treasuries to banks. This is the rate that reaches individual investors, though the changes usually aren't felt for a period of time.

Applying the transformations…

Using the data in its original format could be difficult to interpret. So, after having them turned quarterly, I decided to apply some transformations to make the data more "easily" interpreted, creating new variables most representative or reducing the number of total variables improving the performance of the model

Variable rate: $(p_t - p_{t-x})/p_{t-x}$ is the variation of an amount compared to the period of the previous survey. If the survey is quarterly, it is the variation of a quarter compared to the previous one. Therefore, we want to highlight the progressive course, the trend and the size.

Mathematical transformations: The mathematical functions applied to transform the data are useful to standardize distributions abnormal, trying to linearize a variable. The logarithmic transformations are used to normalize a variable, such as the income, that has an asymmetric distribution. These also tend to reduce the effects of outliers. Taking the logarithm, these variables are turned to normally distribute the data, in this way the result is easy to interpret and sometimes the quality of the results improves too.

1. S&P500 → transformation: **log(S&P500)**
2. EPU
3. CPIASUCSL → transformation: $(p_t - p_{t-4})/p_{t-4}$ **INFLRATE**
4. GDPC1 →transformations:$(p_t - p_{t-4})/p_{t-4}$ **YRATE** or $100 * log(realGDP)$ **log(GDP)**
5. FFR

Section 2: VAR MODEL THEORY

In the early 80's, in response to strong criticism addressed to the "structural models" based on systems of simultaneous equations (SES) VAR models were introduced.

2.1 TRADITIONAL APPROACHES

2.1.1 Structural models

- ✓ Attempt to translate economic relations, based on the theory, deterministic by definition, in statistical equations (i.e. stochastic).
- ✓ The purpose of these structural models was to estimate empirically the coefficients linking the variables of the economic system, and then answer the following question: 'what is the effect of an action of the "policy" variables (considered exogenous to the system and under the control of policy makers) on the variables of interest (considered endogenous)?

2.1.2. Critique of Lucas

- ✓ The economic agents behave in a "forward-looking": that is, the current values of the variables are influenced by expectations about the future of the economy.
- ✓ These agents adjust their expectations based on the information available.
- ✓ New economic policies change available information and expectations of the agents and the parameters change accordingly.
- ✓ Inability to identify the parameters "deep" (deep-parameters) that describe the preferences of consumers and the technology available, the parameters that describe the way in which people form expectations.

2.1.3 LSE approach

- ✓ Economic theory suggests the general specification of the relevant form of the model, but the precise representation of the PGD (data generating process) is unknown. So, to find the model that best describes the data, the assumed PGD is unknown by definition.
- ✓ Model in a reduced form is "well specified" in statistical terms.
- ✓ Test empirically assumptions of exogenous variables.

2.2 SIMS: VECTOR AUTOREGRESSION (VAR) MODEL

With two important articles Sims (1980,1982) introduces VAR models as a response to the "failure" of the traditional one and gave a new approach: starting from a model based on empirical data and on statistical theory, in order to identify the "real" relationships between variables. Some features:

- ✓ All variables of the economic system are treated as endogenous, there are no prior information derived from economic theory.
- ✓ The estimated model is "unrestricted", which turns out to be a pure statistical model.
- ✓ From the unrestricted model, some restrictions allow to give an economic interpretation to the model: structural VAR (SVAR).
- ✓ VAR models are not intended to describe the whole economy on a large scale, we focus on a limited number of economic variables Y (n × 1 vector).
- ✓ VAR models are reduced form models: consist of systems of equations that relate the current values of a given set of economic variables with past values of the variables themselves.
- ✓ All variables assume therefore endogenous nature, while they are only considered exogenous shocks to the system.
- ✓ The emphasis is more on the statistical properties of the model and its ability to grasp the PGD (data generating process).
- ✓ There are more sophisticated techniques, which can easily be extended to multivariate analysis, and more structure in our empirical analysis: we can more clearly see the links between empirical and theoretical macroeconomics.

Vector Auto Regressions (VAR) is the dominant research methodology in empirical (time series) macroeconomics. Its goal is the dynamic response of various macro variables to an unexpected exogenous economics policy shock. This is exactly what I want to search in my paper.

2.2.1 Advantages:

- ✓ The **flexibility** of the autoregressive formulation allows a statistical description of a wide range of real data sets and provides a **unifying framework** in which to analyze alternative theories and hypotheses.

2.2.2 Disadvantages:

- ✓ Such models do not represent the truth in economics but are a useful tool for gaining insight into the **interactions** between different variables.
- ✓ **Difficult to interpret** the estimation results of an unrestricted VAR
- ✓ Unable to say **anything** about **how the economy reacts** to different shocks
- ✓ Many econometricians consider SVARs as more **art** than science. One way to assess the robustness of the results is to see whether the impulse responses match our economic intuition and expectations from economic theory.

2.2.3 Applications:

The dynamic properties of a VAR(p) are often synthesized through various types of structural analysis. Structural VAR models have four main applications:

1. **Impulse response functions (irf)**: they are used to study the average response of the model variables to a given one-time structural shock.
2. They allow the construction of **forecast error variance decompositions** that quantify the average contribution of a given structural shock to the variability of the data.
3. They can be used to provide **historical decompositions** that measure the cumulative contribution of each structural shock to the evolution of each variable over time.
4. Allow the construction of **forecast scenarios** conditional on hypothetical sequences of future structural shocks.

In my analysis I will consider just the first two applications of VAR model: impulse response functions and variance decompositions.

2.3 VAR MODEL STRUCTURE

Consider the **VAR(1) MODEL:**

$$\mathbf{y_t = \Phi_0 + \Phi_1 y_{t-1} + a_t} \qquad (1)$$

where

$y_t = (y_{1t}, \ldots\ldots, y_{kt})^T$ is a stochastic vector ($K \times 1$),

Φ_1 is a fixed matrix ($K \times K$) of coefficients,

Φ_0 is a vector ($K \times 1$) of intercepts (it allows the possibility of a mean different from zero),

$a_t = (a_{1t}, \ldots\ldots, a_{kt})^T \sim WN(0, \Sigma)$ with Σ not-singular matrix

For example, for $K=2$ we have

$$\begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix} = \begin{bmatrix} \phi_{10} \\ \phi_{20} \end{bmatrix} + \begin{bmatrix} \phi_{11} & \phi_{12} \\ \phi_{21} & \phi_{22} \end{bmatrix} \begin{bmatrix} y_{1,t-1} \\ y_{2,t-1} \end{bmatrix} + \begin{bmatrix} a_{1t} \\ a_{2t} \end{bmatrix}$$

with $a_t \sim WN(0, \Sigma)$

and

$$\Sigma = \begin{bmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{21} & \sigma_{22} \end{bmatrix}$$

so

$$y_{1t} = \phi_{10} + \phi_{11}\, y_{1,t-1} + \phi_{12}\, y_{2,t-1} + a_{1t}$$

$$y_{2t} = \phi_{20} + \phi_{21}\, y_{1,t-1} + \phi_{22}\, y_{2,t-1} + a_{2t}$$

The **analysis of the dependences between y_{1t} and y_{2t}** consists in analyzing the coefficients of the matrix:

$$\Phi_1 = \begin{bmatrix} \phi_{11} & \phi_{12} \\ \phi_{21} & \phi_{22} \end{bmatrix}$$

and of the covariance matrix:

$$\Sigma = \begin{bmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{21} & \sigma_{22} \end{bmatrix}$$

In particular the coefficients ϕ_{12} and ϕ_{21} measure the **dynamic effect** between y_{1t} and y_{2t}, while σ_{12} the **contemporaneous effect**.

To see the contemporaneous dependence explicitly, it goes like this:

- ✓ Apply the triangular decomposition to the positive definite matrix Σ, so $\Sigma = LDL^T$ where L is a lower triangular matrix with the same element (the unit) in the diagonal and D is a positive diagonal matrix, such that $L^{-1}\Sigma(L^T)^{-1} = D$.

- ✓ Transform the model in the following way:

$$L^{-1}y_t = L^{-1}\Phi_0 + L^{-1}\Phi_1 y_{t-1} + L^{-1}a_t = \Phi_0^* + \Phi_1^* y_{t-1} + b_t$$

  $E(b_t)=0$ and $Var(b_t)= L^{-1}\sum(L^T)^{-1}=D$ with D diagonal, so the components of b_t are uncorrelated.

- ✓ Given the nature of L^{-1} (triangularity and unity on the mean diagonal) the *k-th* equation of the model becomes:

$$y_{kt} + \sum_{i=1}^{k-1} l_{ki}\, y_{it} = \Phi_{k0}^* + \sum_{i=1}^{K} \phi_{ki}^*\, y_{i,t-1} + b_{kt}$$

  It shows explicitly the contemporaneous relation between y_{kt} and y_{it}, $1 \le i \le k-1$.

Some recalls:

✓ CHOLESKY DECOMPOSITION

Let A be a symmetric and positive definite matrix.
So a unique triangular and lower matrix *P* exists such that ***A=PP^T^***.

$$A = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \quad P = \begin{bmatrix} \sqrt{a} & 0 \\ b/\sqrt{a} & \sqrt{d - b^2/a} \end{bmatrix}$$

✓ TRIANGULAR DECOMPOSITION

Let A be a symmetric and definitive positive matrix.
So a L triangular lower matrix with unities in the mean diagonal exists such that $A=LDL^T$ and *D* positive diagonal matrix.

$$A = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \quad L = \begin{bmatrix} 1 & 0 \\ b/a & 1 \end{bmatrix} \quad D = \begin{bmatrix} a & 0 \\ 0 & d - b^2/a \end{bmatrix}$$

The triangular decomposition is a particular case of Cholesky decomposition.
In fact we can write $\boldsymbol{A=LDL^T} = L\sqrt{D}\sqrt{D}\,L^T = (L\sqrt{D})(\sqrt{D}\,L)^T = PP^T$ where $\boldsymbol{L\sqrt{D} = P}$.

$$L\sqrt{D} = \begin{bmatrix} 1 & 0 \\ b/a & 1 \end{bmatrix} \begin{bmatrix} \sqrt{a} & 0 \\ 0 & \sqrt{d - b^2/a} \end{bmatrix} = P$$

To apply all the methods of analysis within VAR analysis is required the condition of **stationarity** of the autoregressive representation.
The VAR(1) model is stable if all the eigenvalues of Φ_1 are less than 1 in absolute value.
As the stability condition ensures that the moments up to the second order of the process are independent from *t*, in this case stability implies also stationarity.
Stationarity condition results $\boldsymbol{|\lambda i| < 1}$ $i=1,..,K$ where λi are solutions of the equation $|\lambda I_k - \Phi_1|=0$.
This equation is equivalent to $\boldsymbol{|I_k - \Phi_1 z| \neq 0}$ **for each** $\boldsymbol{|z| \le 1}$. Using the lag operator $\boldsymbol{|\Phi(z)| \neq 0}$ **for each** $\boldsymbol{|z| \le 1}$ as $\Phi(z)= I_k - \Phi_1 z = 0$ is the characteristic equation of the model VAR(1). Therefore, if the eigenvalues of Φ_1 are less than 1 in absolute value, for $j\rightarrow\infty$ (MA(∞) form) this equation $y_t = \Phi_0 + \Phi_1 y_{t-1} + a_t$ becomes $y_t = \mu + \sum_{i=0}^{\infty} \phi_1^i\, a_{t-i}$ $t=0,\pm1,\pm2....$ where $\mu = (I_k - \Phi_1)^{-1}\,\Phi_0$.

Consider the **VAR(p) MODEL:**

$$\mathbf{y_t = \Phi_0 + \Phi_1 y_{t-1} + ...+ \Phi_p y_{t-p} + a_t} \qquad (2)$$

where
$y_t = (y_{1t}, ..., y_{kt})^T$ is a stochastic vector $(K \times 1)$,
Φ_j $j=1,\dots,p$ are matrix $(K \times K)$ of coefficients,
Φ_0 is a vector (K x1) of intercepts ,
$a_t = (a_{1t}, ..., a_{kt})^T \sim WN(0, \sum)$ with $\sum$non-singular matrix

Using the lag operator $\mathbf{\Phi(B)\, y_t = \Phi_0 + a_t}$ (3)

where the characteristic polynomial is $\mathbf{\Phi(B) = I_K - \Phi_1 B - .... - \Phi_p B^p}$ (4)

each VAR(p) model can be written in VAR(1) form. So the VAR(p)'s properties can be derived from those of a VAR(1) model. The compact or canonical form is:

$$\mathbf{y_t = A_0 + A_1\, y_{t-1} + b_t} \qquad (5)$$

where: y_t is a *(Kp x1)*-order-matrix, A_0: *(Kpx1)*, A_1 : *(Kp x Kp)*, y_{t-1}*: (Kp x1)* and b_t : *(Kp x1).*

Remembering the results for VAR(1), this VAR(p) model is stable and stationary, if all the eigenvalues of A_1 are less than 1 in absolute value, or $\mathbf{|I_{kp} - A_1 z| \neq 0}$ **for each** $|z| \leq 1$. Moreover $|I_{kp} - A_1 z| = |I_K - \Phi_1 z - .... - \Phi_p z^p|$ where $\Phi(z) = I_K - \Phi_1 z - .... - \Phi_p z^p$ is the characteristic polynomial of VAR(p) model, so the stationarity condition becomes $\mathbf{|I_K - \Phi_1 z - ..... - \Phi_p z^p| \neq 0}$ **for each** $|z| \leq 1$.

The MA(∞) representation of VAR(p) comes from the MA(∞) of VAR(1) as the following:

$$x_t = (I_{Kp} - A_1)^{-1} A_0 + (I_{Kp} - A_1 B)^{-1} b_1 = \mu_x + \sum_{i=0}^{\infty} A_1^i b_{t-i}$$

so: $y_t = J\, x_t = J\mu_x + \sum_{i=0}^{\infty} J A_1^i J^T J b_{t-i} = J\mu_y + \sum_{i=0}^{\infty} \Psi_i\, a_{t-i}$

where: $\Psi i = J A_1^i J^T$ using $b_t = J^T J b_t$ and $J b_t = a_t$..

Introducing the operator $\mathbf{\Psi(B) = I_K + \Psi_1 B + \Psi_2 B^2 + \ldots = \sum_{i=0}^{\infty} \Psi_j\, B^j}$

such that $\mathbf{\Psi(B)\Phi(B) = I_K}$

the matrix Ψi can be calculated recursively from: $\Psi_0 = I_K$ and $\Psi i = \sum_{j=1}^{i} \Psi_{i-j}\, \Phi_j$ i=1,2,….

2.4. STRUCTURAL ANALYSIS:

2.4.1 Impulse response functions

Let $y_t = \begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix}$ the stable VAR, with *a_t~WN(0, ∑)* and the not singular matrix $\sum = \begin{bmatrix} \sum_{11} & \sum_{12} \\ \sum_{21} & \sum_{22} \end{bmatrix}$. So, there is no **instantaneous causality** between y_{1t} and y_{2t} if and only if $\sum_{12}= E(a_{1t}\, a_{2t}^T)=0$. Connecting the uncertainty topic to the VAR model theory, I can create a vector

y_t= (EPU_t, $INFLRATE_t$, $YRATE_t$, FFR_t) and the system:

$EPU = \alpha + \sum_{i=1}^{4} \beta_{1,i}\ \Delta EPU(t-i) + \sum_{i=1}^{4} \lambda_{1,i}\ INFLRATE(t-i) + \sum_{i=1}^{4} \xi_{1,i}\ \Delta YRATE(t-i) + \varphi\ FFR + a_{EPU,t}$

$INFLRATE = \alpha + \sum_{i=1}^{4} \beta_{2,i}\ \Delta EPU(t-i) + \sum_{i=1}^{4} \lambda_{2,i}\ INFLRATE(t-i) + \sum_{i=1}^{4} \xi_{2,i}\ \Delta YRATE(t-i) + \varphi\ FFR$

$YRATE = \alpha + \sum_{i=1}^{4} \beta_{3,i}\ \Delta EPU(t-i) + \sum_{i=1}^{4} \lambda_{3,i}\ INFLRATE(t-i) + \sum_{i=1}^{4} \xi_{3,i}\ \Delta YRATE(t-i) + \varphi\ FFR$

$FFR = \alpha + \sum_{i=1}^{4} \beta_{4,i}\ \Delta EPU(t-i) + \sum_{i=1}^{4} \lambda_{4,i}\ INFLRATE(t-i) + \sum_{i=1}^{4} \xi_{4,i}\ \Delta YRATE(t-i) + \varphi\ FFR$

To study the effect of an uncertainty's shock, I need to isolate this effect. Suppose that y_t= μ=0 for t<0 and the shock grows by one unit in the period *t=0*, so $a_{1,0}= a_{EPU,0}=1$. You want to see what happens to the system in the following periods *t=1,2,…* in the absence of other shocks, that are $a_{2,0}= a_{3,0}= a_{4,0}=0$ and $a_1= a_2=a_3=a_4=0$.

$$y_j=\Phi_1^j y_0$$

Remembering that $\Phi_1^j=\Psi_j$ represents the *j-th* matrix of coefficients of MA(∞) representation of VAR(1), that is

$$y_t = \sum_{j=0}^{\infty} \phi_1^j\, a_{t-j} = \sum_{j=0}^{\infty} \Psi_j\, a_{t-j}$$

then the coefficient of place *(i, k)* of the matrix Ψ_j represents the **expected response** of the variable $y_{i,t+j}$ with respect to a unit change of the variable $y_{k,t}$. Those coefficients are also called **dynamic multipliers**.

The result is immediately generalizable to the stationary model VAR(p), recalling that the compact form of a VAR(p) is a VAR(1).

Therefore, be given the VAR(p): $y_t = \Phi_0 + \Phi_1 y_{t-1} + ... + \Phi_p y_{t-p} + a_t$ or $\Phi(B)y_t = \Phi_0 + a_t$ where $\Phi(B)= I_K - \Phi_1 B - .... - \Phi_p B^p$. Given the stability condition, MA(∞) form is $y_t = \Phi^{-1}(B)\Phi_0 + \Phi^{-1}(B)\, a_t = \mu + \sum_{i=0}^{\infty} \Psi_j\, a_{t-j}$ where the matrix's coefficients Ψ_j are obtained recursively from the relation $\Psi(B)\Phi(B)= I_K$.

The coefficients $\Psi_{ik,j}$ of the matrix Ψ represent the reaction after *j* periods of the *i-th* variable of the system with respect to a unit change in the *k-th* variable. Those coefficients are the **dynamic multipliers**.

$\Psi_{ik,j}$ as function of *j=0,1,2,…* is called **impulse response function** (irf). Its graphic is very useful to briefly describe the evolution of the response.

If you are interested in the cumulative effect for various periods of a shock in a variable, then you have to consider the matrix sum $S_n = \sum_{j=0}^{n} \Psi_j$. Its elements $S_{ik,n}$ represent the cumulative effect after *n* periods on the *i-th* variable in relation to a unit shock of the k-th variable. These quantities are also called **intermediate multipliers** of order n.

Total cumulative effects for all future periods are obtained from the matrix $S_\infty = \sum_{j=0}^{\infty} \Psi_j = \Psi(1) = (I_K - \Phi_1 - \ldots\ldots\ldots - \Phi_p)^{-1}$. Such effects are also called long-term effects or **total multipliers**.

Responses to orthogonal impulse

If the components of the error terms a_t are simultaneously related to each other, i.e. Σ is not diagonal, it is unlikely that the shock which happens to a component remains isolated, but it is easy that a shock in a variable is accompanied by a shock in another variable because of the contemporaneous correlation between components. In this situation it is preferable to orthogonalize the errors and consequently derive the impulse response functions.

For the VAR (1) with *K* components, zero mean, $a_t \sim WN(0, \Sigma)$, Σ not-singular and not-diagonal matrix, you have $\mathbf{y_t = \Phi_1 y_{t-1} + a_t}$. (1)

Consider the Cholesky decomposition of Σ; $\Sigma = \mathbf{PP^T}$ where P is a lower triangular matrix with positive diagonal elements. Then $\mathbf{P^{-1}\Sigma (P^{-1})^T = I}$

To get the the irf with orthogonalized errors, take the representation of MA(∞):

$$y_t = a_t + \Psi_1 a_{t-1} + \Psi_2 a_{t-2} + \ldots..$$

which can write as

$$y_t = PP^{-1}a_t + \Psi_1 PP^{-1}a_{t-1} + \Psi_2 PP^{-1}a_{t-2} + \ldots.. = \Theta_0\varepsilon_t + \Theta_1\varepsilon_{t-1} + \Theta_2\varepsilon_{t-2} + \ldots..$$

where: $\Theta_0 = P$, $\Theta_j = \Psi_j P$, $\varepsilon_t = P^{-1}a_t$ and $var(\varepsilon_t) = I$.

Pre-multiplying the compact form for $B = P^{-1}$, you have

$$\mathbf{B\, y_t = B_1 y_{t-1} + \varepsilon_t} \qquad (1^*)$$

where: $B_1 = P^{-1}\Phi_1$, $\varepsilon_t = P^{-1} a_t$ and $\varepsilon_t \sim WN(0, I)$.

The (1*) representation of VAR model, with $B \neq I$ and orthogonal errors, is called **structural form SVAR**, while the (1) representation is **reduced form**.

2.4.2 Forecast error variance decompositions

It allows you to analyze the contribution of innovation of the *j-th* variable, to the variance of forecast error (*h* steps ahead) of the k-th variable. Should use the orthogonal errors to identify the contribution.

The forecast error, h step in the future, is:

$$(y_{t+s} - E[y_{t+s}]) = \Theta_0 \varepsilon_{t+s} + \Theta_1 \varepsilon_{t+s-1} + \Theta_2 \varepsilon_{t+s-2} + \ldots + \Theta_{s-1} \varepsilon_{t+1}$$

The variance of this forecast error h-steps ahead is:

$$\mathrm{Var}(y_{t+s} - E[y_{t+s}]) = \Theta_0 \Omega\, \Theta_0^T + \Theta_1 \Omega\, \Theta_1^T + \Theta_2 \Omega\, \Theta_2^T + \ldots + \Theta_{s-1} \Omega\, \Theta_{s-1}^T$$

The variance decomposition indicates what proportion of the variance of the forecast error for a given variable can be attributed to the different variances Ω. Since the operation makes sense, it is necessary that the total variance of the forecast error is only function of variances and not of covariances. As for the impulse response functions, the variance decomposition requires shocks mutually orthogonal. Since the VAR is a reduced form of a closed system, it is difficult to assume that the residuals of the VAR are mutually orthogonal. Therefore it needs some transformations on the VAR residuals in order to make them orthogonal; considering the structural form we overcome the problem of correlated residuals. The solution proposed by Sims (1980) to the problem of identification is to consider B=I and lower triangular $[I-\Phi_1]^{-1}$, to have exact identification of the VAR. This hypothesis has strong implications both from the economic point of view and from the statistic point of view. Firstly, we assume that the economy has a recursive structure, secondly we make the impulse response functions and variance decomposition dependent from the arrangement of variables in the VAR. The triangulation (decomposition of Cholesky) is a special case of identification.

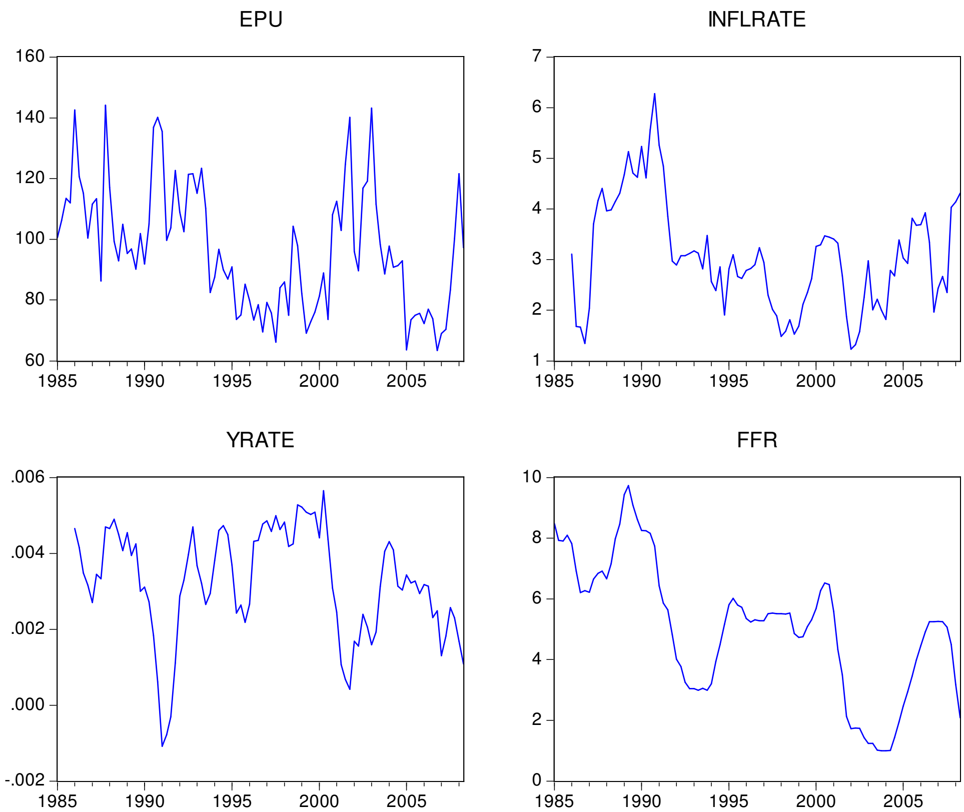
Section 3: ANALYSIS

In this chapter I analyze the relationships between the variables using the VAR methodology, through which each variable is regressed on p lags of itself and on p lags of the other variables. My data are expressed in the form of time series, so the values vary with respect to a time line, in a sample that goes from the first quarter of 1985 to the second quarter of 2008, the period where there were no real crises yet. The **baseline** model time series are:

1. **EPU**
2. **CPI** → transformation: $(p_t - p_{t-4})/p_{t-4}$ annualized (grow rate) **INFLRATE**
3. **GDPC1** → transformation: $(p_t - p_{t-4})/p_{t-4}$ annualized (grow rate) **YRATE**
4. **FFR**

3.1 PRELIMINARY DESCRIPTIVE ANALYSIS

3.1.1 Graphics:



Time series are not seasonal. These series are quite stationary. There is a decreasing trend for FFR. The graph of a time series can be useful at the level intuitive to see if the hypothesis of stationarity applies or not, but it is not a formal test of the assumption of stationarity.

3.1.2 Descriptive statistics

Date: 06/24/13
Time: 15:41
Sample: 1985Q1 2008Q2

	EPU	INFLRATE	YRATE	FFR
Mean	96.59667	3.058427	0.003229	4.910222
Median	94.15000	2.954695	0.003242	5.250000
Maximum	144.2000	6.276466	0.005646	9.730000
Minimum	63.40000	1.231950	-0.001079	1.000000
Std. Dev.	20.58962	1.073354	0.001436	2.133087
Skewness	0.528465	0.541177	-0.753677	-0.039488
Kurtosis	2.531131	2.950392	3.258348	2.499871
Jarque-Bera	5.013527	4.402320	8.770717	0.961374
Probability	0.081532	0.110675	0.012458	0.618358
Sum	8693.700	275.2584	0.290573	441.9200
Sum Sq. Dev.	37729.99	102.5358	0.000184	404.9552
Observations	90	90	90	90

3.1.3 Correlation

Covariance Analysis: Ordinary
Date: 06/24/13 Time: 15:37
Sample (adjusted): 1986Q1 2008Q2
Included observations: 90 after adjustments
Balanced sample (listwise missing value deletion)

Correlation	EPU	INFLRATE	YRATE	FFR
EPU	1.000000			
INFLRATE	0.245330	1.000000		
YRATE	-0.338659	-0.244254	1.000000	
FFR	0.005365	**0.509898**	0.187198	1.000000

FFR and INFLRATE are positively and moderately correlated.
YRATE-EPU and YRATE-INFLRATE are negatively correlated.

3.2 VAR MODEL with grow rate variables

3.2.1 Lag order Selection criteria - Choice of lags

The choice of the lags' order of the VAR is based on the Akaike information criteria (AIC), the function of which is given by:

$$\frac{-2L}{n} + \frac{2k}{n}$$

where L is the likelihood, n is the number of observations and k the number of parameters. Since this is a loss function, les is its value and better is the specification choice.

The test results favors a VAR(4).

VAR Lag Order Selection Criteria
Endogenous variables: EPU INFLRATE YRATE FFR
Exogenous variables: C
Date: 06/24/13 Time: 16:01
Sample: 1985Q1 2008Q2
Included observations: 86

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-214.8836	NA	0.001909	5.090317	5.204473	5.136260
1	58.63076	515.2248	4.79e-06	-0.898390	-0.327611*	-0.668678
2	88.00124	52.59366	3.52e-06	-1.209331	-0.181930	-0.795850*
3	111.5871	40.04109*	2.97e-06*	-1.305746	0.098278	-0.788495
4	124.1112	20.09676	3.25e-06	**-1.384911***	0.635736	-0.523890

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

As we can see from the model's output and coefficients' table in the appendix, many coefficients are not significant (p-values in **bold** are significant) but the signs are those expected on the basis of economic theory.

Equation: EPU = **C(1)***EPU(-1) + C(2)*EPU(-2) + C(3)*EPU(-3) + C(4)*EPU(
-4) + C(5)*INFLRATE(-1) + C(6)*INFLRATE(-2) + C(7)*INFLRATE(-3) +
C(8)*INFLRATE(-4) + C(9)*YRATE(-1) + **C(10)***YRATE(-2) + C(11)
*YRATE(-3) + C(12)*YRATE(-4) + C(13)*FFR(-1) + C(14)*FFR(-2) +
C(15)*FFR(-3) + C(16)*FFR(-4) + **C(17)**

The independent variable EPU(-1) and YRATE(-2) and the constant C(17) are significant to explain the dependent variable EPU. Their sign is positive so they accord with the dependent variable EPU sign.

Observations: 86

R-squared	0.599972	Mean dependent var	95.52209
Adjusted R-squared	0.507212	S.D. dependent var	20.17046
S.E. of regression	14.15944	Sum squared resid	13833.78
Durbin-Watson stat	2.014444		

Equation: INFLRATE = C(18)*EPU(-1) + C(19)*EPU(-2) + C(20)*EPU(-3) + C(21)*EPU(-4) + **C(22)***INFLRATE(-1) + C(23)*INFLRATE(-2) + C(24) *INFLRATE(-3) + **C(25)***INFLRATE(-4) + C(26)*YRATE(-1) + C(27) *YRATE(-2) + C(28)*YRATE(-3) + C(29)*YRATE(-4) + **C(30)***FFR(-1) + C(31)*FFR(-2) + C(32)*FFR(-3) + C(33)*FFR(-4) + C(34)

The independent variable INFLRATE(-1), INFLRATE(-4) and FFR(-1) are significant to explain the dependent variable INFLRATE. The sign of the lagged variable, INFLARATE(-4), is not in accordance with the dependent one, INFLRATE. As we can see later its dynamic response will not be significative.

Observations: 86

R-squared	0.812105	Mean dependent var	3.110004
Adjusted R-squared	0.768535	S.D. dependent var	1.060163
S.E. of regression	0.510053	Sum squared resid	17.95060
Durbin-Watson stat	1.763258		

Equation: YRATE = C(35)*EPU(-1) + C(36)*EPU(-2) + C(37)*EPU(-3) + C(38)*EPU(-4) + C(39)*INFLRATE(-1) + C(40)*INFLRATE(-2) + C(41) *INFLRATE(-3) + C(42)*INFLRATE(-4) + **C(43)***YRATE(-1) + C(44) *YRATE(-2) + C(45)*YRATE(-3) + C(46)*YRATE(-4) + C(47)*FFR(-1) + C(48)*FFR(-2) + C(49)*FFR(-3) + C(50)*FFR(-4) + C(51)

The independent variable YRATE(-1) is significant to explain the dependent variable YRATE and their signs accord to each other.

Observations: 86

R-squared	0.832637	Mean dependent var	0.003199
Adjusted R-squared	0.793828	S.D. dependent var	0.001457
S.E. of regression	0.000662	Sum squared resid	3.02E-05
Durbin-Watson stat	1.987276		

Equation: FFR = **C(52)***EPU(-1) + **C(53)***EPU(-2) + C(54)*EPU(-3) + C(55) *EPU(-4) + C(56)*INFLRATE(-1) + C(57)*INFLRATE(-2) + C(58) *INFLRATE(-3) + C(59)*INFLRATE(-4) + C(60)*YRATE(-1) + C(61) *YRATE(-2) + C(62)*YRATE(-3) + C(63)*YRATE(-4) + **C(64)***FFR(-1) + **C(65)***FFR(-2) + C(66)*FFR(-3) + C(67)*FFR(-4) + C(68)

The independent variable EPU(-1), EPU(-2), FFR(-1) and FFR(-2) are significant to explain the dependent variable FFR.

Observations: 86

R-squared	0.981471	Mean dependent var	4.821977
Adjusted R-squared	0.977175	S.D. dependent var	2.137020
S.E. of regression	0.322862	Sum squared resid	7.192564
Durbin-Watson stat	2.020470		

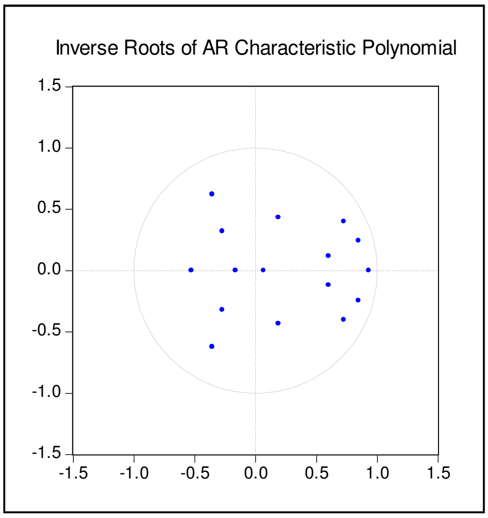
3.2.2 Stability/ Stationarity VAR model

To investigate stability and stationarity we have to verify that the roots of the characteristic polynomial are all placed in the unit circle. The model's estimation responds well to the requirement of stationarity as evidenced by the roots lower than one below and by the unit circle.

Roots of Characteristic Polynomial
Endogenous variables: EPU INFLRATE YRATE FFR
Exogenous variables: C
Lag specification: 1 4
Date: 06/24/13 Time: 17:27

Root	Modulus
0.930191	0.930191
0.845646 - 0.244128i	0.880180
0.845646 + 0.244128i	0.880180
0.725722 - 0.401336i	0.829303
0.725722 + 0.401336i	0.829303
-0.355349 - 0.621726i	0.716112
-0.355349 + 0.621726i	0.716112
0.599442 - 0.118812i	0.611103
0.599442 + 0.118812i	0.611103
-0.526969	0.526969
0.188129 - 0.432507i	0.471651
0.188129 + 0.432507i	0.471651
-0.273179 - 0.321383i	0.421799
-0.273179 + 0.321383i	0.421799
-0.164197	0.164197
0.066485	0.066485

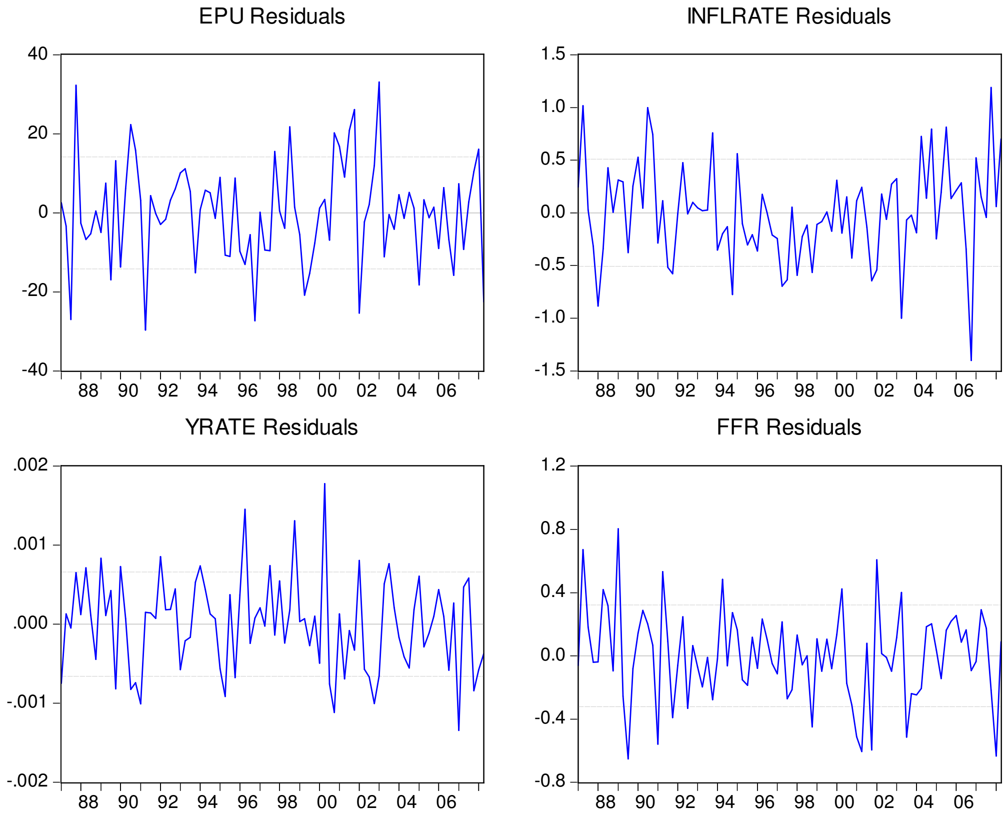
No root lies outside the unit circle.
VAR satisfies the stability condition.



3.3 RESIDUAL TESTS

It checks the adequacy of the model: the absence of autocorrelation and the presence or absence of heteroskedasticity.

3.3.1 Residual graphics



Variables' residuals product stationary and White Noise graphs.

3.3.2 White Heteroskedasticity Test

The test regression is run by regressing each cross product of the residuals on the cross products of the regressors and testing the joint significance of the regression. The *No Cross Terms* option uses only the levels and the squares of the original regresses. The test regression always includes a constant term as a regressor.

The first part of the output displays the joint significance of the regressors excluding the constant term for each test regression. You may think that each test regression is testing the constancy of each element in the residual covariance matrix separately. Under the null hypothesis of no heteroskedasticity (= homoskedasticity), or no misspecification, the non-constant regressors should not be jointly significant.

VAR Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)
Date: 06/28/13 Time: 17:36
Sample: 1985Q1 2008Q2
Included observations: 86

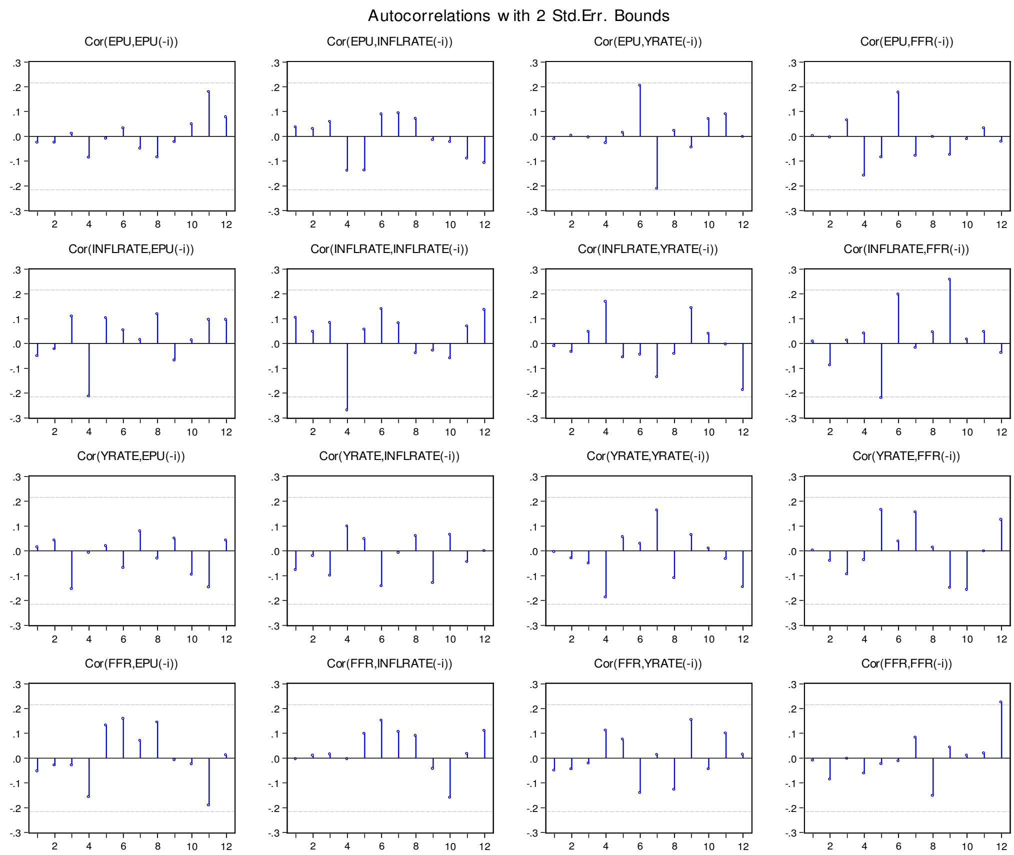
Joint test:

Chi-sq	Df	Prob.
317.6857	320	0.5260

From the joint test, p-value results greater than 0.05. The null hypothesis H_0 is accepted; concluding homoskedasticity.

3.3.3 Correlograms

Displays the pairwise cross-correlograms (sample autocorrelation) for the estimated residuals in the VAR for the specified number of lags (VAR(4)). The graph cross-correlograms displays a matrix of pairwise cross-correlograms. The dotted line in the graphs represents plus or minus two times the asymptotic standard errors of the lagged correlations (computed as $1/\sqrt{T}$). Here the autocorrelation functions doesn't exit from the confidence bands for any lags so we can conclude that residuals are distribuited randomly.



Following there are the autocorrelation functions of the model residuals. They don't exit from the confidence bands ($\pm\frac{2}{\sqrt{T}}$) for any delays, thus bringing us to conclude that the residuals are distributed randomly.

3.3.4 Autocorrelation (test LM)

Reports the multivariate LM test statistics for the residual serial correlation up to the specified order. The test statistic for the lag order h is computed by running an auxiliary regression of the residuals u_t on the original right-hand regressors and the lagged residual u_{t-h}, where the missing first h values of u_{t-h} are filled with zero. Under the null hypothesis of no serial correlation of order h, the LM statistic is asymptotically distribuited X^2 with k^2 degreed of freedom.

VAR Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Date: 06/28/13 Time: 17:40
Sample: 1985Q1 2008Q2
Included observations: 86

Lags	LM-Stat	Prob
1	27.37522	**0.0375**
2	25.55162	0.0607
3	19.23625	0.2566
4	34.79361	**0.0042**
5	13.30415	0.6504
6	26.12379	0.0523
7	14.82390	0.5376
8	12.90378	0.6798
9	14.73896	0.5438
10	14.39650	0.5692
11	12.10213	0.7369
12	21.58291	0.1572

Probs from chi-square with 16 df.

Moreover, to test the presence of serial correlation, using the LM test, we can say that the residuals are not autocorrelated. The null hypothesis of absence of correlation is always accepted at any confidence level, except for the 1st delay in which accept to 1% . There is a problem with the 4th delay that rejects also al'1%. For lag *h=1,4* p-values are less than 0.05. Rejecting the null hypothesis H_0, there is serial correlation for lag order *h*. For the other lags (*h* different from 1 and 4) p-values are greater than 0.0h. Null hypothesis H_0 is accepted, stating no serial correlation for lag order *h*.

3.4 IMPULSE RESPONSE FUNCTION (irf)

To switch from the reduced form to the structural form of the VAR, in order to correctly estimate the functions of the impulse response and the variance decomposition, Cholesky decomposition has been assumed, considering B = I and $[I\text{-}C_0]^{-1}$ lower triangular to have proper identification of the VAR with shocks mutually orthogonal.

Here there are the macroeconomic variables' reactions to an uncertainty policy shocks suffered by the EPU index. These are presented through the functions of the impulse response, using the condition of residues orthogonal guaranteed by the Cholesky decomposition. Through this it is possible follow over time the movements' effects of the other macroeconomics variables.

The impulse response function is a shock to a VAR system. Impulse responses identify the responsiveness of the endogenous variables in the VAR when a shock is put to the error term such as u_1 at the equation given below. A unit shock is applied to each variable and to see its effect on the VAR system:

EPU = $\alpha + \sum_{i=1}^{4} \beta_{1,i}\ \Delta\mathrm{EPU}(t-i) + \sum_{i=1}^{4} \lambda_{1,i}\ \mathrm{INFLRATE}(t-i) + \sum_{i=1}^{4} \xi_{1,i}\ \Delta\mathrm{YRATE}(t-i) + \varphi\ \mathrm{FFR} + \mathbf{u}_{EPU,t}$

INFLRATE = $\alpha + \sum_{i=1}^{4} \boldsymbol{\beta}_{2,i}\ \boldsymbol{\Delta\mathrm{EPU}(t-i)} + \sum_{i=1}^{4} \lambda_{2,i}\ \mathrm{INFLRATE}(t-i) + \sum_{i=1}^{4} \xi_{2,i}\ \Delta\mathrm{YRATE}(t-i) + \varphi\ \mathrm{FFR}$

YRATE = $\alpha + \sum_{i=1}^{4} \beta_{3,i}\ \Delta\mathrm{EPU}(t-i) + \sum_{i=1}^{4} \boldsymbol{\lambda}_{3,i}\ \boldsymbol{\mathrm{INFLRATE}(t-i)} + \sum_{i=1}^{4} \xi_{3,i}\ \Delta\mathrm{YRATE}(t-i) + \varphi\ \mathrm{FFR}$

FFR = $\alpha + \sum_{i=1}^{4} \beta_{4,i}\ \Delta\mathrm{EPU}(t-i) + \sum_{i=1}^{4} \lambda_{4,i}\ \mathrm{INFLRATE}(t-i) + \sum_{i=1}^{4} \boldsymbol{\xi}_{4,i}\ \boldsymbol{\Delta\mathrm{YRATE}(t-i)} + \varphi\ \mathrm{FFR}$

$u_2=u_3=u_4=0$; there is no shocks for INFLRATE, YRATE and FFR.

$\sum_{P=1}^{4} \Delta\mathrm{EPU}(t-p)$ is the lagged EPU variable; EPU(-1)+EPU(-2)+EPU(-3)+EPU(-4)

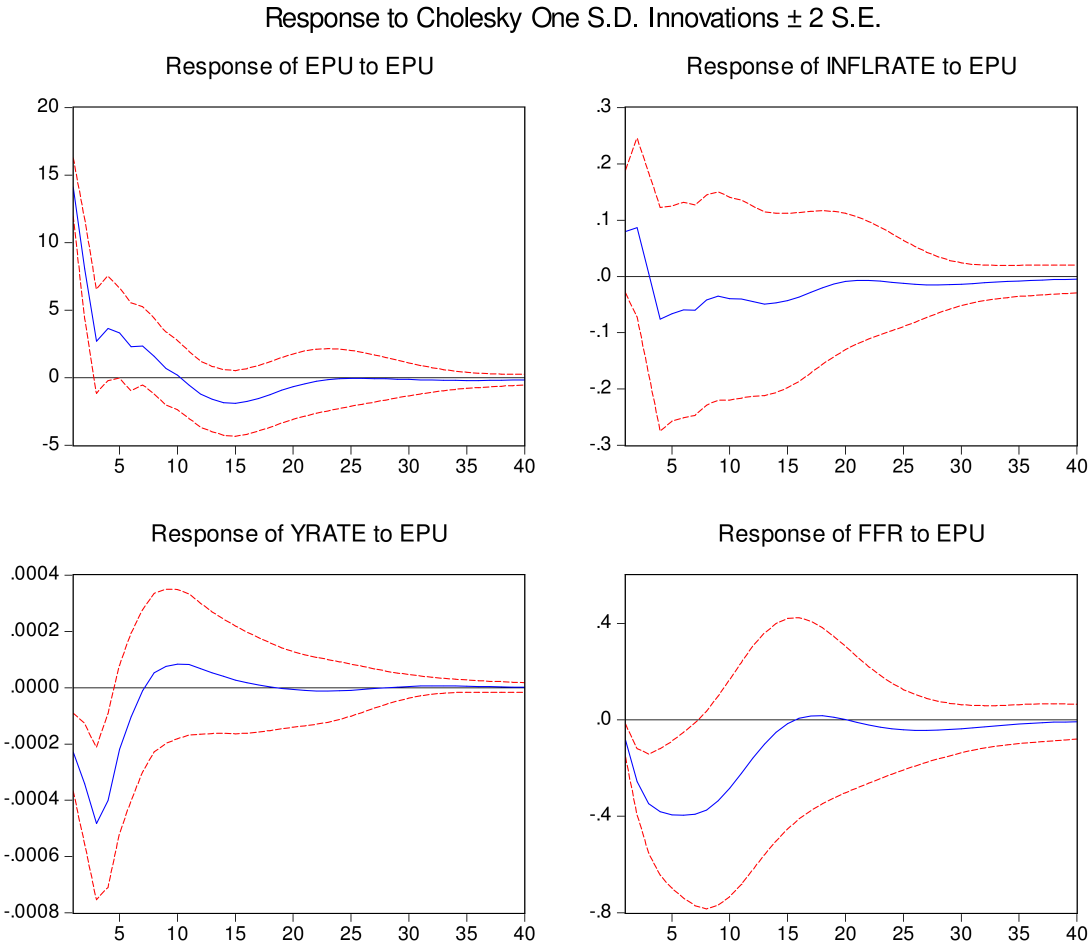
A change in u_1 affects all the VAR system. A change in u_1 will bring a change in EPU. It will change INFLRATE and also YRATE and FFR during the next periods. So we give a shock to the innovation or residual, that is u_1 of the VAR model above, to see how it affects the whole VAR model.

u_1→EPU→$\sum_{P=1}^{4} \Delta\mathrm{EPU}(t-p)$→INFLRATE→$\sum_{P=1}^{4} \mathrm{INFLRATE}(t-p)$ →….. → all the system

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 $u_{i,t}$ are contemporaneously uncorrelated, interpretation of the impulse response is straightforward. The *i-th* innovation $u_{i,t}$ is simply a shock to the *i-th* endogenous variable.
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: $b_t = P\, u_{it} \sim (0, D)$ where D is a diagonal covariance matrix.
Cholesky uses the inverse of the Cholesky factor of the residual covariance matrix to orthogonalize the impulses. This option 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. Note that responses can change dramatically if you change the ordering of the variables:

1. Economics Policy uncertainty index **EPU**
2. Inflation rate **INFLRATE**
3. Outcome rate **YRATE**
4. Effective federal funds rate **FFR**



EPU's shock negatively effects YRATE and FFR for 7 and 15 periods (2 and 4 years) respectively. It provokes a drop with minimum peak in the 3rd period and 5th period, respectively. This shock is absorbed in all the three variables in the long run. These results are consistent and in accordance with the macroeconomic **theory**. The GDP can be defined as a complex income products (sum of consumption C, investment I and government expenditure G) equal to: Y = G + I + C(Y-T) where T are taxes.

$U_{EPU}\uparrow$: C ↓ I↓ Y↓ π↓ r↓

Respectively in my analysis: YRATE↓ FFR↓

EPU: economic policy uncertainty index

C: consumption→ measured as INFLRATE

Y: outcome→YRATE

r: interest rate→federal fund rate FFR

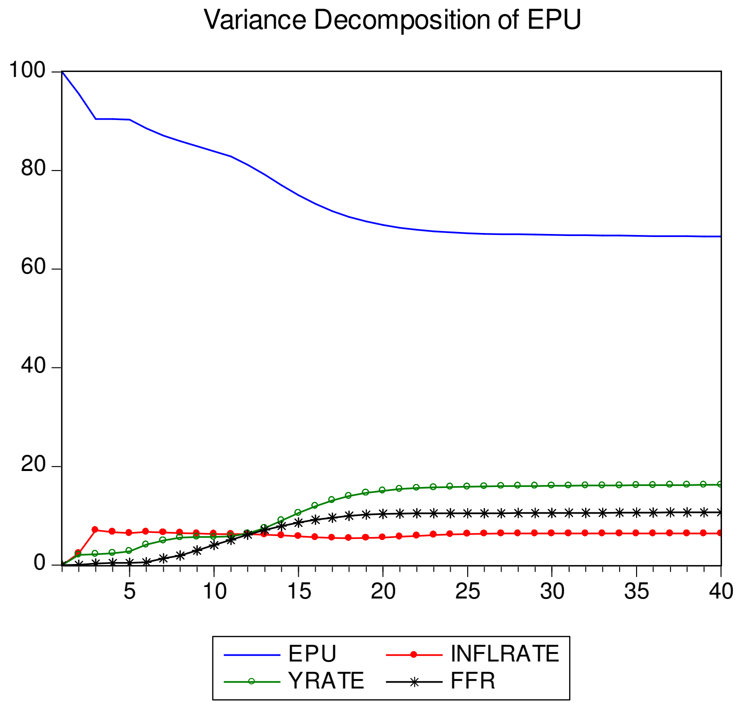
The impulse response's graphs show that INFLRATE has not a significant dynamic response, so it can be ignored differently from FFR and YRATE that accord to the macro theory.

3.5 VARIANCE DECOMPOSITION OF THE FORECAST ERROR

While impulse response functions trace the effects of a shock to one endogenous variable on to the other variables in the VAR, 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.
The table format displays a separate variance decomposition for each endogenous variable.
The second column, labeled "S.E.", contains 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 remaining columns give the percentage of the forecast variance due to each innovation, with each row adding up to 100.

PERIODS:1,2,4,8,16,40
Cholesky Ordering: EPU INFLRATE YRATE FFR

Period	S.E.	EPU	INFLRATE	YRATE	FFR
1	14.15944	100.0000	0.000000	0.000000	0.000000
2	16.66441	95.59263	2.338974	2.066350	0.002046
4	17.78709	90.45089	6.708054	2.423873	0.417185
8	19.00025	86.01600	6.476331	5.575264	1.932407
16	21.07925	73.23380	5.636591	11.94480	9.184804
20	21.89693	68.95150	5.591831	15.08111	10.37556
40	22.29825	66.61871	6.394910	**16.28496**	10.70141



We can note that after 40 delays (10 years) an uncertainty shock still affects so much the variance of outcome (16.28 %) and the interest rate (10.70 %).

Section 4: ROBUSTNESS CHECKS

Robustness is a characteristic describing a model's ability to effectively perform while its variables or assumptions are altered. A robust concept can operate without failures under a variety of conditions. Robustness can relate to both economic and statistical concepts. For statistics, a test is claimed as robust if it still provides insight to a problem despite having its assumptions altered or violated. In economics, robustness is attributed to financial markets that continue to perform despite alterations in market conditions. In general, being robust means a system that can handle variability and remain effective.

Here I want check three robustness tests:

4.1 VAR(4) with log variables

Inflation rate and interest rate can never be transformed with a logarithmic transformation. Neither can the index EPU , so just the outcome (not its grow rate) is transformed with a log-transformation: EPU,CPI,100log(GDP),FFR. This transformation is useful to stabilize and reduce the variance of the time series GDP. As we can see from the table the standard deviation goes down enormously.

Date: 08/05/13
Time: 17:28
Sample: 1985Q1 2008Q2

	GDP	LOGGDP
Mean	9847.991	917.3539
Median	9532.550	916.2453
Maximum	13326.00	949.7472
Minimum	6734.500	881.4999
Std. Dev.	**2044.595**	**20.89083**
Skewness	0.200472	-0.001034
Kurtosis	1.680189	1.660514
Jarque-Bera	7.452069	7.027385
Probability	0.024088	0.029787
Sum	925711.2	86231.26
Sum Sq. Dev.	3.89E+08	40587.68
Observations	94	94

VAR model's output can be find in the appendix.

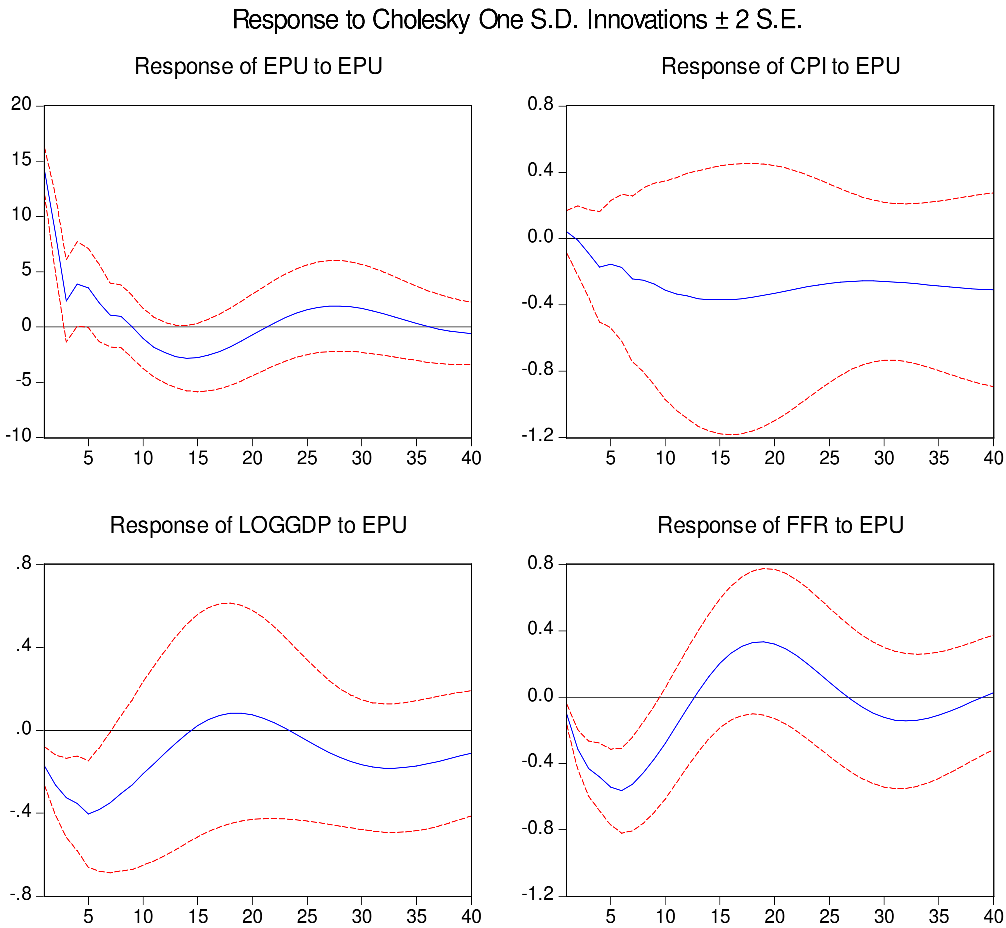
EPU = C(1)*EPU(-1) + C(2)*EPU(-2) + C(3)*EPU(-3) + C(4)*EPU(-4) + C(5)*CPI(-1) + C(6)*CPI(-2) + C(7)*CPI(-3) + C(8)*CPI(-4) + C(9)*LOGGDP(-1) + C(10)*LOGGDP(-2) + C(11)*LOGGDP(-3) + C(12)*LOGGDP(-4) + C(13)*FFR(-1) + C(14)*FFR(-2) + C(15)*FFR(-3) + C(16)*FFR(-4) + C(17)

CPI = C(18)*EPU(-1) + C(19)*EPU(-2) + C(20)*EPU(-3) + C(21)*EPU(-4) + C(22)*CPI(-1) + C(23)*CPI(-2) + C(24)*CPI(-3) + C(25)*CPI(-4) + C(26)*LOGGDP(-1) + C(27)*LOGGDP(-2) + C(28)*LOGGDP(-3) + C(29)*LOGGDP(-4) + C(30)*FFR(-1) + C(31)*FFR(-2) + C(32)*FFR(-3) + C(33)*FFR(-4) + C(34)

LOGGDP = C(35)*EPU(-1) + C(36)*EPU(-2) + C(37)*EPU(-3) + C(38)*EPU(-4) + C(39)*CPI(-1) + C(40)*CPI(-2) + C(41)*CPI(-3) + C(42)*CPI(-4) + C(43)*LOGGDP(-1) + C(44)*LOGGDP(-2) + C(45)*LOGGDP(-3) + C(46)*LOGGDP(-4) + C(47)*FFR(-1) + C(48)*FFR(-2) + C(49)*FFR(-3) + C(50)*FFR(-4) + C(51)

FFR = C(52)*EPU(-1) + C(53)*EPU(-2) + C(54)*EPU(-3) + C(55)*EPU(-4) + C(56)*CPI(-1) + C(57)*CPI(-2) + C(58)*CPI(-3) + C(59)*CPI(-4) + C(60)*LOGGDP(-1) + C(61)*LOGGDP(-2) + C(62)*LOGGDP(-3) + C(63)*LOGGDP(-4) + C(64)*FFR(-1) + C(65)*FFR(-2) + C(66)*FFR(-3) + C(67)*FFR(-4) + C(68)

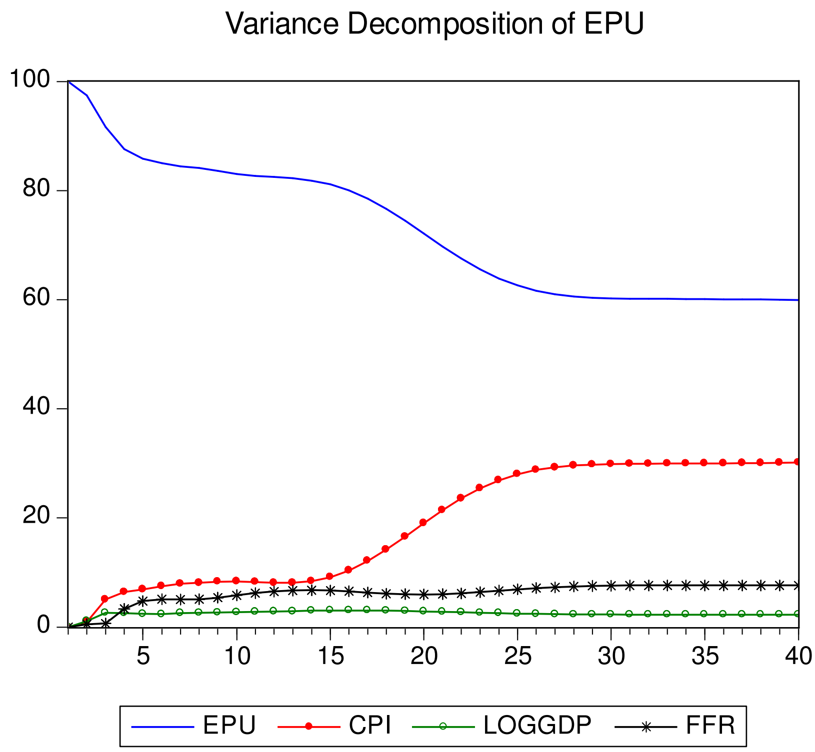
This VAR system can be interpreted as a **semi-elastic** model; the percentage change in a function f(x) in terms of an absolute (not percentage-wise) change in its parameter. Algebraically, the semi-elasticity of a function f at point x is f'(x)/f(x) where f'(x)=log(x).



EPU's shock effects negatively LOGGDP and FFR for 15 and 13 periods (4 and 3 years) respectively. It provokes a drop with minimum peak in the 5th period and 7th period, respectively.

Period	S.E.	EPU	CPI	LOGGDP	FFR
1	14.16394	100.0000	0.000000	0.000000	0.000000
2	16.72591	97.50034	0.897093	1.074305	0.528258
4	18.29988	87.62511	6.433215	2.579968	3.361705
8	19.27097	84.18623	8.121474	2.597629	5.094671
16	20.97074	80.04013	10.37515	3.042057	6.542669
20	22.41183	72.13242	19.03771	2.866461	5.963412
40	25.47197	59.96263	**30.14485**	2.262147	7.630372

Cholesky Ordering: EPU CPI LOGGDP FFR



We can note that after 40 delays (10 years) an uncertainty shock still affects so much the variance of consumption (30.14%) and the interest rate (7.63%).

4.2 VAR(4) baseline with exogenous FFR

This robustness test proves what happens to the macroeconomic model after the policy-related economic uncertainty shock if the Fed does not react reducing the cost of money; the FFR, the interest rate. What changes, and with how much significance, for the absence of this reaction? To reply to this question, FFR should be treated as exogenous variable instead of endogenous. As exogenous, it assumes a value independent from the balance represented in model, so it is a variable which influences the balance represented in the model, but is not influenced by the balance itself. The balance is not the effect of that variable, but it is the effect of other variables that do not belong to the model. In reality there are not totally exogenous variables, since all aspects of reality can be considered connected through complex relationships. Anyway we can identify the variables that, in a certain model specification, can be regarded as approximately exogenous since changes of balance are able to influence only relatively the value of these variables.

A VAR model based on only two endogenous variables and an exogenous variable can be presented as:

$$y_{1,t} = \alpha + \sum_{i=1}^{4} \beta_{1,i}\ y_{1,t-i} + \sum_{i=1}^{4} \lambda_{1,i}\ y_{2,t-i} + \sum_{i=1}^{4} \xi_{1,i}\ y_{3,t-i} + \varphi x + u_{1,t}$$

$$y_{2,t} = \alpha + \sum_{i=1}^{4} \beta_{2,i}\ y_{1,t-i} + \sum_{i=1}^{4} \lambda_{2,i}\ y_{2,t-i} + \sum_{i=1}^{4} \xi_{2,i}\ y_{3,t-i} + \varphi x + u_{2,t}$$

$$y_{3,t} = \alpha + \sum_{i=1}^{4} \beta_{3,i}\ y_{1,t-i} + \sum_{i=1}^{4} \lambda_{3,i}\ y_{2,t-i} + \sum_{i=1}^{4} \xi_{3,i}\ y_{3,t-i} + \varphi x + u_{3,t}$$

Where y_{t-i} is the *i*-th lagged variable of y_t and x_j is the *k-th* exogenous variable, and it is assumed that each of the error terms has no serial correlations or autocorrelations.

I need to focalize my attention on possible variations and reactions of grow rate of income. So:

δ=EPU= $y_{1,t}$; r =INFLRATE =$y_{2,t}$; y=YRATE= $y_{3,t}$; r=FFR= x_j

$$\delta_t = \alpha + \sum_{i=1}^{4} \beta_{1,i}\ \delta_{t-i} + \sum_{i=1}^{4} \lambda_{1,i}\ \pi_{t-i} + \sum_{i=1}^{4} \xi_{1,i}\ y_{t-i} + \varphi r + u_{1,t}$$

$$r_t = \alpha + \sum_{i=1}^{4} \beta_{2,i}\ \delta_{t-i} + \sum_{i=1}^{4} \lambda_{2,i}\ \pi_{t-i} + \sum_{i=1}^{4} \xi_{1,i}\, y_{t-i} + \varphi r$$

$$y_t = \alpha + \sum_{i=1}^{4} \beta_{3,i}\ \delta_{t-i} + \sum_{i=1}^{4} \lambda_{3,i}\ \pi_{t-i} + \sum_{i=1}^{4} \xi_{1,i}\, y_{t-i} + \varphi r$$

In our case the shock at *t=0* is just one $u_{1,t} = u_{EPU,t} = 1$ related to EPU. Other are null $u_{2,t} = u_{3,t} = 0$.

$$EPU = \alpha + \sum_{i=1}^{4} \beta_{1,i}\ \Delta EPU(t-i) + \sum_{i=1}^{4} \lambda_{1,i}\ INFLRATE(t-i) + \sum_{i=1}^{4} \xi_{1,i}\ \Delta YRATE(t-i) + \varphi\ FFR + u_{EPU,t}$$

$$INFLRATE = \alpha + \sum_{i=1}^{4} \beta_{2,i}\ \Delta EPU(t-i) + \sum_{i=1}^{4} \lambda_{2,i}\ INFLRATE(t-i) + \sum_{i=1}^{4} \xi_{2,i}\ \Delta YRATE(t-i) + \varphi\ FFR$$

$$YRATE = \alpha + \sum_{i=1}^{4} \beta_{3,i}\ \Delta EPU(t-i) + \sum_{i=1}^{4} \lambda_{3,i}\ INFLRATE(t-i) + \sum_{i=1}^{4} \xi_{3,i}\ \Delta YRATE(t-i) + \varphi\ FFR$$

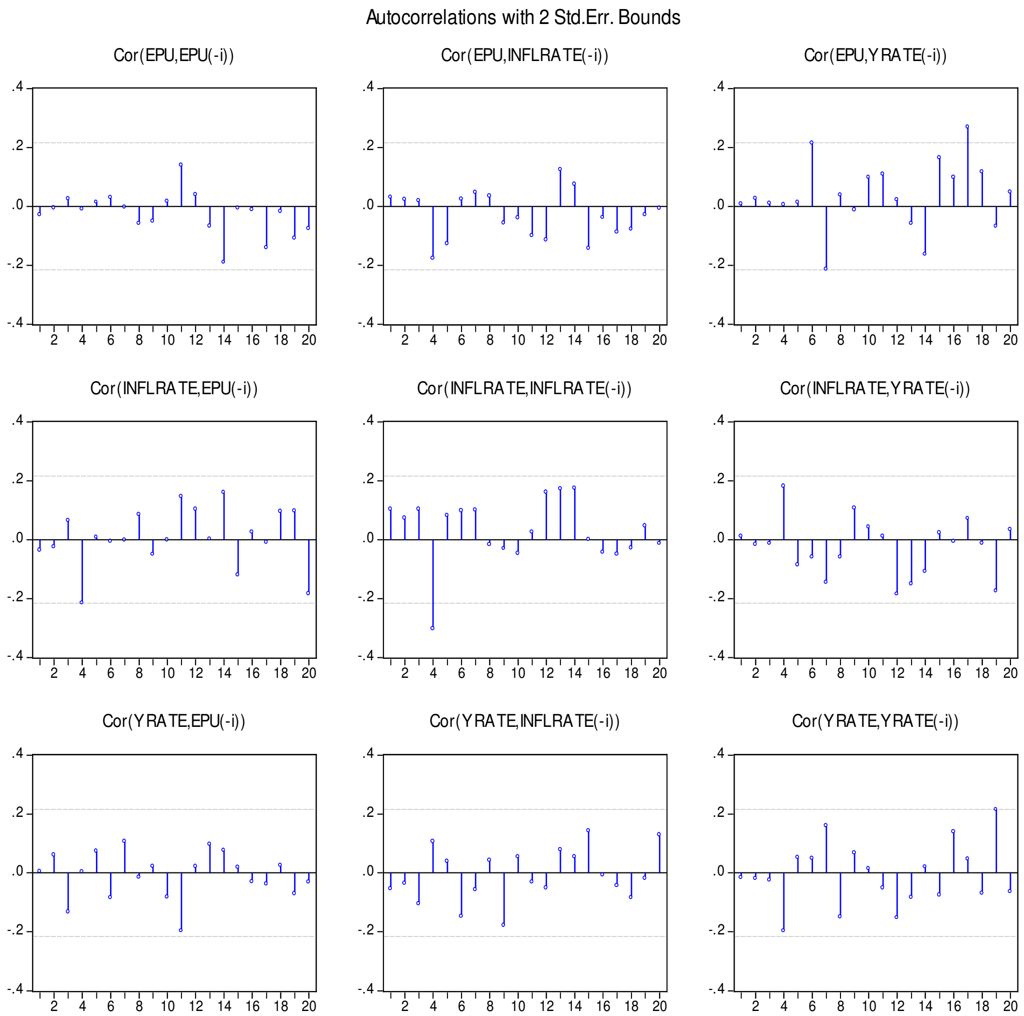
EPU = C(1)*EPU(-1) + C(2)*EPU(-2) + C(3)*EPU(-3) + C(4)*EPU(-4) + C(5)*INFLRATE(-1) + C(6)*INFLRATE(-2) + C(7)*INFLRATE(-3) + C(8)*INFLRATE(-4) + C(9)*YRATE(-1) + C(10)*YRATE(-2) + C(11)*YRATE(-3) + C(12)*YRATE(-4) + C(13) + C(14)*FFR

INFLRATE = C(15)*EPU(-1) + C(16)*EPU(-2) + C(17)*EPU(-3) + C(18)*EPU(-4) + C(19)*INFLRATE(-1) + C(20)*INFLRATE(-2) + C(21)*INFLRATE(-3) + C(22)*INFLRATE(-4) + C(23)*YRATE(-1) + C(24)*YRATE(-2) + C(25)*YRATE(-3) + C(26)*YRATE(-4) + C(27) + C(28)*FFR

YRATE = C(29)*EPU(-1) + C(30)*EPU(-2) + C(31)*EPU(-3) + C(32)*EPU(-4) + C(33)*INFLRATE(-1) + C(34)*INFLRATE(-2) + C(35)*INFLRATE(-3) + C(36)*INFLRATE(-4) + C(37)*YRATE(-1) + C(38)*YRATE(-2) + C(39)*YRATE(-3) + C(40)*YRATE(-4) + C(41) + C(42)*FFR

ASSUMPTION

In the VAR model with exogenous variables (FFR in this case), it is assumed that each of the error terms does not have serial correlations or autocorrelations. These assumptions could be accepted because the model has been using the lagged dependent variables.

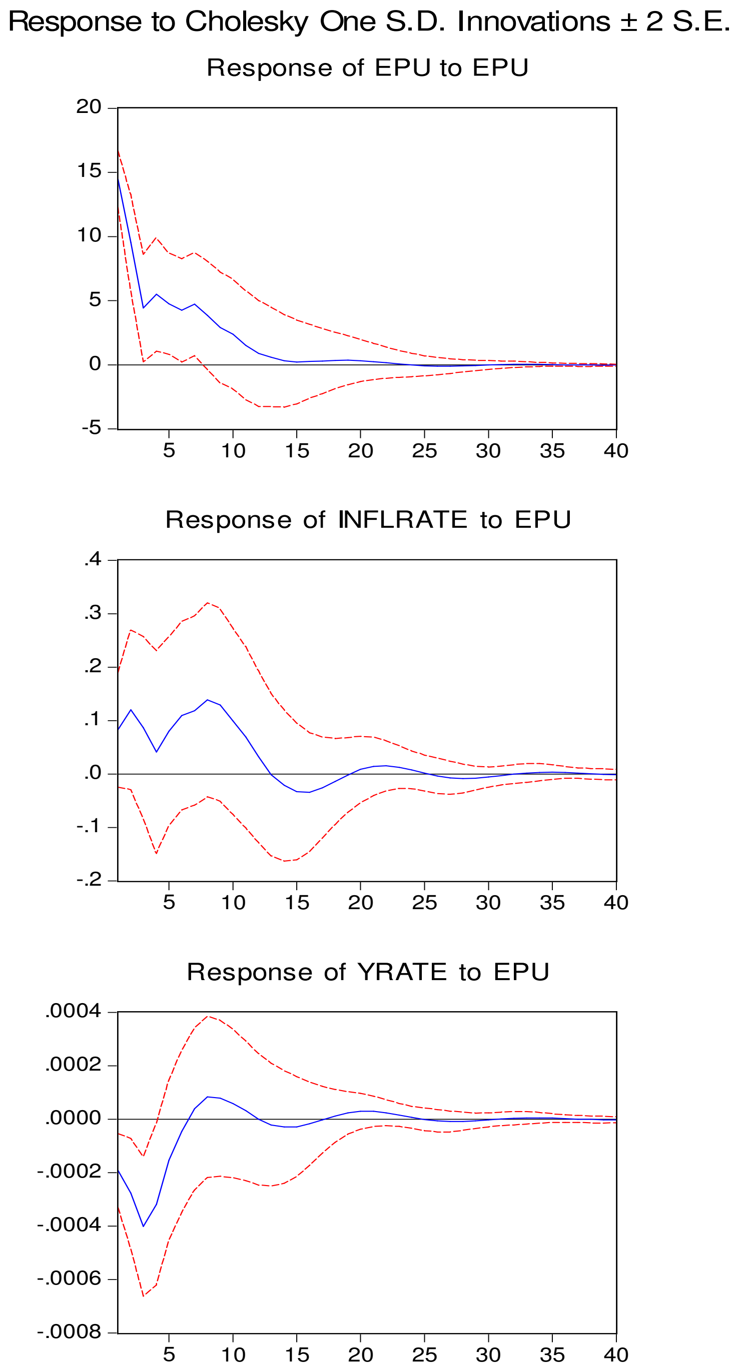


VAR Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Date: 07/17/13 Time: 09:27
Sample: 1985Q1 2008Q2
Included observations: 86

Lags	LM-Stat	Prob
1	21.08213	**0.0123**
2	13.95152	0.1241
3	15.88658	0.0693
4	25.00765	**0.0030**
5	5.473413	0.7912
6	11.09235	0.2694
7	10.19902	0.3346
8	5.135883	0.8223
9	7.455244	0.5898
10	2.507251	0.9807
11	8.598495	0.4751
12	13.28888	0.1500
13	11.19051	0.2629
14	18.77119	**0.0272**
15	8.811148	0.4549
16	4.553571	0.8714
17	10.68715	0.2978
18	6.437594	0.6954
19	8.413160	0.4931
20	7.881336	0.5461

Probs from chi-square with 9 df.

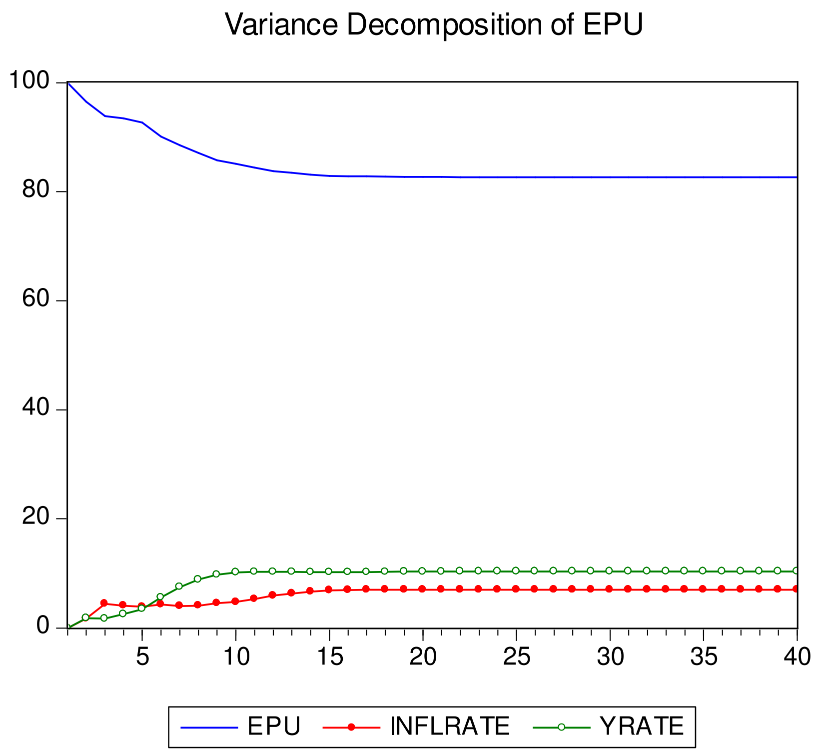
The null hypothesis of absence of correlation is always accepted at any confidence level, except for the 1st and 14th delay in which accept to 1% . There is a problem with the 4th delay that rejects also al'1%. For lag h=1,4,14 p-values are less than 0.05. Rejecting the null hypothesis H_0, there is serial correlation for lag order h. Except for these three lags (1,4 and 14) p-values are greater than 0.05. Null hypothesis H_0 is accepted, stating no serial correlation for lag order h.



EPU shock effects negatively YRATE for 7 periods (almost 2 years) with a minimum peak in the 3rd period. This shock is absorbed from the variable YRATE during the long run.

Period	S.E.	EPU	INFLRATE	YRATE
1	14.46980	100.0000	0.000000	0.000000
2	17.63570	96.52791	1.714231	1.757861
4	19.35291	93.43086	4.064325	2.504814
8	22.16444	87.10161	4.068794	8.829595
16	23.19786	82.83568	6.951190	10.21313
20	23.22646	82.71102	6.975042	10.31393
40	23.23558	82.67244	6.984983	**10.34258**

Cholesky Ordering: EPU INFLRATE YRATE



We can note that after 40 delays (10 years) an uncertainty shock still affects so much the variance of outcome (10.34 %), a little less for the inflation rate (6.98%).

4.3 VAR(4) baseline with FFR endogenous and S&P500

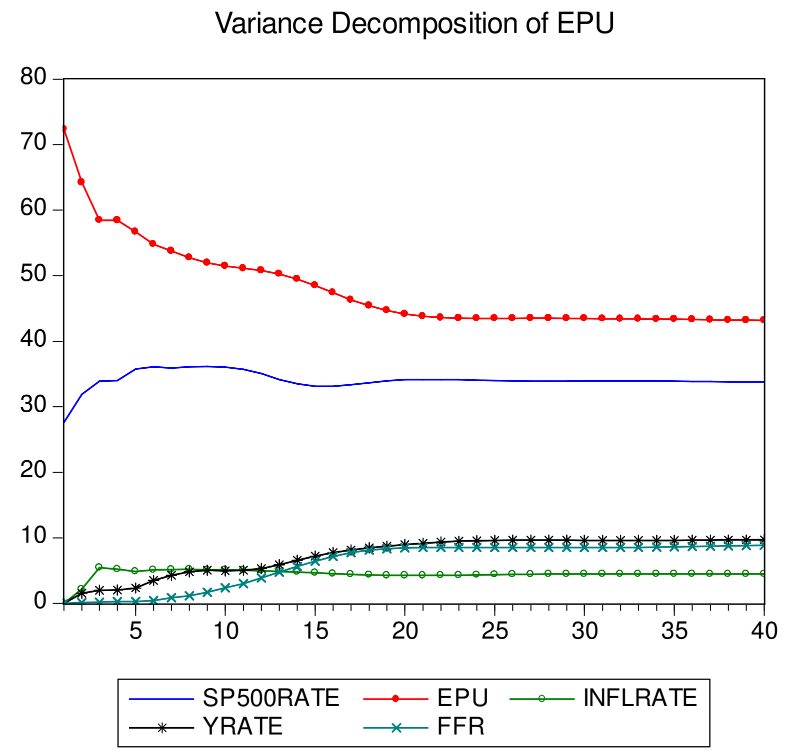
SP500RATE = C(1)*SP500RATE(-1) + C(2)*SP500RATE(-2) + C(3)*SP500RATE(-3) + C(4)*SP500RATE(-4) + C(5)*EPU(-1) + C(6)*EPU(-2) + C(7)*EPU(-3) + C(8)*EPU(-4) + C(9)*INFLRATE(-1) + C(10)*INFLRATE(-2) + C(11)*INFLRATE(-3) + C(12)*INFLRATE(-4) + C(13)*YRATE(-1) + C(14)*YRATE(-2) + C(15)*YRATE(-3) + C(16)*YRATE(-4) + C(17)*FFR(-1) + C(18)*FFR(-2) + C(19)*FFR(-3) + C(20)*FFR(-4) + C(21)

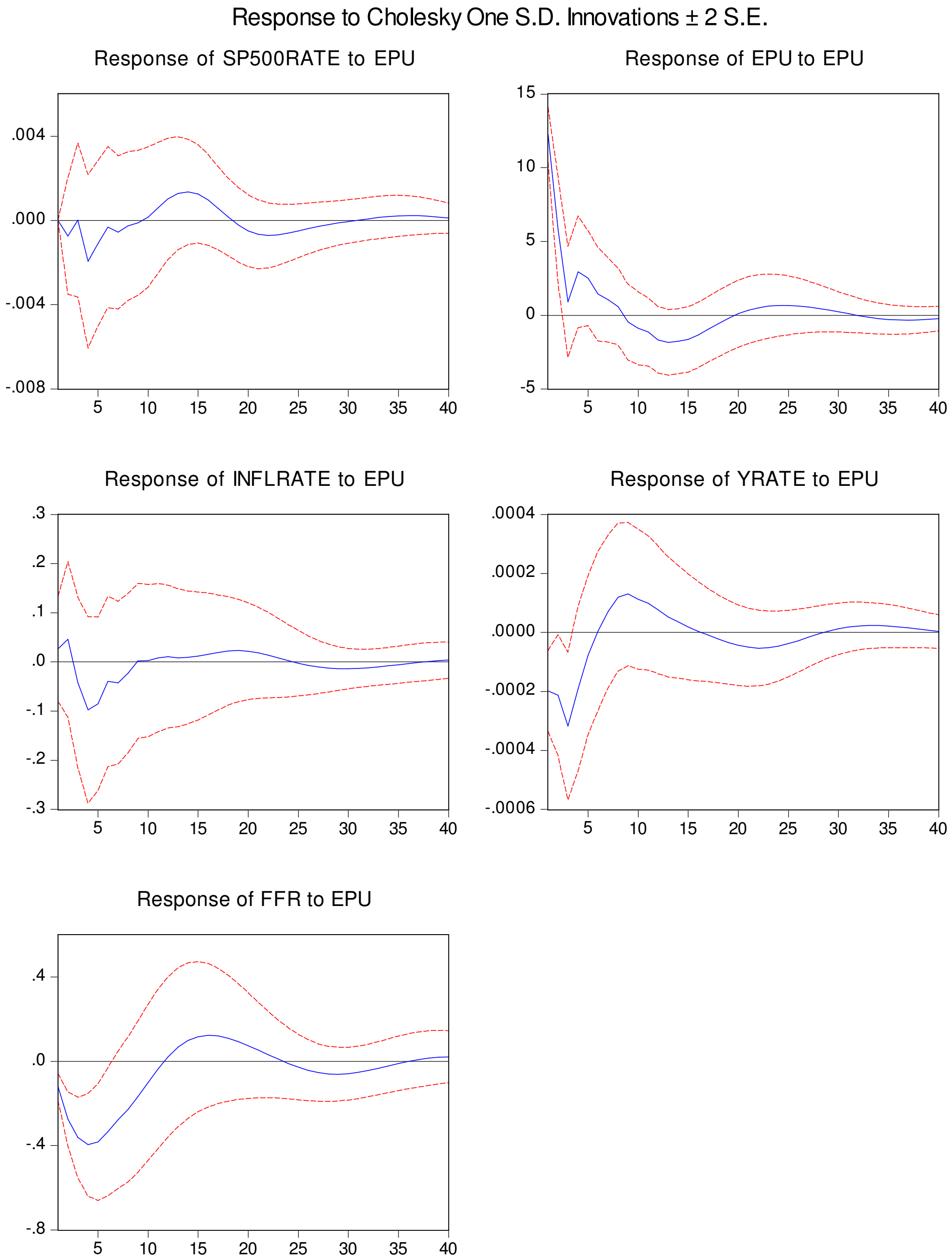
EPU = C(22)*SP500RATE(-1) + C(23)*SP500RATE(-2) + C(24)*SP500RATE(-3) + C(25)*SP500RATE(-4) + C(26)*EPU(-1) + C(27)*EPU(-2) + C(28)*EPU(-3) + C(29)*EPU(-4) + C(30)*INFLRATE(-1) + C(31)*INFLRATE(-2) + C(32)*INFLRATE(-3) + C(33)*INFLRATE(-4) + C(34)*YRATE(-1) + C(35)*YRATE(-2) + C(36)*YRATE(-3) + C(37)*YRATE(-4) + C(38)*FFR(-1) + C(39)*FFR(-2) + C(40)*FFR(-3) + C(41)*FFR(-4) + C(42)

INFLRATE = C(43)*SP500RATE(-1) + C(44)*SP500RATE(-2) + C(45)*SP500RATE(-3) + C(46)*SP500RATE(-4) + C(47)*EPU(-1) + C(48)*EPU(-2) + C(49)*EPU(-3) + C(50)*EPU(-4) + C(51)*INFLRATE(-1) + C(52)*INFLRATE(-2) + C(53)*INFLRATE(-3) + C(54)*INFLRATE(-4) + C(55)*YRATE(-1) + C(56)*YRATE(-2) + C(57)*YRATE(-3) + C(58)*YRATE(-4) + C(59)*FFR(-1) + C(60)*FFR(-2) + C(61)*FFR(-3) + C(62)*FFR(-4) + C(63)

YRATE = C(64)*SP500RATE(-1) + C(65)*SP500RATE(-2) + C(66)*SP500RATE(-3) + C(67)*SP500RATE(-4) + C(68)*EPU(-1) + C(69)*EPU(-2) + C(70)*EPU(-3) + C(71)*EPU(-4) + C(72)*INFLRATE(-1) + C(73)*INFLRATE(-2) + C(74)*INFLRATE(-3) + C(75)*INFLRATE(-4) + C(76)*YRATE(-1) + C(77)*YRATE(-2) + C(78)*YRATE(-3) + C(79)*YRATE(-4) + C(80)*FFR(-1) + C(81)*FFR(-2) + C(82)*FFR(-3) + C(83)*FFR(-4) + C(84)

FFR = C(85)*SP500RATE(-1) + C(86)*SP500RATE(-2) + C(87)*SP500RATE(-3) + C(88)*SP500RATE(-4) + C(89)*EPU(-1) + C(90)*EPU(-2) + C(91)*EPU(-3) + C(92)*EPU(-4) + C(93)*INFLRATE(-1) + C(94)*INFLRATE(-2) + C(95)*INFLRATE(-3) + C(96)*INFLRATE(-4) + C(97)*YRATE(-1) + C(98)*YRATE(-2) + C(99)*YRATE(-3) + C(100)*YRATE(-4) + C(101)*FFR(-1) + C(102)*FFR(-2) + C(103)*FFR(-3) + C(104)*FFR(-4) + C(105)




Response to Cholesky One S.D. Innovations ± 2 S.E.
Response of SP500RATE to EPU
Response of EPU to EPU
Response of INFLRATE to EPU
Response of YRATE to EPU
Response of FFR to EPU

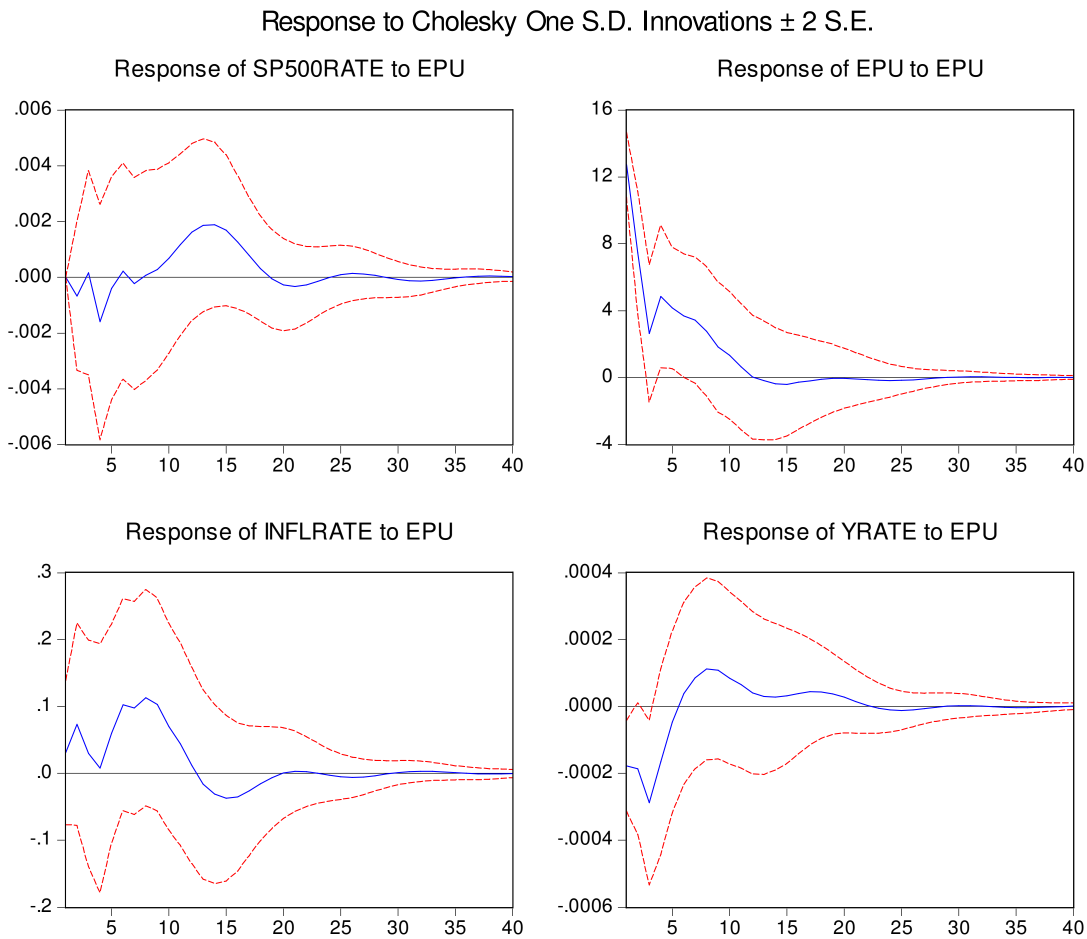
4.4 VAR(4) baseline with FFR exogenous and S&P500

SP500RATE = C(1)*SP500RATE(-1) + C(2)*SP500RATE(-2) + C(3)*SP500RATE(-3) + C(4)*SP500RATE(-4) + C(5)*EPU(-1) + C(6)*EPU(-2) + C(7)*EPU(-3) + C(8)*EPU(-4) + C(9)*INFLRATE(-1) + C(10)*INFLRATE(-2) + C(11)*INFLRATE(-3) + C(12)*INFLRATE(-4) + C(13)*YRATE(-1) + C(14)*YRATE(-2) + C(15)*YRATE(-3) + C(16)*YRATE(-4) + C(17) + C(18)*FFR

EPU = C(19)*SP500RATE(-1) + C(20)*SP500RATE(-2) + C(21)*SP500RATE(-3) + C(22)*SP500RATE(-4) + C(23)*EPU(-1) + C(24)*EPU(-2) + C(25)*EPU(-3) + C(26)*EPU(-4) + C(27)*INFLRATE(-1) + C(28)*INFLRATE(-2) + C(29)*INFLRATE(-3) + C(30)*INFLRATE(-4) + C(31)*YRATE(-1) + C(32)*YRATE(-2) + C(33)*YRATE(-3) + C(34)*YRATE(-4) + C(35) + C(36)*FFR

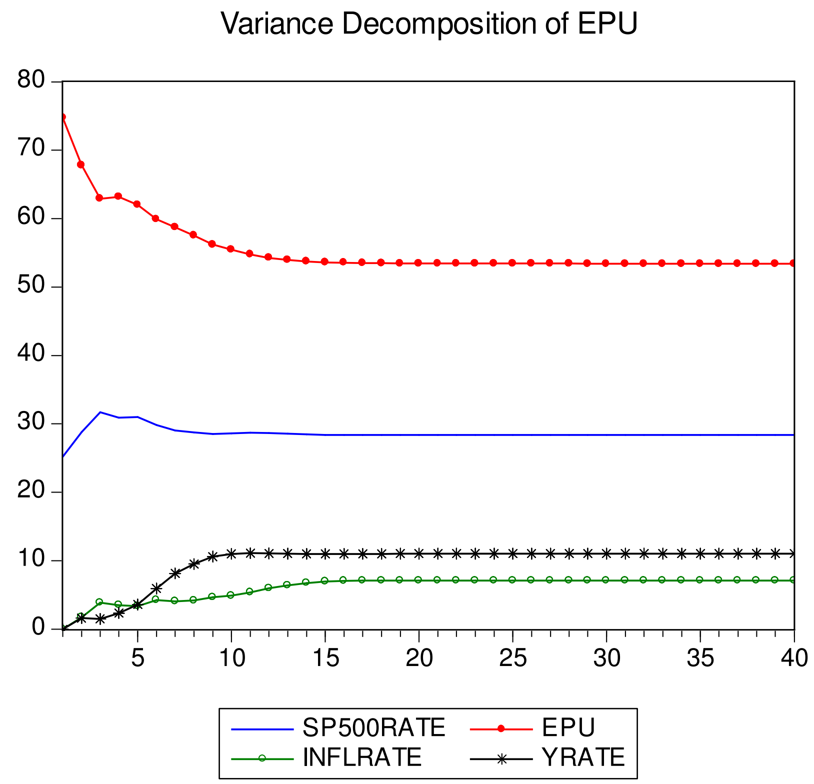
INFLRATE = C(37)*SP500RATE(-1) + C(38)*SP500RATE(-2) + C(39)*SP500RATE(-3) + C(40)*SP500RATE(-4) + C(41)*EPU(-1) + C(42)*EPU(-2) + C(43)*EPU(-3) + C(44)*EPU(-4) + C(45)*INFLRATE(-1) + C(46)*INFLRATE(-2) + C(47)*INFLRATE(-3) + C(48)*INFLRATE(-4) + C(49)*YRATE(-1) + C(50)*YRATE(-2) + C(51)*YRATE(-3) + C(52)*YRATE(-4) + C(53) + C(54)*FFR

YRATE = C(55)*SP500RATE(-1) + C(56)*SP500RATE(-2) + C(57)*SP500RATE(-3) + C(58)*SP500RATE(-4) + C(59)*EPU(-1) + C(60)*EPU(-2) + C(61)*EPU(-3) + C(62)*EPU(-4) + C(63)*INFLRATE(-1) + C(64)*INFLRATE(-2) + C(65)*INFLRATE(-3) + C(66)*INFLRATE(-4) + C(67)*YRATE(-1) + C(68)*YRATE(-2) + C(69)*YRATE(-3) + C(70)*YRATE(-4) + C(71) + C(72)*FFR



Period	S.E.	SP500RATE	EPU	INFLRATE	YRATE
1	0.011454	25.23749	74.76251	0.000000	0.000000
2	0.016204	28.80899	67.83084	1.742320	1.617847
4	0.020751	30.91595	63.20645	3.521202	2.356395
8	0.022340	28.76591	57.53427	4.175169	9.524649
16	0.023501	28.37886	53.56292	7.071537	10.98668
20	0.023671	28.41465	53.46231	7.098067	11.02497
40	0.023748	**28.39882**	53.43175	7.113113	11.05632

Cholesky Ordering: SP500RATE EPU INFLRATE YRATE



Comparing the last 2 models: VAR(4) with 5 variables, where FFR is firstly endogenous and secondly exogenous, I can see:

Impulse responses:

1. EPU's shock effects negatively INFLRATE, YRATE and FFR for 10, 7 and 13 periods respectively (almost 2 and 3 years) with a minimum peak in the 5th ,3rd and 5th period.

2. EPU's shock affects negatively YRATE for 7 periods with a minimum peak in the 3rd one.

Variance decompositions:

1. after 40 delays (10 years) an uncertainty shock still affects so much the variance of share index (35%) while the outcome one for 11%.
2. after 40 delays (10 years) an uncertainty shock still affects so much the variance of share index (28.4 %) while the outcome one for 11%.

CONCLUSIONS

This thesis, through the estimation of structural VAR models on quarterly data from the first quarter of 1985 to the second quarter of 2008, studies the effects of a shock of the index of economic uncertainty and political business cycle USA.

Summarizing the IMPULSE RESPONSES results:

	SP500	INFLRATE	YRATE	FFR
BASELINE	-	not significative	↓ *7periods,peak in 3rd*	↓ *15periods,peak in 5th*
LOG	-	(CPI)	↓log(GDP) *15periods,peak in5th*	↓ *13periods,peak in 7th*
FFR exo	-		↓ *7periods,peak in 3rd*	-
SP500, FFR endo		↓ *10periods,peak in 5th*	↓ *7periods,peak in 3rd*	↓ *13periods,peak in 5th*
SP500, FFR exo			↓ *7periods,peak in 3rd*	-

and the VARIANCE DECOMPOSITION's ones:

	SP500	INFLRATE/CPI	YRATE/log(GDP)	FFR
BASELINE	-	6.4%	16.3%	10.7%
LOG	-	30.1%	2.3%	7.6%
FFR exo	-	6.9%	10.3%	-
SP500, FFR endo	35%	7%	11%	10%
SP500, FFR exo	28.4%	7.1%	11%	-

We cannot find significant differences in the impulse responses except for an extension of the duration of the negative effect for the outcome in the log model and for the interest rate in the baseline one. This confirms the robustness of the specification of the baseline model. We can consider the best model, in accordance with the Macro theory, to be one with share index and endogenous interest rate. Looking at the second table and focusing our attention on the outcome effects, the variance decomposition is around the same values.

An important consideration to make is that we are assuming Cholesky ordering, to construct orthogonal shocks, although it has its limitations: the economy is not always represented by the Cholesky approach and incurs incident not to go to identify a shock, when in fact you are identifying many shocks. I find that a policy uncertainty shock foreshadows drops of 10% in the interest rate after 40 quarters (10 years) and GDP reductions of 16% within 40 quarters. These findings reinforce concerns that policy-related uncertainty played a role in the slow growth and fitful recovery of recent years, and they invite further research into the effect of policy-related uncertainty on economic performance.

To the uncertainty increase the **consumers** begin to consume less in the present, saving more for the future, to be able to protect themselves against a possible recession and to ensure their survival. This consumption reduction lowers the outcome too, considering the equation Y=G+I+C(Y-T). Moreover, another collateral effect comes from the **investors** and in accordance with some of Bernanke's intuitions behind the depressing effect of uncertainty (1983). He pointed out that an high uncertainty gives firms an incentive to delay or postpone investment and employment decisions. If every firm waits to invest or hire, the economy contracts generating a recession. When uncertainty falls back down, firms start hiring and investing again to address pent-up demand. Here is that the real economy (production, employment, consumption) is in crisis. The Fed, aware of the income decline and worried about the inflation, decides to lower the cost of currency to ensure that the income may go up stimulating a recovery. In the long term the interest rate vanishes again, returning to zero. Thus, an aggressive policy by the Federal Reserve, that reduces interest rates, is the main way for the central bank to stimulate the weak economy's recovery that had produced rising unemployment and business failures. The interest rate market has the important function to balance supply and demand for money. On the contrary, when it increases, other aggregates decrease: *Investment and aggregate demand, income and the demand for money; *The price of the bonds that raises the income of the same; this motivates people to buy bonds and discourages savings in money. The result is a reduction in the demand for money for speculative purposes.

Making the dollar more expensive (increasing the rate of interest) causes a reduction in the currency demand by the banking system and thus placing less liquidity in the production system. By doing this, you can keep inflation under control in the growth phase. But now, in times of economic crisis and recession, this would definitely be a suicidal maneuver; this is the reason for the Fed's descending reaction. A decrease in the federal funds interest rate stimulates economic growth, but an excessively high level of economic activity can cause inflationary pressures to build to a point that ultimately undermines the sustainability of economic expansion. An increase in the federal funds interest rate will curb economic growth and help contain inflationary pressures, and thus can promote the sustainability of an economic expansion, but too large an increase could retard economic growth too much.

The role of economic policy is to find the correct mix between monetary and fiscal policy that can help a country to go out from a recession, improve the commercial situation without overheating the economy and stimulate the investments and the capital accumulation. The economics policy aim is the stabilization: avoid prolonged recession, slow down the excessive expansion and prevent inflationary and deflationary pressures. However, the belief that the authorities in economic policy should limit their intervention is increasingly widespread. There are many reasons why it would be desirable to have limited intervention of government in the economy; the main one is the Uncertainty that characterizes the economic policy interventions.

APPENDIX

BASELINE MODEL

Vector Autoregression Estimates
Date: 06/24/13 Time: 15:55
Sample (adjusted): 1987Q1 2008Q2
Included observations: 86 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	EPU	INFLRATE	YRATE	FFR
EPU(-1)	0.482261	0.002499	-8.39E-06	-0.007062
	(0.13106)	(0.00472)	(6.1E-06)	(0.00299)
	[3.67964]	[0.52942]	[-1.36928]	[-2.36300]
EPU(-2)	-0.090311	-2.42E-05	-4.33E-06	0.006152
	(0.13378)	(0.00482)	(6.3E-06)	(0.00305)
	[-0.67509]	[-0.00502]	[-0.69323]	[2.01685]
EPU(-3)	0.176413	-0.005775	7.34E-06	0.000590
	(0.13751)	(0.00495)	(6.4E-06)	(0.00314)
	[1.28287]	[-1.16583]	[1.14276]	[0.18809]
EPU(-4)	0.036684	0.005933	4.56E-06	0.001422
	(0.12470)	(0.00449)	(5.8E-06)	(0.00284)
	[0.29417]	[1.32074]	[0.78306]	[0.50019]
INFLRATE(-1)	3.757428	0.784601	-0.000141	-0.030772
	(3.38549)	(0.12195)	(0.00016)	(0.07720)
	[1.10986]	[6.43366]	[-0.88856]	[-0.39862]
INFLRATE(-2)	2.270267	0.045445	0.000116	0.004800
	(4.15694)	(0.14974)	(0.00019)	(0.09479)
	[0.54614]	[0.30349]	[0.59661]	[0.05064]
INFLRATE(-3)	-7.263999	0.153568	-2.57E-05	0.122805
	(4.16050)	(0.14987)	(0.00019)	(0.09487)
	[-1.74594]	[1.02467]	[-0.13219]	[1.29449]
INFLRATE(-4)	0.587033	-0.353750	-0.000167	-0.056188
	(3.57606)	(0.12882)	(0.00017)	(0.08154)
	[0.16416]	[-2.74614]	[-1.00176]	[-0.68908]
YRATE(-1)	-3975.939	-115.5794	0.965077	100.2978
	(2786.48)	(100.375)	(0.13021)	(63.5370)
	[-1.42687]	[-1.15148]	[7.41158]	[1.57857]
YRATE(-2)	7366.027	245.1616	0.007998	-22.13627
	(3560.60)	(128.260)	(0.16639)	(81.1886)
	[2.06876]	[1.91144]	[0.04807]	[-0.27265]
YRATE(-3)	-5711.725	-194.2567	-0.211895	22.13476
	(3607.58)	(129.953)	(0.16858)	(82.2598)
	[-1.58326]	[-1.49483]	[-1.25692]	[0.26908]
YRATE(-4)	-219.0998	-30.12922	-0.029289	10.87578
	(2830.00)	(101.943)	(0.13225)	(64.5294)
	[-0.07742]	[-0.29555]	[-0.22147]	[0.16854]

FFR(-1)	-0.255389	0.441632	-0.000101	1.534396
	(5.68807)	(0.20490)	(0.00027)	(0.12970)
	[-0.04490]	[2.15539]	[-0.37886]	[11.8304]
FFR(-2)	1.822257	-0.515243	0.000520	-0.554285
	(10.2122)	(0.36787)	(0.00048)	(0.23286)
	[0.17844]	[-1.40063]	[1.08870]	[-2.38035]
FFR(-3)	-7.312695	0.195149	-0.000741	-0.070372
	(10.2026)	(0.36752)	(0.00048)	(0.23264)
	[-0.71675]	[0.53099]	[-1.55333]	[-0.30250]
FFR(-4)	7.903322	0.003792	0.000384	0.036569
	(5.52843)	(0.19915)	(0.00026)	(0.12606)
	[1.42958]	[0.01904]	[1.48452]	[0.29009]
C	36.74894	0.615995	0.001278	-0.352959
	(14.7780)	(0.53233)	(0.00069)	(0.33697)
	[2.48674]	[1.15716]	[1.85056]	[-1.04746]
R-squared	0.599972	0.812105	0.832637	0.981471
Adj. R-squared	0.507212	0.768535	0.793828	0.977175
Sum sq. resids	13833.78	17.95060	3.02E-05	7.192564
S.E. equation	14.15944	0.510053	0.000662	0.322862
F-statistic	6.467999	18.63917	21.45480	228.4332
Log likelihood	-340.4911	-54.65959	517.0256	-15.33283
Akaike AIC	8.313748	1.666502	-11.62850	0.751926
Schwarz SC	8.798909	2.151664	-11.14334	1.237088
Mean dependent	95.52209	3.110004	0.003199	4.821977
S.D. dependent	20.17046	1.060163	0.001457	2.137020

Determinant resid covariance (dof adj.)	1.58E-06
Determinant resid covariance	6.56E-07
Log likelihood	124.1112
Akaike information criterion	-1.304911
Schwarz criterion	0.635736

COEFFICIENTS' P-VALUES TABLE OF BASELINE MODEL

System: UNTITLED
Estimation Method: Least Squares
Date: 06/24/13 Time: 17:22
Sample: 1987Q1 2008Q2
Included observations: 86
Total system (balanced) observations 344

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.482261	0.131062	3.679639	**0.0003**
C(2)	-0.090311	0.133777	-0.675086	0.5002
C(3)	0.176413	0.137515	1.282866	0.2006
C(4)	0.036684	0.124703	0.294168	0.7689
C(5)	3.757428	3.385489	1.109863	0.2680
C(6)	2.270267	4.156937	0.546139	0.5854
C(7)	-7.263999	4.160504	-1.745942	0.0819
C(8)	0.587033	3.576060	0.164156	0.8697
C(9)	-3975.939	2786.478	-1.426869	0.1547
C(10)	7366.027	3560.604	2.068758	**0.0395**

C(11)	-5711.725	3607.582	-1.583256	0.1145
C(12)	-219.0998	2830.001	-0.077420	0.9383
C(13)	-0.255389	5.688072	-0.044899	0.9642
C(14)	1.822257	10.21223	0.178439	0.8585
C(15)	-7.312695	10.20256	-0.716751	0.4741
C(16)	7.903322	5.528428	1.429579	0.1540
C(17)	36.74894	14.77797	2.486738	**0.0135**
C(18)	0.002499	0.004721	0.529422	0.5969
C(19)	-2.42E-05	0.004819	-0.005019	0.9960
C(20)	-0.005775	0.004954	-1.165828	0.2447
C(21)	0.005933	0.004492	1.320742	0.1877
C(22)	0.784601	0.121952	6.433664	**0.0000**
C(23)	0.045445	0.149742	0.303490	0.7617
C(24)	0.153568	0.149870	1.024674	0.3064
C(25)	-0.353750	0.128817	-2.746138	**0.0064**
C(26)	-115.5794	100.3748	-1.151478	0.2505
C(27)	245.1616	128.2604	1.911437	0.0570
C(28)	-194.2567	129.9527	-1.494827	0.1361
C(29)	-30.12922	101.9426	-0.295551	0.7678
C(30)	0.441632	0.204896	2.155395	**0.0320**
C(31)	-0.515243	0.367866	-1.400628	0.1624
C(32)	0.195149	0.367517	0.530992	0.5959
C(33)	0.003792	0.199146	0.019039	0.9848
C(34)	0.615995	0.532334	1.157160	0.2482
C(35)	-8.39E-06	6.12E-06	-1.369282	0.1720
C(36)	-4.33E-06	6.25E-06	-0.693228	0.4887
C(37)	7.34E-06	6.43E-06	1.142761	0.2541
C(38)	4.56E-06	5.83E-06	0.783060	0.4343
C(39)	-0.000141	0.000158	-0.888562	0.3750
C(40)	0.000116	0.000194	0.596606	0.5513
C(41)	-2.57E-05	0.000194	-0.132194	0.8949
C(42)	-0.000167	0.000167	-1.001756	0.3173
C(43)	0.965077	0.130212	7.411583	**0.0000**
C(44)	0.007998	0.166387	0.048068	0.9617
C(45)	-0.211895	0.168582	-1.256922	0.2098
C(46)	-0.029289	0.132246	-0.221473	0.8249
C(47)	-0.000101	0.000266	-0.378860	0.7051
C(48)	0.000520	0.000477	1.088703	0.2772
C(49)	-0.000741	0.000477	-1.553330	0.1215
C(50)	0.000384	0.000258	1.484521	0.1388
C(51)	0.001278	0.000691	1.850556	0.0653
C(52)	-0.007062	0.002988	-2.363000	**0.0188**
C(53)	0.006152	0.003050	2.016853	**0.0447**
C(54)	0.000590	0.003136	0.188087	0.8509
C(55)	0.001422	0.002843	0.500189	0.6173
C(56)	-0.030772	0.077196	-0.398620	0.6905
C(57)	0.004800	0.094786	0.050644	0.9596
C(58)	0.122805	0.094867	1.294491	0.1966
C(59)	-0.056188	0.081541	-0.689080	0.4914
C(60)	100.2978	63.53704	1.578572	0.1156
C(61)	-22.13627	81.18859	-0.272653	0.7853
C(62)	22.13476	82.25978	0.269084	0.7881
C(63)	10.87578	64.52945	0.168540	0.8663
C(64)	1.534396	0.129699	11.83044	**0.0000**
C(65)	-0.554285	0.232859	-2.380349	**0.0180**
C(66)	-0.070372	0.232638	-0.302497	0.7625
C(67)	0.036569	0.126059	0.290095	0.7720
C(68)	-0.352959	0.336966	-1.047461	0.2958

Determinant residual covariance	6.56E-07

VAR(4) WITH LOG VARIABLES

Vector Autoregression Estimates
Date: 08/05/13 Time: 17:49
Sample (adjusted): 1986Q1 2008Q2
Included observations: 90 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	EPU	CPI	LOGGDP	FFR
EPU(-1)	0.512782	-0.002217	-0.008740	-0.011165
	(0.12447)	(0.00544)	(0.00402)	(0.00264)
	[4.11985]	[-0.40764]	[-2.17441]	[-4.22613]
EPU(-2)	-0.109789	0.000532	-0.001534	0.002093
	(0.14119)	(0.00617)	(0.00456)	(0.00300)
	[-0.77763]	[0.08625]	[-0.33642]	[0.69845]
EPU(-3)	0.189968	-0.006156	-0.003995	-0.002529
	(0.13391)	(0.00585)	(0.00432)	(0.00284)
	[1.41861]	[-1.05214]	[-0.92369]	[-0.88969]
EPU(-4)	-0.108200	0.009435	-0.005379	-0.001878
	(0.12896)	(0.00563)	(0.00416)	(0.00274)
	[-0.83903]	[1.67456]	[-1.29165]	[-0.68596]
CPI(-1)	2.551635	1.119642	-0.095067	0.014627
	(2.67866)	(0.11703)	(0.08651)	(0.05686)
	[0.95258]	[9.56697]	[-1.09897]	[0.25726]
CPI(-2)	1.634085	-0.011367	0.030660	-0.015888
	(3.79739)	(0.16591)	(0.12263)	(0.08060)
	[0.43032]	[-0.06851]	[0.25001]	[-0.19711]
CPI(-3)	-2.909789	0.256203	-0.077105	0.031726
	(3.71927)	(0.16250)	(0.12011)	(0.07895)
	[-0.78236]	[1.57667]	[-0.64195]	[0.40186]
CPI(-4)	-1.932194	-0.361533	0.113713	-0.062663
	(2.87054)	(0.12542)	(0.09270)	(0.06093)
	[-0.67311]	[-2.88268]	[1.22665]	[-1.02842]
LOGGDP(-1)	-3.903547	-0.072812	0.986305	0.059353
	(3.76984)	(0.16471)	(0.12174)	(0.08002)
	[-1.03547]	[-0.44207]	[8.10145]	[0.74172]
LOGGDP(-2)	11.46770	0.286942	0.139868	-0.156440
	(4.95706)	(0.21658)	(0.16008)	(0.10522)
	[2.31341]	[1.32490]	[0.87371]	[-1.48679]
LOGGDP(-3)	-12.06136	-0.225366	-0.334662	0.172791
	(5.36055)	(0.23421)	(0.17311)	(0.11378)
	[-2.25002]	[-0.96226]	[-1.93318]	[1.51858]
LOGGDP(-4)	5.226324	0.017300	0.226977	-0.047047
	(4.12571)	(0.18025)	(0.13324)	(0.08757)
	[1.26677]	[0.09598]	[1.70356]	[-0.53723]
FFR(-1)	-4.397415	0.353732	-0.328414	1.397368
	(5.83482)	(0.25493)	(0.18843)	(0.12385)

	[-0.75365]	[1.38758]	[-1.74289]	[11.2826]
FFR(-2)	8.764997	-0.715910	0.488194	-0.585503
	(10.1022)	(0.44137)	(0.32624)	(0.21443)
	[0.86763]	[-1.62202]	[1.49641]	[-2.73048]
FFR(-3)	-17.36895	0.498320	-0.422538	0.100893
	(9.90115)	(0.43259)	(0.31975)	(0.21016)
	[-1.75424]	[1.15195]	[-1.32146]	[0.48007]
FFR(-4)	13.02816	-0.072297	0.104594	-0.072323
	(5.14066)	(0.22460)	(0.16601)	(0.10912)
	[2.53434]	[-0.32190]	[0.63004]	[-0.66280]
C	-526.1338	-6.072914	-8.814041	-19.29041
	(497.433)	(21.7331)	(16.0642)	(10.5587)
	[-1.05770]	[-0.27943]	[-0.54868]	[-1.82697]
R-squared	0.611846	0.999632	0.999572	0.983706
Adj. R-squared	0.526771	0.999551	0.999478	0.980134
Sum sq. resids	14645.05	27.95544	15.27361	6.598416
S.E. equation	14.16394	0.618831	0.457414	0.300648
F-statistic	7.191850	12386.88	10653.26	275.4453
Log likelihood	-356.8466	-75.09057	-47.88873	-10.12036
Akaike AIC	8.307703	2.046457	1.441972	0.602675
Schwarz SC	8.779889	2.518643	1.914158	1.074861
Mean dependent	96.59667	159.0284	918.8764	4.910222
S.D. dependent	20.58962	29.20772	20.02206	2.133087

Determinant resid covariance (dof adj.)	1.027864
Determinant resid covariance	0.444895
Log likelihood	-474.3716
Akaike information criterion	12.05270
Schwarz criterion	13.94145

VAR(4) BASELINE WITH EXOGENOUS FFR

Date: 06/29/13 Time: 11:43
Sample (adjusted): 1987Q1 2008Q2
Included observations: 86 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	EPU	INFLRATE	YRATE
EPU(-1)	0.588551	0.002286	-6.07E-06
	(0.12319)	(0.00426)	(5.6E-06)
	[4.77755]	[0.53606]	[-1.08834]
EPU(-2)	-0.097657	-0.001119	-4.81E-06
	(0.13220)	(0.00458)	(6.0E-06)
	[-0.73873]	[-0.24452]	[-0.80371]
EPU(-3)	0.216604	-0.003825	6.50E-06
	(0.13095)	(0.00453)	(5.9E-06)
	[1.65414]	[-0.84386]	[1.09630]
EPU(-4)	0.012888	0.005941	6.43E-06
	(0.11555)	(0.00400)	(5.2E-06)

	[0.11154]	[1.48519]	[1.22925]
INFLRATE(-1)	3.126535	0.796934	-0.000180
	(3.33480)	(0.11543)	(0.00015)
	[0.93755]	[6.90385]	[-1.19321]
INFLRATE(-2)	1.640635	0.011292	0.000124
	(4.16327)	(0.14411)	(0.00019)
	[0.39407]	[0.07836]	[0.65641]
INFLRATE(-3)	-8.610766	0.132246	-7.55E-05
	(4.18830)	(0.14498)	(0.00019)
	[-2.05591]	[0.91219]	[-0.39853]
INFLRATE(-4)	3.398376	-0.331454	-0.000158
	(3.44641)	(0.11930)	(0.00016)
	[0.98606]	[-2.77840]	[-1.01498]
YRATE(-1)	-3930.084	-108.9518	0.907458
	(2821.65)	(97.6708)	(0.12769)
	[-1.39283]	[-1.11550]	[7.10658]
YRATE(-2)	7145.286	236.5332	0.053868
	(3562.36)	(123.310)	(0.16121)
	[2.00577]	[1.91819]	[0.33414]
YRATE(-3)	-6939.643	-195.3922	-0.236078
	(3649.10)	(126.313)	(0.16514)
	[-1.90174]	[-1.54689]	[-1.42958]
YRATE(-4)	645.7165	-33.48587	-0.058302
	(2877.36)	(99.5989)	(0.13021)
	[0.22441]	[-0.33621]	[-0.44774]
C	30.97350	0.570664	0.001294
	(14.7600)	(0.51091)	(0.00067)
	[2.09848]	[1.11695]	[1.93741]
FFR	1.405058	0.139410	9.33E-05
	(1.26338)	(0.04373)	(5.7E-05)
	[1.11214]	[3.18786]	[1.63153]
R-squared	0.564080	0.810933	0.828955
Adj. R-squared	0.485372	0.776796	0.798072
Sum sq. Resids	15075.00	18.06258	3.09E-05
S.E. equation	14.46980	0.500868	0.000655
F-statistic	7.166766	23.75518	26.84165
Log likelihood	-344.1859	-54.92701	516.0899
Akaike AIC	8.329904	1.602954	-11.67651
Schwarz SC	8.729449	2.002499	-11.27696
Mean dependent	95.52209	3.110004	0.003199
S.D. dependent	20.17046	1.060163	0.001457
Determinant resid covariance (dof adj.)		1.81E-05	
Determinant resid covariance		1.06E-05	
Log likelihood		126.4188	
Akaike information criterion		-1.963228	
Schwarz criterion		-0.764593	

VAR(4) BASELINE WITH ENDOGENOUS FFR AND S&P500

Vector Autoregression Estimates
Date: 08/05/13 Time: 18:11
Sample (adjusted): 1987Q1 2008Q2
Included observations: 86 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	SP500RATE	EPU	INFLRATE	YRATE	FFR
SP500RATE(-1)	1.003981	-193.4704	6.261364	0.013399	5.698490
	(0.13937)	(174.688)	(6.25947)	(0.00795)	(3.74758)
	[7.20362]	[-1.10752]	[1.00030]	[1.68454]	[1.52058]
SP500RATE(-2)	-0.099330	110.6596	-10.21307	-0.006582	-9.365684
	(0.20418)	(255.924)	(9.17034)	(0.01165)	(5.49032)
	[-0.48647]	[0.43239]	[-1.11371]	[-0.56483]	[-1.70585]
SP500RATE(-3)	-0.086577	-13.65364	7.878701	0.003602	-0.729308
	(0.19710)	(247.045)	(8.85220)	(0.01125)	(5.29985)
	[-0.43926]	[-0.05527]	[0.89003]	[0.32017]	[-0.13761]
SP500RATE(-4)	-0.115635	-22.17774	0.646573	-0.000834	8.325399
	(0.13112)	(164.341)	(5.88871)	(0.00748)	(3.52560)
	[-0.88193]	[-0.13495]	[0.10980]	[-0.11146]	[2.36142]
EPU(-1)	8.48E-06	0.391974	0.005045	-1.63E-06	-0.005740
	(0.00012)	(0.15204)	(0.00545)	(6.9E-06)	(0.00326)
	[0.06988]	[2.57806]	[0.92611]	[-0.23547]	[-1.75975]
EPU(-2)	0.000101	-0.082720	-0.002401	-4.17E-06	0.003336
	(0.00012)	(0.15542)	(0.00557)	(7.1E-06)	(0.00333)
	[0.81537]	[-0.53222]	[-0.43116]	[-0.58874]	[1.00055]
EPU(-3)	-0.000196	0.191174	-0.004405	7.14E-06	-8.03E-05
	(0.00012)	(0.15292)	(0.00548)	(7.0E-06)	(0.00328)
	[-1.60680]	[1.25018]	[-0.80401]	[1.02612]	[-0.02447]
EPU(-4)	0.000167	0.055313	0.006550	2.38E-06	0.004265
	(0.00011)	(0.13628)	(0.00488)	(6.2E-06)	(0.00292)
	[1.53480]	[0.40587]	[1.34133]	[0.38352]	[1.45861]
INFLRATE(-1)	-0.002774	3.732758	0.803240	-0.000147	-0.018545
	(0.00289)	(3.62015)	(0.12972)	(0.00016)	(0.07766)
	[-0.96039]	[1.03111]	[6.19219]	[-0.88931]	[-0.23879]
INFLRATE(-2)	0.003218	2.021919	0.011499	0.000127	-0.000610
	(0.00350)	(4.38918)	(0.15727)	(0.00020)	(0.09416)
	[0.91903]	[0.46066]	[0.07311]	[0.63365]	[-0.00648]
INFLRATE(-3)	-0.002893	-6.920203	0.144339	-3.16E-05	0.074598
	(0.00346)	(4.34282)	(0.15561)	(0.00020)	(0.09317)
	[-0.83499]	[-1.59348]	[0.92755]	[-0.15960]	[0.80070]
INFLRATE(-4)	0.002049	0.045068	-0.321206	-0.000135	-0.008925
	(0.00296)	(3.70492)	(0.13276)	(0.00017)	(0.07948)
	[0.69336]	[0.01216]	[-2.41953]	[-0.79751]	[-0.11229]
YRATE(-1)	-1.170766	-3323.940	-123.8331	0.909823	93.58037
	(2.37685)	(2979.14)	(106.749)	(0.13565)	(63.9113)
	[-0.49257]	[-1.11574]	[-1.16004]	[6.70706]	[1.46422]

YRATE(-2)	-1.087257	6969.023	235.0532	0.027542	-5.721551
	(2.96378)	(3714.80)	(133.110)	(0.16915)	(79.6934)
	[-0.36685]	[1.87602]	[1.76586]	[0.16283]	[-0.07179]
YRATE(-3)	3.525558	-5750.084	-208.0407	-0.195217	-22.33620
	(2.98223)	(3737.92)	(133.938)	(0.17020)	(80.1893)
	[1.18219]	[-1.53831]	[-1.55326]	[-1.14698]	[-0.27854]
YRATE(-4)	-0.266940	-139.4584	-23.15322	-0.036890	16.36300
	(2.30976)	(2895.05)	(103.736)	(0.13182)	(62.1074)
	[-0.11557]	[-0.04817]	[-0.22319]	[-0.27985]	[0.26346]
FFR(-1)	0.008303	-2.327986	0.512114	6.74E-05	1.538188
	(0.00487)	(6.10413)	(0.21872)	(0.00028)	(0.13095)
	[1.70496]	[-0.38138]	[2.34136]	[0.24247]	[11.7462]
FFR(-2)	-0.011011	5.870823	-0.716042	0.000219	-0.638336
	(0.00935)	(11.7235)	(0.42008)	(0.00053)	(0.25150)
	[-1.17726]	[0.50078]	[-1.70455]	[0.40987]	[-2.53809]
FFR(-3)	0.002812	-9.363165	0.453919	-0.000599	0.118348
	(0.00955)	(11.9761)	(0.42913)	(0.00055)	(0.25692)
	[0.29434]	[-0.78182]	[1.05776]	[-1.09811]	[0.46063]
FFR(-4)	0.000573	8.499003	-0.143074	0.000333	-0.085798
	(0.00512)	(6.41864)	(0.22999)	(0.00029)	(0.13770)
	[0.11187]	[1.32411]	[-0.62207]	[1.14041]	[-0.62308]
C	-0.009093	40.97535	0.492438	0.000907	-0.333123
	(0.01236)	(15.4905)	(0.55506)	(0.00071)	(0.33232)
	[-0.73575]	[2.64519]	[0.88718]	[1.28637]	[-1.00243]
R-squared	0.784327	0.610652	0.819044	0.845337	0.984037
Adj. R-squared	0.717966	0.490852	0.763365	0.797749	0.979125
Sum sq. resids	0.008571	13464.47	17.28771	2.79E-05	6.196730
S.E. equation	0.011483	14.39256	0.515718	0.000655	0.308763
F-statistic	11.81913	5.097278	14.71015	17.76348	200.3403
Log likelihood	274.1632	-339.3276	-53.04160	520.4192	-8.924711
Akaike AIC	-5.887516	8.379711	1.721898	-11.61440	0.695924
Schwarz SC	-5.288199	8.979029	2.321215	-11.01508	1.295241
Mean dependent	0.013553	95.52209	3.110004	0.003199	4.821977
S.D. dependent	0.021622	20.17046	1.060163	0.001457	2.137020

Determinant resid covariance (dof adj.)	1.21E-10
Determinant resid covariance	2.99E-11
Log likelihood	431.8445
Akaike information criterion	-7.601034
Schwarz criterion	-4.604448

VAR(4) BASELINE WITH EXOGENOUS FFR AND S&P500

Vector Autoregression Estimates
Date: 08/05/13 Time: 18:21
Sample (adjusted): 1987Q1 2008Q2
Included observations: 86 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	SP500RATE	EPU	INFLRATE	YRATE
SP500RATE(-1)	0.943798	-144.0795	1.722905	0.013627
	(0.12892)	(165.719)	(5.76166)	(0.00726)
	[7.32060]	[-0.86942]	[0.29903]	[1.87697]
SP500RATE(-2)	-0.049845	45.66039	-3.798987	-0.011320
	(0.17798)	(228.775)	(7.95397)	(0.01002)
	[-0.28006]	[0.19959]	[-0.47762]	[-1.12943]
SP500RATE(-3)	-0.119905	121.8712	3.877726	0.008612
	(0.17909)	(230.206)	(8.00375)	(0.01009)
	[-0.66951]	[0.52940]	[0.48449]	[0.85387]
SP500RATE(-4)	-0.099354	-21.12696	0.836646	-0.002236
	(0.12954)	(166.515)	(5.78934)	(0.00730)
	[-0.76695]	[-0.12688]	[0.14451]	[-0.30656]
EPU(-1)	-5.51E-05	0.522921	0.002260	-1.80E-06
	(0.00011)	(0.13921)	(0.00484)	(6.1E-06)
	[-0.50851]	[3.75637]	[0.46696]	[-0.29595]
EPU(-2)	7.73E-05	-0.093559	-0.002022	-6.49E-06
	(0.00011)	(0.14710)	(0.00511)	(6.4E-06)
	[0.67540]	[-0.63601]	[-0.39526]	[-1.00731]
EPU(-3)	-0.000156	0.248019	-0.003033	8.41E-06
	(0.00011)	(0.14506)	(0.00504)	(6.4E-06)
	[-1.38630]	[1.70975]	[-0.60134]	[1.32332]
EPU(-4)	0.000202	0.029798	0.006406	5.10E-06
	(9.8E-05)	(0.12646)	(0.00440)	(5.5E-06)
	[2.05461]	[0.23564]	[1.45714]	[0.92013]
INFLRATE(-1)	-0.002017	2.950347	0.808741	-0.000138
	(0.00272)	(3.50166)	(0.12174)	(0.00015)
	[-0.74055]	[0.84256]	[6.64292]	[-0.89831]
INFLRATE(-2)	0.002453	1.264083	-0.003947	8.74E-05
	(0.00341)	(4.37913)	(0.15225)	(0.00019)
	[0.72014]	[0.28866]	[-0.02592]	[0.45542]
INFLRATE(-3)	-0.003176	-7.688142	0.143304	-6.48E-05
	(0.00342)	(4.39449)	(0.15279)	(0.00019)
	[-0.92890]	[-1.74949]	[0.93794]	[-0.33634]
INFLRATE(-4)	0.002361	2.747384	-0.329355	-0.000136
	(0.00281)	(3.60732)	(0.12542)	(0.00016)
	[0.84113]	[0.76161]	[-2.62605]	[-0.85927]
YRATE(-1)	-0.495117	-3973.810	-110.0339	0.895650
	(2.35112)	(3022.13)	(105.073)	(0.13240)
	[-0.21059]	[-1.31490]	[-1.04722]	[6.76469]
YRATE(-2)	-1.139483	6539.516	225.5173	0.047799
	(2.92880)	(3764.69)	(130.890)	(0.16493)
	[-0.38906]	[1.73707]	[1.72296]	[0.28981]
YRATE(-3)	3.383815	-6735.491	-194.6060	-0.212379
	(2.94507)	(3785.60)	(131.617)	(0.16585)

	[1.14898]	[-1.77924]	[-1.47858]	[-1.28056]
YRATE(-4)	-0.076753	668.2220	-30.05708	-0.057990
	(2.30041)	(2956.96)	(102.807)	(0.12955)
	[-0.03336]	[0.22598]	[-0.29237]	[-0.44765]
C	-0.010071	33.78964	0.546379	0.000913
	(0.01208)	(15.5336)	(0.54007)	(0.00068)
	[-0.83337]	[2.17526]	[1.01168]	[1.34207]
FFR	0.000705	1.508594	0.128541	5.52E-05
	(0.00106)	(1.35825)	(0.04722)	(6.0E-05)
	[0.66749]	[1.11069]	[2.72199]	[0.92737]
R-squared	0.775494	0.573742	0.813486	0.843251
Adj. R-squared	0.719367	0.467178	0.766858	0.804064
Sum sq. resids	0.008922	14740.87	17.81865	2.83E-05
S.E. equation	0.011454	14.72337	0.511897	0.000645
F-statistic	13.81686	5.383989	17.44614	21.51849
Log likelihood	272.4371	-343.2221	-54.34235	519.8430
Akaike AIC	-5.917141	8.400514	1.682380	-11.67077
Schwarz SC	-5.403441	8.914214	2.196081	-11.15707
Mean dependent	0.013553	95.52209	3.110004	0.003199
S.D. dependent	0.021622	20.17046	1.060163	0.001457

Determinant resid covariance (dof adj.)	1.74E-09
Determinant resid covariance	6.80E-10
Log likelihood	419.5746
Akaike information criterion	-8.083131
Schwarz criterion	-6.028328

BIBLIOGRAPHY

[1] Jean-Paul Renne. *Structural VAR and Applications*. Banque de France, ENSTA.

[2] Multivariate time series models, Ch 6

[3] Bordignon. SSE progredito, slides.

[4] G. Mankiw.2004, *Macroeconomia*, VI edizione italiana, Zanichelli, 2004.

[5] Damjan Pfajar. *Macroeconomics I, Empirical Macroeconomics (Monetary Economics)*.

[6] Lutkepahl Helmet. *New introduction to multiple time series analysis.* Springer, Heidelberg, 2005.

[7] Walter Enders. *Applied Econometric Time Series*.

[8] I.Gusti Ngurah Angung . *Time Series Data Analysis Using EViews*.

[9] Attilio di Battista. *L'economia dell'incertezza*, 2008.

[10] Giuliano Amato. Fabrizio Forquet. *Lezioni dalla crisi*. Laterza, 2013.

[11] Time series' sources in: http://www.research.stlouisfed.org/

[12] Scott R. Baker, Nicholas Bloom, and Steven J. Davis. *Measuring Economic Policy Uncertainty*, 2013. In: http://www.policyuncertainty.com/us_monthly.html

[13] Bureau of Labor Statistics. *Handbooks of methods. Chapter 17: The Consumer Price Index*, 2007. In: http://www.bls.gov/opub/hom/pdf/homch17.pdf

[14] Bureau of Economic Analysis. *A Guide to the National Income and Product Accounts of the United States*. In: http://www.bea.gov/national/pdf/nipaguid.pdf

[15] Arto Luoma. Jani Luoto. *Is There Support for the Sticky Information Models in the Michigan Inflation Expectation Data?* In: https://.jyu.fi/jsbe/tutkimus/julkaisut/workingpaper/wp331

[16] http://www.standardandpoors.com/indices/sp-500/en/us/?indexId=spusa-500-usduf--p-us-l--

[17] http://www.economiq.org/series/mich/

[18] http://thomsonreuters.com/products_services/financial/financial_products/a-z/umichigan_surveys_of_consumers/

[19] http://www.econmodel.com/classic/terms/fedfunds.htm