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TITTEL: **Extreme events in the stock market and economy**

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PREFACE

This work has been a challenging journey of acquiring new knowledge with lost-and-regained-knowledge bumps on the way.

We would like first of all to thank ourselves for getting involved into this challenge as it required a great deal of persistence, concentration, time contribution, and reliance upon each other. As Kingman Brewste once said *“There is no greater challenge than to have someone relying upon you; no greater satisfaction than to vindicate his expectation.”*

As all areas in our lives are greatly challenged and prone to extremes at times, we have decided to choose a topic which would follow our general direction in life, the topic that could give us enough ups and downs to feel the joy of satisfaction after its completion.

We, of course, would like to express a special gratitude to our advisor, Associate Professor Lorán Chollete, for showing us a new fork on the road of extremes and steering our journey to the progress once we would get off the road.

In the end, we would like to thank our families and work colleagues for understanding several months of elusive presence, and our friends for giving us a helping hand with useful advice, PC maintenance and technical support, and cheering us up so that we would eventually come to the finish line.

Olesia Chayko & Vera Morozova

Stavanger, 2012

ABSTRACT

Reoccurring financial and macroeconomic disasters consequences of which lead to greater financial costs and hinder a healthy market functioning in the world's economy, need to be paid a special attention to in terms of understanding their nature and the ways to hedge them.We base our empirical study on long term data including 42 countries for GDP, consumption, real exchange rates, net import, long term government bond yield, stock price indices and inflaton. The countries are organized in three main groups: Global, OECD and non-OECD and then split in six groups on the basis of continents division. First, we reveal the essential data chactericstics using descriptive statistics analysis. Then, with the help of correlation analysis we detect statistically significant relationships between the variables for each country category. The purpose is to establish the interaction process between macroeconomic and financial factors. Further, we perform the logistic regression analysis with binary codes for both dependent and independent variables in order to establish the best predictor models. The purpose is to discover whether annual growths in some variable would lead to increase/decrease in real pc GDP. We document that the best prediction ability is revealed by consumption on GDP, though for some country categories other best predictors are detected. These include stock price indices, inflation, long term government bond yield, net import and real exchange rates for various categories. Potential future research involves data modification in terms of collecting data of higher frequency, constructing missing data gaps, and forming binary variables for logistic regression analysis on the basis of improved crisis thresholds.

Key words: Extreme values, disasters, kurtosis, skewness, standard deviation, correlation, probability distributions, heavy tails, logistic regression.

1 INTRODUCTION AND MOTIVATION

"The greatest danger in times of turbulence
is not the turbulence; it is to act with
yesterday's logic."
Peter Drucker

The interest to extreme events topic has grown fast within the past years, which is caused by extreme events leaving their undesirable and most times destructive prints on socioeconomic life. Economic and financial disasters affect the global economy drastically which involves increasing number of people affected and financial costs rising. Therefore, it is essential to understand the causes of extremes and search for the ways to forecast them and hinder their occurrence.

Today, economic, natural and technological disasters, civil emergencies, disease epidemics yield an increasing concern about the world's economy. The diversity of disciplines involved in studying extreme events on different scientific levels and from different perspectives, includes both social and exact sciences. Thus, scientific and societal interests are converging in the field of extreme events study. The diversity of participating disciplines evidences that extreme events are not an insulated phenomena, but actually must be understood and addressed in terms of various interactions.

The purpose of this paper is to study extreme events and disasters in the stock market and economy. This goal will be gradually achieved using various approaches, both theoretical and empirical.

In Chapter 2 we dwell upon the related research on the topic, providing evidence of studies made in the field of extreme events and macroeconomic disasters, proving the importance of the subject concerned. Chapter 3 contains the theoretical part about macro-financial factors included into our empirical analysis. Chapter 4 bears the theoretical character and involves the basic concepts of the Extreme Value Theory. Chapter 5 includes the description of data sample construction, containing explanation of the calculations for each set of variables.

The empirical analysis will be performed using three timeline periods: the full period (1900-2011), the 1900-47 period, and the 1948-2011 period.The data set compiled from different data sources, embraces not only the recent global economic and financial crises, but also such great disasters as WWI, German hyperinflation, The Great Depression, and WWII.

The empirical realization of the purpose set in the paper will be achieved by implementing certain statistical procedures to the compiled macro-financial data set. These procedures will first involve a set of descriptive statistics analysis with the help of which we will obtain the results of kurtosis, skewness and standard deviation in order to discover the essential characteristics of the data. These will further be used to determine the best fitted distributions for the data samples. The results of the descriptive statistics analysis are found in Chapter 6.

Second, we will perform correlation analysis in order to reveal the relationships between pairs of macro-financial factors and to establish the existence of either positive or negative correlations between several pairs of variables. The outcome of the correlation analysis is presented in Chapter 6.

Third, we will attempt to detect the mechanism of extreme events prediction with the help of logistic regression by assigning codes 1 and 0 to both dependent and independent variables on the ground of their negative or positive annual performance. The performance of logistic regression is to tell us whether growth rates in one variable could be predicted by growth rates in the others. The results of the logistic regression are found in Chapter 6 of our paper.

Finally, we will discuss the results of our empirical analysis in order to summarize and assess the achieved results and estimate if they are according to the theory and our expectations. The discussion of the results is presented in Chapter 7.

In conclusion (Chapter 8) we finalize our thoughts on the performed empirical analysis and point out approaches to improve it in further research.

Appendices attached to the paper serve as a documentary proof and visual aid for the performed empirical analysis.

2 RELATED RESEARCH

The topic of extreme and rare events has emerged in scientific research for about a decade ago. Extreme events studies provide growing evidence that extreme events and disasters have a tendency to reoccur. Economists do not converge about the nature of extreme and rare events, what drives them, how to predict and how to hedge them.

Taleb (2007) for example, in his book “The Black Swan: The Impact of the Highly Improbable” describes extreme and unpredictable events referring to the latter as “black swans”. Taleb uses the terminology of “black swan” to define rare events as “any behavior where the adage bewares of calm waters can hold” (Cholette, 2010, p.2). Taleb also suggests the idea that rare events are always unexpected and generally caused by panics.

Dungey and Tambakis (2005) in their book “Identifying International Financial Contagion” describe the international transmission of financial crises. Dungey and Tambakis point out different mechanisms through which the crises are transmitted internationally – these are both financial and political.

Barro and Ursúa (2009) in the paper “On the Size Distribution of Macroeconomic Disasters” state that a key determinant of the equity premium in the rare disaster setting is the size distribution of macroeconomic disasters, which are measured by proportionate decrease in consumption per capita and GDP per capita. In their research “Rare Macroeconomic Disasters”, Barro and Ursúa (2011) attempt to explain asset-pricing puzzles with the help of rare macroeconomic disasters approach. Barro and Ursúa state that the rare macroeconomic disasters perspective provides an important link between macroeconomics and finance. Moreover, Barro and Ursúa mean that it helps to explain an array of asset-pricing puzzles, including the high equity premium.

Farhi and Gabaix (2008) in their paper “Rare Disasters and Exchange Rates” develop a model of exchange rates, which serves to combine the explanation on the possibility of rare economic disasters and an asset view on the exchange rate. The authors mean that each country is exposed to disaster risk according to a mean-reverting process. Farhi and Gabaix point that risky countries control high risk premia: “as their risk premium reverts, their exchange rate appreciates” (Farhi and Gabaix, 2011, p.1).

Chollete (2007) in the work "The Nature and Causes of Extreme Events: An Application to Subprime Market Spillovers" builds a taxonomy of extremes. The author constructs empirical probabilities of extremes and documents that the latter are rather frequent and persistent.

Chollete and Jaffee (2012) in the research paper "Financial Implications of Extreme and Rare Events" develop a framework that explains why banks, investors, and policymakers may avoid taking precautions against extreme events, even when those events are exogenously determined.

Reinhart and Rogoff (2009) in the book "This Time is Different: Eight Centuries of Financial Folly" provide the quantitative history of financial crises. The authors have developed the so called BCDI index, which stands for banking, currency, default, and inflation crises, and can take values from 0 to 5, and BCDI index +, where the plus sign stands for stock market crash. Reinhart and Rogoff state that financial crises and extreme events reoccur in history, and therefore, are important to be studied.

As we can see from the previous research overview, the outcomes and consequences of extreme and rare events are unpredictable and at most extent undesirable. The topic of extreme events is relatively new and hasn't been explored to the fullest yet, as the earliest research papers date back to the mid 2000's. It has plenty of undiscovered areas which ought to be considered when answering the questions about the nature of rare events; how to predict them and handle the consequences once they have occurred.

3 CHOICE OF MACRO-FINANCIAL FACTORS

For our emprical part of the thesis, we have selected seven factors which we believe are of an importance each in analyzing economic and financial disasters performance. In this chapter, we present these factors theoretically and explain the reasons of their importance for our empirical study.

3.1 GDP

In economic theory the Gross Domestic Product (GDP) is considered to be one of the primary indicators which provides a gauge of the overall health of a country's economy. Gross Domestic Product measures the market value of all final goods and services produced within a country during a specified period (month, quarter, or year). Thus, GDP measures a country's total productivity (Steigum, 2006). Hence, having a low level GDP number for a long period of time is not good for a country's economy, particularly, when the trend in GDP becomes negative. Besides GDP, there are many other factors that can dictate recession, but many economists track the GDP number very closely for that reason (Collins, 2010).

GDP function looks as follows:

$$GDP = C + G + I + (X - Q)$$

Equation 3.1 Gross Domestic Product function (from Steigum, 2006).

where *C* denotes private consumption; *I* – gross investments in real capital, *G* – government consumption; *X* – export of goods and services; *Q* – import of goods and services (Steigum E., 2006).

The GDP is often used as an indicator of the standard of living of a country's population. The GDP is particularly useful when comparing one country to another as it provides with the information about the relative performance of the countries. A drop in the GDP signals a decline in economy. An increase in the GDP on the other hand indicates national economic growth. As such, economists use the GDP in monitoring economic growth in particular countries during specific periods (Steigum, 2006).

Despite the importance of the GDP as an indicator of economic growth, there yet exist several shortcomings with GDP as an economic tool. First, services performed in households by the residents themselves such as cooking, cleaning, and child care go unrecorded in GDP statistics as they do not take place in organized markets. Second, GDP ignores transactions from underground, illegal economic activities. Nevertheless, GDP still remains a good measure of the value of output produced in a country's economy and a nation's welfare (McEachern, 2009). Based on the described above reasons, we have included GDP into our empirical analysis as a significant factor for our extreme events study.

3.2 Consumption

"Consumption is the sole end and purpose of all production; and the interest of the producer ought to be attended to, only so far as it may be necessary for promoting that of the consumer. The maxim is so self-evident that it would be absurd to attempt to prove it. But in the mercantile system, the interest of the consumer is almost constantly sacrificed to that of the producer; and it seems to consider production, and not consumption, as the ultimate end and object of all industry and commerce" (Smith, 1904, p. 35).

Why consumption is an important macroeconomic variable?

Consumption is the value of goods and services bought by households in a particular time period. Consumption accounts for the largest part of aggregate demand. There are many factors that have an important impact on how much people are willing and able to spend. Since changes in consumer spending have an important effect on direction of the economic cycle,hence, it is crucial to understand these factors (Riley and College, 2006).

Consumption is normally the largest GDP component; therefore, it has an immediate impact on GDP (Steigum, 2006). Figure 3.1 below serves as a graphical representation of this statement showing the swings in consumption relative to those in GDP.

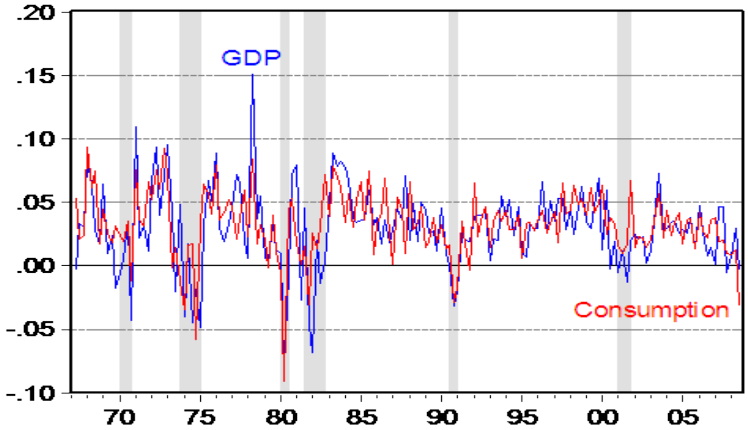

Figure 3.1 Quarter-on-quarter annualized growth rates of real GDP and consumption (from Chinn, 2008).

Mathematical formula of the consumption function was developed by economist John Maynard Keynes. The formula shows relationship between consumer spending and different factors that determine it. These factors include income (current, life time average or permanent), wealth, expectations about future income or wealth, interest rate (nominal) and the availability of the credit, changes in employment and unemployment. Consumer's preferences, attitude to risk may also influence the consumption (Gubta, 2004).

The consumption function has the following form:

$$C = a(Y - T) + b, \qquad 0 < a < 1, b > 0.$$

Equation 3.2 The Keynesian consumption function (from Steigum E., 2006).

where: C is a consumer spending; b is the autonomous consumption; a is marginal propensity to consume showing how much the consumption will increase with the one unit increase in real disposable income changes $(Y - T)$ is a real disposable income (Steigum, 2006).

The consumption function predicts that the link between income shocks and consumption is strong, especially in the case of unpredictable income shocks. Hence, consumption may fall as an immediate consequence of a decline in income induced by job losses, reduced hours or productivity, and negative returns from assets (Dornbusch et al., 2011).

In other words, changes in consumption are a good indicator of recessions or prosperity time. For these reasons we have chosen to include consumption into our empirical analysis as another significant factor for our extreme events study.

3.3 Net import

Before shortly describing net import we want to present the "circular flow model" that shows the flow of goods through the various sectors of the economy:

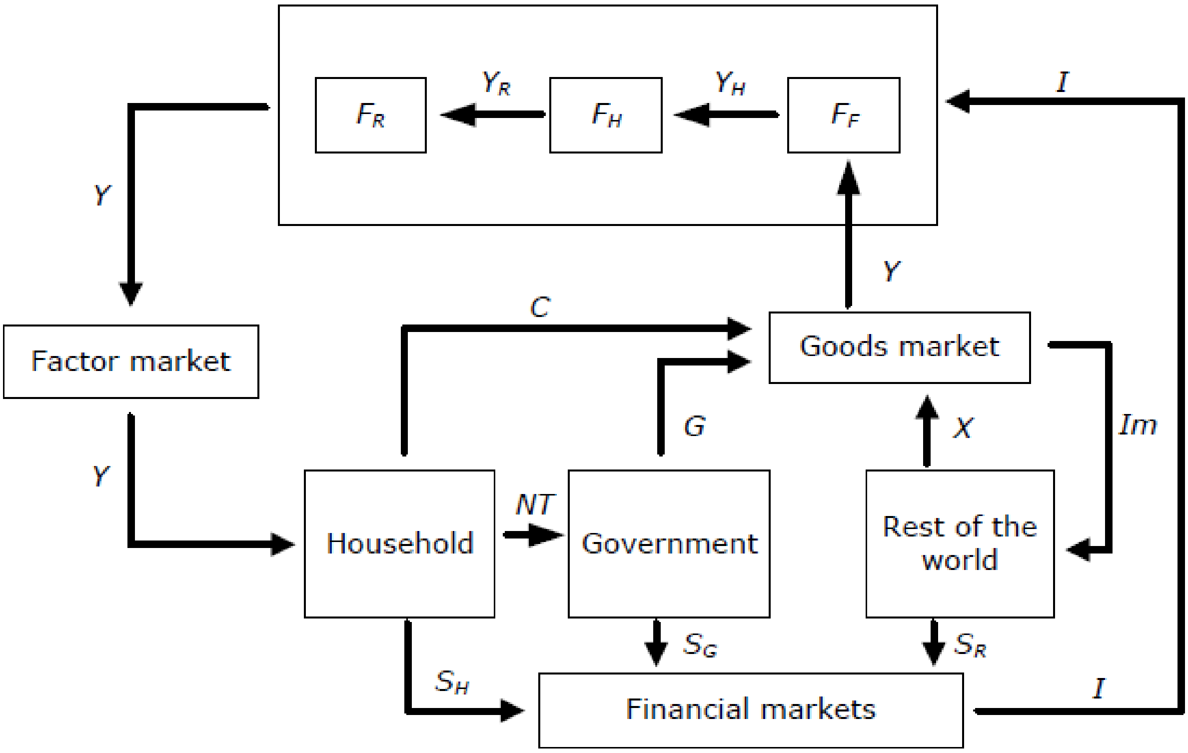

Figure 3.2 Circular flow model – circulation of money (from Jochumzen, 2010).

where Y stands for national income; NT – net tax; C – consumption, S_H – private sectors savings; G – government expenditure; S_G –government savings; X – the total value of all exports to the rest of the world; Im – the total value of all imports from the rest of the world; S_R – rest of the world savings; I – investments; F_R – firms acquiring raw materials; F_H – firms producing semi-manufactured goods; F_F – firms producing finished goods; Y_R – the total value of all goods going from F_R to F_H and Y_H is the total value of all goods going from F_H to F_F (Jochumzen, 2010, pp. 26-29).

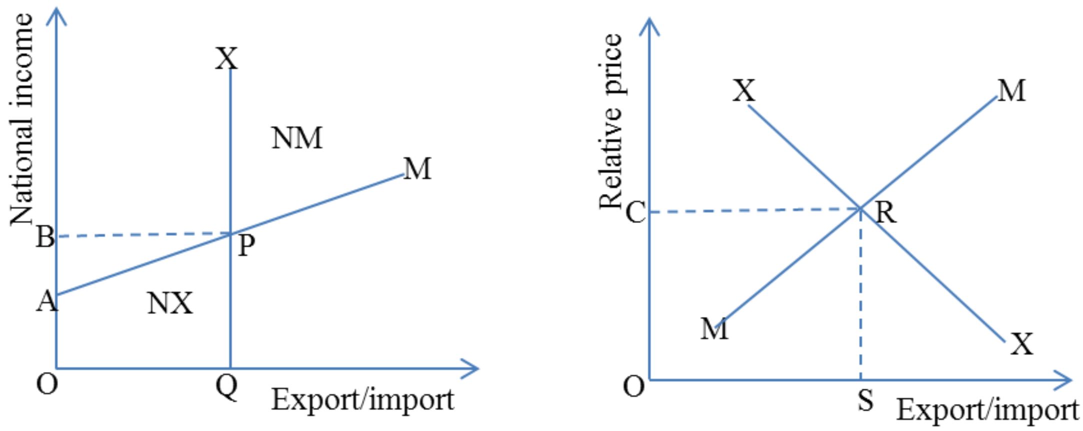

Figure 3.3 Export/import function. Left: export/income – national income relationships; Right: export/import – relative price relationship (from Gubta, 2004).

Export/Import relationships with national income and relative prices are presented in the Figure 3.3. The import and export curves are non-linear in general but for convenience have been drawn as linear. The left part of Figure 3.3 shows the relationship between national income and export/import. The export curve (marked as QX) is vertical as the exports are independent of the home income. The distance marked as OQ is positively governed by the level of the world income. The import function is given as the curve AM for a given relative price. The equilibrium position is in the intersection point P. From the graph one can see that when imports are less than OQ the area between the export and import curves represents net export marked as NX. Net import which is indicated by the area above point P between the export and import curves (marked as NM) occurs when the imports exceed exports. "Therefore if the domestic income grows, the world income remaining the same, the trade deficit goes up, and vice versa. Thus, the relative home prosperity is harmful from the view point of trade balance, and vice versa" (Gubta, 2004, pp. 139-140).

The right part of Figure 3.3 shows the role of the relative price in the export and export functions for given values of other determinants. A positively sloped import curve MM is due to the fact that imports vary directly with income and the negatively sloped export line XX is due to the inverse relationship between the relative price and exports. The intersections point R is consistent with zero trade balance. Therefore, one will expect more trade deficit with the higher relative price (Gubta, 2004).

"The conventional empirical relationship determines imports through a demand function with prices and a variety of activity variables, such as income and expenditure, as the explanatory variables. Traditional studies assume that imports depend upon the price of imports in domestic currency, the price of domestically produced substitutes, as well as income the demand for imports correlates negatively with relative prices (as defined here) and positively to income ” (Metwally, 2004, p. 61).

A certain proportion of an increase in national income will be spent on purchases of imports; as suggested by theory on the marginal propensity. Therefore, the shortfall caused by the spending exceeding domestic supply results in higher imports (all else equal) leading to a positive net imports and negative net exports. Income changes and the pace of domestic economics are expected to be one of the important factors influencing the value of imports. In theory the relationship between economic activity and real imports is positively correlated. Also, movements in the real effective exchange rate are positively correlated with the growth in real imports. The fall of the real effective exchange rate is reflected in the higher cost for imports which leads to a decline in the volume demanded (Rogers, 2000).

In governing purpose some restrictions or sanctions (tariffs, quotas etc.) can be placed on import or export. Tariffs-taxes on imports are one of the methods of adjusting current account deficit. However, such international organizations like World Trade Organization and International Monetary Fund partly prevent free use of tariffs (for adjustment of trade balance) (Dornbusch et al., 2011). It is worth mentioning that ‘tariff is superior to quota on social consideration” (Gubta, 2004, p. 137). It means that under tariffs, government collects tax revenues while under quota firms or persons who can manage to grab the quota gain from the trade restrictions (Gubta, 2004).

For our analysis we have chosen net import as one of the variables that is of the most interest for us to study in the context of extreme events occurrence.

3.4 Inflation

“The prices of goods and services fluctuate over time, but when prices change too much and too quickly, the effects can shock an economy” (Mahorney, 2011).

Prices in some markets (e.g., the price of calculator) can decrease even in times of inflation, and prices in some markets (e.g., health care) even in times of deflation can rise. Therefore, the determinant of extent to which an economy experiencing inflation or deflation is not the change in individual prices but the upward or downward movement in the average prices of all goods and services combined (price level) (Saunders and Gilliard, 2000).

As the price level increases during inflation, the value of money is decreasing. The main causes are the rise in demand for many and fall in money supply. As the value of money rises during deflation the price level decreasing. The main causes for deflation are opposite for those for inflation (i.e. fall in the demand for money and increase in money supply).

There is no common definition of inflation among the economists. From time to time different economists have given different definitions (Jain and Khanna, 2006). Some of the definitions are cited below.

“According to Paul Enzing, “Inflation is a state of disequilibrium in which an expansion of purchasing power tends to cause or is the effect of an increase in the price level” .

Prof. Turvey in the article, “Some Aspects of the Theory of Inflation in a Closed Economy”, has given a scientific definition of inflation in these words: “Inflation is the process resulting from competition in attempting to maintain total real expenditure or total real output at a level which has become physically impossible” (Jain and Khanna, 2006, p. 262)”.

There are many different measures of inflation, but the most common index known and broadly used is the consumer price index (CPI) (Kaplan, 2002).

CPI is a price index of a particular market basket called the CPI-basket. All the goods and services consumed in a country such as food, gas, medicine, transportation, house rent etc., are included in the CPI-basket. The composition of the basket is determined by the value of what is consumed in the country – the larger the value of total consumption of a good or service, the larger the weight in the basket (Jochumzen, 2010).

Other most important, but not used in our paper, measurement of inflation are the producer price index (PPI) that measures the average price level of goods sold by producers to wholesalers, and the wholesale price index that measures the average price levels of goods sold by wholesalers to retailers (Kaplan, 2002).

There are several origins of inflation and economists sometimes distinguish between demand-pull inflation and cost-push inflation.

When the aggregate demand in the economy increases faster than the aggregate supply at the full employment level, the average prices of goods and services are pulled up - demand-pull inflation (Saunders and Gilliard, 2000).

Wage increase enforced by unions and profit increases by employers cause cost-push inflation (Totonchi, 2011). A cost-push inflation is a result of supply-side shocks when looking on a macroeconomic scale. The economic effect of the OPEC oil embargoes during the early and late 1970s was a surge in the price of oil and other petroleum products (Kaplan, 2002).

Many distortions in the economy have been caused by inflations. When the economy is experiencing rapid growth in GDP “it can cause price inflation as firms are forced to bid against one another for increasingly scarce workers” (Panagar, 2012). In order to safely maintain the economy, most economists agree that 2,5-3,5% GDP growth per year won’t cause negative side effects (Barnes, 2010).

The growth in GDP over time causes inflation, and inflation brings hyperinflation. In the world of increasing inflation people will spend more money knowing that it will be less valuable in the future. (Panagar, 2012). Widely known is hyperinflation in Germany 1922-23 that “had its roots in the Treaty of Versailles, where the victorious allied nations imposed impossible war “reparation” payments on Germany, faced with financial debts beyond its economic capacity to generate the required amount of payment, the German government started printing money to meet its obligations. A major cause of inflation is printing money in large quantities, which can lead to an inflationary spiral” (Kaplan, 2002).

One of the causes of increase in risk amount potential trade partners are uncertainties about future prices, interest rates and exchange rates that in turn caused by inflation. One of the main problems with inflation and stock is that company’s returns can be overstated (Panagar, 2012).

“The CPI is one of the most important and widely watched economic indicator, and it's the best known measure for determining cost of living changes-which, as history shows, can be detrimental if they are large and rapid. The CPI is used to adjust wages, retirement benefits, tax brackets and other important economic indicators. It can tell investors some things about what may happen in the financial markets, which share both direct and indirect relationships with consumer prices” (Mahorney, 2011). Therefore, CPI has been chosen in our empirical analysis.

3.5 Stock prices

“The word stock in North American usage means ownership or equity in a corporation. Stock is typically issued in the form of shares, and a share of ownership concisely defines what stock is” (Teweles and Bradley, 1998, p. 3). A firm can raise the financing it needs to pay for its investments by selling shares or equity, rather than borrowing. When firm’s share price (stock price) is high, company raises a lot of money by selling relatively few shares. Corporations are more willing to sell equity to finance investment when the stock market is high. Therefore, the best time for investment is a “booming” stock market. The q-theory of investment points out the connection between the stock market and investment. The company’s price of a share is the price of a claim on the capital in the company (Dornbusch et al., 2011).

“The only thing certain about the stock market is that you can’t predict what is going to happen in the future” (Taylor, 2005, p. 1). Doctor Bryan Taylor (2005) has analyzed the historical returns on the stocks, bonds and bills. And number of interesting conclusions has been made by him. For example,high inflations usually caused by political and economic disorders “destroyed” the firm’s stock value, leading to the reduction in the stock returns and increasing their volatility. Therefore, changes in government policies might have a strong impact on investment returns (Taylor, 2005).

As stated in the book “Macroeconomic Theory: A dynamic general equilibrium approach” by Michael Wickens, understanding what macroeconomic risks trigger the “factor risk premia” and the average returns on the portfolios employed in finance research is of a challenge to both finance and macroeconomics (Wickens, 2008).

It is therefore of a big interest for us to use a financial variable such as stock price index in order to investigate the relationship with the chosen macroeconomic variables within our data set.

3.6 Long-term government bond yield

“Bond is a security issued by a borrower which obligates the issuer to make specified payments to the holder over a specific period” (Bodie Z et al., 2008, G-2).

Bonds are considered to be the most important financial assets competing with stocks. Bonds provide fixed payments over time. Unlike stocks, a maximum value of the cash flows from bonds is set by the contract. Bond returns do not vary with the profitability of the firm, except for default cases (Siegel, 2008).

A government bond is a security which is issued by a national government and denominated in the country’s domestic currency. Governments usually borrow to make up deficit. A government bond which is issued by a national government and denominated in a foreign currency is called a sovereign bond. Usually, it happens for countries with unstable economies which denominate its bonds in a currency of a country which has a stable economy. Government bonds are believed to be risk free. This can be explained by the fact that the issuer has a power to raise taxes or devaluate the currency to redeem bonds at maturity. The risk-free element of government bonds doesn’t though secure the latter from inflation and currency risks (Bodie et al., 2008; Siegel, 2008).

According to Smirlock (1986) who examined the response of the long-term bond market to inflation announcements, there exsists a significant positive connection of long-term rates to unpredicted price increases.

The bond yield is simply a percentage return from the bond that a holder expects to receive within a specified period of time. Current bond yield measures only the cash income obtained from the bond as a percentage of bond’s price and it doesn’t take into account capital gains or losses perspective. The yield to maturity measures the total rate of return (Bodie et al., 2009).

As mentioned above, according to Siegel (2008), bonds are believed to be the most important financial assets competing with stocks. In addition, government bonds are considerered to be risk free. However, there are some examples in history when a government has defaulted on its domestic currency debt (Dungey and Tambakis, 2005). The Ruble crisis in Russia (1998) and on-going sovereign debt crisis in the European Union can serve as examples of the statement above.

Therefore, government bond yield factor is included into our empirical analysis as it will be interesting to observe the behavior and interaction of government bonds with other variables under the performance of extreme economic and financial disasters.

3.7 Exchange rates

One unit of currency in terms of another currency is defined as the exchange rate. Exchange rate systems vary depending on country. The most important characteristics of the exchange rate system are to what degree the country is trying to control the exchange rate (Jochumzen, 2010).

When the exchange rate is determined solely by supply and demand in a free market without intervention of the government or the central bank a country may have a completely flexible exchange rate. By pegging the exchange rate to another currency or to an average of several currencies, the country implements a completely fixed exchange rate policy (Jochumzen, 2010). The practice when exchange rates neither freely float in response to supply and demand at all times nor are fixed has been called a “managed float” (Saunders and Gilliard, 2000). It can be no exchange rate between the countries if they are in a monetary union where all countries share the same currency. The largest monetary union is the European Monetary Union (EMU). The

EMU's currency euro is flexible against other currencies except those that are fixed to the euro (Jochumzen, 2010).

Until 1930's most currencies were pegged to the price of gold. After the World War II most of the world's countries signed the Bretton Woods agreement under which each currency in the system was fixed to the US dollar. Since the so-called Bretton Woods system collapse in the 1970's, exchange rates have been more or less flexible (Jochumzen et al., 2000).

There are several theories of exchange rate determination, the brief review of which is provided below.

Purchasing power parity (PPP) theory constructs linkage between the exchange rate and prices of goods in two economies and called the "inflation theory of exchange rates." Interest rate parity theory examines the determination of exchange rates in financial markets. The monetary model that forecast how price level and exchange rate change with the variations in money supply, foreign interest rate and income level is known as the simple monetary model. The Mundell-Fleming model is the extension of a closed IS-LM model.

This model has two most important forecasts that state: "perfect capital mobility, monetary policy independence and a fixed exchange rate regime can not be achieved simultaneously…; devaluation may lead to further devaluation if fiscal discipline, inflation and the balance of payments are not well managed, because a self-fulfilling bubble may be produced" (Kanamori and Zhao, 2006, p. 55).

The Dornbusch model "shows that once a real economic shock happens, markets may move to equilibrium either through a flexible exchange rate or change of prices. The difference between the two is mainly that in the latter, adjustment may consume more time and be less risky than in the former. If prices are relatively flexible and inflation can be controlled in a moderate range, a fixed change rate regime is desirable" (Kanamori and Zhao, 2006, pp. 55-56). No single theory described above contains all the factors that may impact the foreign exchange rates (Kanamori and Zhao, 2006).

Looking at the results of the analysis done by Carmen M. Reinhart in the book "This time is different", we can see that she came to the conclusion that inflation and exchange rate crises in the majority of episodes across countries "travel hand in hand" (Reinhart and Rogoff , 2009). A significant effect on the flow of the world trade and on the domestic economy of a country might impact changes in exchange rates (Saunders and Gilliard, 2000). In our thesis, we are interested in studying the effect which real exchange rate can impose on other analyzed variables.

4 EXTREME VALUE THEORY

Extreme value theory (EVT) is a field of statistics which deals with the extreme deviations from the median of a probability distribution. The theory enables the shape of a distribution's tails to be estimated from a given data sample. EVT calculates VaR (which is another name for the quantile of a distribution) by taking into account the fat-tailed shape of the cumulative distribution function for a random variable. The theory assesses the probability of events which are more extreme than any observed before. EVT has a broad spectrum of applications in finance, engeneering, geology and other sciences as it is a practical tool for quantifying and modelling risk (Hull, 2010;Ho and Lee, 2004).

The Extreme Value distribution is often used to model the smallest or largest value of among a set of independent, identically distributed random values. Extreme value distribution is also used to model extreme or rare events, such as floods, snowfalls, temperature fluctuations, market crashes, large fluctuations in stock process and exchange rates (Hill and Lewicki, 2007).

The class of extreme value distribution mainly involves three types (families) of extreme value distributions described below (Kotz and Nadarajah, 2000).

The extreme value distribution of type 1 (Gumbel-type distribution) has the probability density function:

$$Pr[X \leq x] = exp\left[-e^{(x-\mu)/\sigma}\right]$$

Equation 4.1 Gumbel-type distribution (from Kotz and Nadarajah, 2000).

The extreme value distribution of type 2 (Fréchet-type distribution) has the probability density function:

$$Pr[X \leq x] = \begin{cases} 0, & x < \mu, \\ exp\left\{-\left(\frac{x-\mu}{\sigma}\right)^{-\xi}\right\}, & x \geq \mu. \end{cases}$$

Equation 4.2 Fréchet-type distribution (from Kotz and Nadarajah, 2000).

where μ, σ are the mean and standard deviations, respectively. The parameter $\boldsymbol{\xi}$ indicates heaviness of the tails. The bigger $\boldsymbol{\xi}$, the heavier the tails (Kotz, Nadarajah, 2000).

The extreme value distribution of type 3 (Weibull-type distribution) has the probability density function:

$$Pr[X \leq x] = \begin{cases} exp\left\{-\left(\frac{\mu - x}{\sigma}\right)^{\xi}\right\}, & x \leq \mu, \\ 0, & x > \mu. \end{cases}$$

Equation 4.3 Weibull-type distribution from (Kotz and Nadarajah, 2000)

where μ, σ (>0) and $\boldsymbol{\xi}$ (>0) are parameters. The corresponding distributions of (-X) are also called extreme value distributions (Kotz and Nadarajah, 2000, pp. 3-4).

The first two types of distributions Gumbel and Fréchet relate to the Largest Extreme Value, while Weibull-type distribution relates to the Smallest Extreme Value.

5 SAMPLE CONSTRUCTION

Our empirical analysis involves the combination of macroeconomic and financial variables. The macroeconomic variables include real per capita Gross Domestic Product (GDP pc), per capita consumer expenditure (we refer to it as “C pc”), Inflation (we use abbreviation CPI for inflation), Net Import (NI), and Foreign Exchange Rate (FX). The financial variables include Stock Price Index (Stock PI) and Long Term Government Bond Yield (abbreviation LT GVNT Bond Yield is used when referring to Long Term Government Bond Yield).

Our analysis study focuses on 42 countries. These 42 countries are first split into three main categories: Global (all 42 countries), OECD countries (25 countries) and non-OECD countries (17 countries) which are listed in Appendix 1 Table 1 in columns “Global”, “OECD” and “non-OECD”, respectively. The classification into “OECD” and “non-OECD” is based on the information sourced from www.oecd.org. The countries are further subcategorized on the ground of continents division: The North America(3 countries), The South America(7 countries), Europe (16 countries), Asia (12 countries), Africa (2 countries), Oceania (2 countries) Appendix 1 Table 2. The goal for this sub-categorization is to study if there should occur significant differences in results compared to those we get in the three main categories.

5.1 GDP and Consumption

For our analysis we use growth rates of real per capita GDP and pc C. We use indexes of pc C and GDP , setting the values of both variables to 100 for each country in 2006, as per Barro and Ursua (2011). As a source of pc GDP and C indices,we use Professor Robert Barro’s data set which is publicly available on his website.[1]

When assembling our unique annual data set, we have chosen 1900 as a start year and 2011 as an end year for GDP pc, and 2010 as an end year for C pc. For further references concerning start and end dates, see Table 5.1.

Barro-Ursua’s macroeconomic data set goes as far as till 2009 and contains pc GDP and C indices for the period of 1900-2009. The two missing years of 2010-11 for pc GDP index are calculated using Doctor Mathew Shane’s data source.[2]

[1] http://rbarro.com/

[2] http://www.ers.usda.gov/

		GDP	C	CPI	Stock Price Index	LT GVNT Bond Yield	Net Import	FX
		Variables						
		years	years	years	years	years	years	years
Categories	*Global*	1900 -2011	1900 -2010	1900-2011	1951-2011	1951-2011	1956 -2011	1971 -2011
	OECD	1900 -2011	1900 -2010	1900-2011	1951-2011	1951-2011	1956 -2011	1971 -2011
	non-OECD	1900 -2011	1900 -2010	1900-2011	1974-2011	1958-2011	1958 -2011	1971 -2011
	North America	1900 -2011	1900 -2010	1900-2011	1951-2011	1952-2011	1956 -2011	1971 -2011
	South America	1900 -2011	1900 -2010	1900-2011	1983-2011	1996-2011	1965 -2011	1971 -2011
	Africa	1900 -2011	1900 -2010	1900-2011	1974-2011	1958-2011	1958 -2011	1971 -2011
	Asia	1900 -2011	1900 -2010	1900-2011	1958-2011	1968-2011	1958 -2011	1971 -2011
	Europe	1900 -2011	1900 -2010	1900-2011	1958-2011	1951-2011	1958 -2011	1971 -2011
	Oceania	1900 -2011	1900 -2010	1900-2011	1973-2011	1971-2011	1958 -2011	1971 -2011

Table 5.1 Starting dates for GDP, Consumption, CPI, Stock PI, Net Import, LT GVNT Bond Yield, FX.
Note: The time spans for our analysis are determined by the availability of the data.

The following formula is employed to compute pc GDP index for 2010-2011 years:

$$GDP\ index = \frac{Current\ year\ *100\ (2006\ base\ year, Barro's\ data)}{GDP\ 2006\ year\ (Shane's\ data)}$$

Equation 5.1 GDP index computation

Calculations of annual change in pc GDP are done by computing the difference between *future year (FY) minus previous year (PY)*. The same calculations are done for each of the following samples: OECD and non-OECD, The North America, The South America, Europe, Asia, Africa, and Oceania.

Pc GDP avg for Global country category (42 countries) are then computed by taking average of the annual changes.The same approach is implemented to calculate pc GDP avg for the samples of OECD (25 countries) and non-OECD (17 countries), and separately for the six continents:The North America (3 countries), The South America (7 countries), Europe (16 countries), Asia (12 countries), Africa (2 countries), Oceania (2 countries).

In order to compute the missing pc C index for 2010, we use personal consumption data for the 41 countries for the time period of 2009-2011 from Datastream and from World Bank for Greece for 2010. Data on population for 2009-2010 are procured from Doctor Mathew Shane's data source. The year 2011for C pc is omitted from our data set due to unavailability of population data for 2011.

Further, we employ the following approach to compute pc C indices for 2010:

1) In oreder to get pc C we divide personal consumption for each of the 42 selected countries for 2009-2010 by the population in these countries for 2009-2010.

2) Further, we take C pc for 2010 obtained in 1) multiply it with C pc index for 2009 from Barro-Ursua's data set and divide it by C pc for 2009 obtained in 1).

We leave certain space for errors when calculating pc C indices for 2010, yet we believe that they are very inconsiderable and our pc C indices for 2010 are approximately very close to those computed by Barro and Ursua for 1900-2009.

Calculations of annual change in pc C are done by computing the difference between *future year (FY) and previous year (PY)*. The same calculations are done for each country included into our analysis.

Pc C avg for Global country category (42 countries) are then computed by taking average of the annual changes.The same approach is implemented to calculate pc C avg for the samples of OECD (25 countries) and non-OECD (17 countries), and separately for the six continents The North America(3 countries), The South America(7 countries), Europe (16 countries), Asia (12 countries), Africa (2 countries), Oceania (2 countries).

5.2 Net Import

We use OECD website[3] as a source to obtain annual data on imports and exports. We have procured data for the period of 1955-2011. The values are in U.S dollars. The Net Import (NI) calculations are performed by subtracting the value of exports from the value of imports in a country.

This calculation is further applied for all the countries included into the analysis. The following countries are excluded from the analysis due to unavailability of data on exports and imports: Argentina, Colombia, Egypt, Malaysia, Peru, Philippines, Singapore, Sri Lanka, Taiwan, Uruguay, and Venezuela.

[3] http://www.oecd.org/

Annual growths are then computed by dividing the difference in values between the future year and the previous year by the previous year values for each country. In order to compute NI avg for all the samples of Global, *OECD* and non-*OECD*, The North America, The South America, Europe, Asia, Africa, Oceania, we take the average of the obtained annual growths.

5.3 Inflation

The main source for annual data on inflation (CPI) from 1900-2010 for all 42 countries is Professor Carmen M.Reinhart's data source [4], which is publicly available on her website. The missing data for 2011 are obtained from Doctor Mathew Shane's data source for the 41 countries. Data on inflation for Russia are procured from OECD website.

Calculations of annual changes in inflation rate for all countries are made by computing the difference between future year and previous year. The CPI avg for all data categories is calculated using the same procedure as for GDP avg, C avg, and NI avg.

5.4 Real exchange rate

We use Doctor Mathew Shane's data on real exchange rates to compile our annual data set on foreign exchange rates (FX). As a start year (due to data availability) we have chosen 1971 and 2011 as an end year. The foreign exchange rates are in local currencies to USD.

Calculations of annual change rate in real exchange rate for all countries are made by taking the already computed by Doctor Shane annual percentage growth rates and dividing them by 100.

The FX avg for all data categories is calculated using the same procedure as for the previous variables.

5.5 Stock price index

Datastream is used as a source for annual data on stock price indices for the period of 1950-2011. Start dates vary for different country categories (due to data availability), which is presented in Table 5.1.

We first compile the data on stock price indices (Stock PI) for all the countries included into our empirical analysis.

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[4] http://www.carmenreinhart.com/

Further, annual change rate of stock price indices for each country is computed by dividing the difference in values between the future year and the previous year by the previous year values.

Calculations for Stock Price Index avg for Global country category are then done by taking average of the annual change rates.The same approach is implemented to calculate Stock PI avg for all the country categories according to the mentioned above classification.

5.6 Long Term Government Bond Yield

Datastream is used as a source for annual data on Long Term Government Bond Yield (LT GVNT Bond Yield) for the period of 1951-2011. Start dates vary for different country categories (due to data availability), which is presented in Table 5.1.

Further, annual change on Long Term Government Bond Yield for each country is computed by taking the difference between *the future year and the previous year*.

Calculations for LT GVNT Bond Yield avg for Global country category are then done by taking average of the annual changes.The same approach is implemented to calculate LT GVNT Bond Yield avg for all the country categories according to the mentioned above classification.

The durability of long term government bonds varies for different countries in our data samples ranging from 3 to 20 years.

6 METHODOLOGY AND EMPIRICAL RESULTS

This chapter explains the methodology which will be applied to our macro-financial data set, seeking for the evidence of extreme events and disasters performance and tools of their prediction.

6.1 Descriptive statistics

6.1.1 Variance

When estimating the risk, we are interested in checking for the likelihood of deviations from our expectations. Variance is the arithmetic mean of the squared deviations from the mean. It is a measure of variability which is calculated by squaring the standard deviation. The variance helps to answer the question of where the variability comes from, and if something important has happened. The variance measures how far a set of numbers is spread out from the mean (the expected value) (Lind et al., 2006; Newbold et al., 2010).

The formulas for population and sample variance are slightly different. We are more interested in sample variance as it is applied to our empirical analysis.

$$Variance = \frac{\sum_{i=1}^{n}(x - \bar{x})^2}{(n-1)}$$

Equation 6.1 Sample variance formula (from Lind et al., 2006).

where x is the value of each observation in the sample, $\bar{x}$ is the mean of the sample, n is the number of observations in the sample.

6.1.2 Standard deviation

Standard deviation is the square root of the variance. It shows the dispersion from the mean. A low standard deviation shows that the data lie close to its mean, while a high standard devation indicates that the values are spead away on a large distance from the mean. Standard deviation is important in finance as it measures the volatility of investment. In oher words, it is used as a tool of quantifying the risk. According to Markovitz, investors should base their decisions only on the excpected returns and standard deviations (Sharpe et al., 1999; Bodie et al, 2008).

$$Standard\ deviation = \sqrt{\frac{\sum_{i=1}^{n}(x-\bar{x})^2}{(n-1)}}$$

Equation 6.2 Sample standard deviation formula (from Lind et al., 2006).

6.1.3 Correlation

The numerical way of describing the linear relationship between two variables is correlation. The correlation coefficient gives both the direction and the strength of the linear relationship between corresponding variables (Newbold et al., 2010).

The correlation coefficient is computed in the following way:

$$\rho = \frac{Cov(x,y)}{\sigma_x \sigma_y}$$

Equation 6.3 A population correlation coefficient (from Newbold et al., 2010).

where $Cov(x,y)$ is a covariance and σ_x, σ_y are the population standard deviations of the two variables.

The correlation coefficient is always in the range of -1 to 1. When the correlation coefficient equals zero, there is no linear relationship between two variables but not necessarily lack of relationship. A positive linear relationship is indicated by the positive correlation coefficient and vice versa. The closer the coefficient to -1 (1), the closer the data points are to an increasing (decreasing) straight line (Newbold et al.,2010).

6.1.4 Skewness

Skewness is a statistical measure of asymmetry. There are four shapes that are commonly observed: symmetric, positively skewed, negatively skewed, and bimodal. If a set of observations is symmetric, there is a single peak, and the mean and the median are equal and the values are spread evenly around the mean and the median. Skewness is said to be zero for the normal distribution (Lind et al.,2006).

If a set of values is positively skewed or skewed to the right, there is a single peak, and the mass of the distribution is concentrated on the left of the distribution and therefore the right tail is longer than the left one. In this case the mean is larger than the median. It can also be called a right-skewed or right-tailed distribution. Right-skewed distribution is greater than zero. Positive skewness as well signifies relatively few high values in the data set. Positively skewed distributions are more common (Lind et al., 2006; Bodie et al., 2009).

If a set of values is negatively skewed or skewed to the right, there is one peak, and the mass of the distribution is concentrated on the right of the distribution and therefore the left tail is longer than the right one. In a negatively skewed distribution the mean is smaller than the median. It is also referred to as left-skewed or left-tailed distribution. Negative skewness signifies relatively few low values in the data for these categories (Lind et al.,2006).

A bimodal distribution has two or more peaks. It happens when the values come from two populations (Lind et al.,2006).

The following formula is used to calculate skewness:

$$Skewness = \frac{n}{(n-1)(n-2)} \sum \left(\frac{x_j - \bar{x}}{s} \right)^3$$

Equation 6.4 The equation for Skewness (from STATGRAPHICS Centurion XVI User Manual, 2009).

where $\bar{x}$ is the mean; *s* is the standard deviation; *n* is the sample size and x_j is a set of data.

Skewness uses the ratio of the averaged cubed deviations from the mean to the cubed standard deviation to measure any asymmetry of a distribution. Cubing deviations maintain their signs, so when the distribution is skewed to the right, then the extreme positive values will dominate, resulting in a positive measure of skew. Following this logic, if the distribution is skewed to the left, the cubed extreme negative value will dominate, resulting in a negative skew. When the distribution is right-skewed, then the standard deviation overestimates the risk as the extreme positive deviations from expectation increase the estimate of volatility. By the same logic, when distribution is negatively skewed, the standard deviation will underestimate the risk (Bodie et al., 2008).

6.1.5 Kurtosis

The concept of kurtosis is introduced in almost every book on statistics. Kurtosis as well as skewness is often used to measure non-normality. Though it's mostly implemented for measuring non-normality, scientists do not converge in opinion on the matter of kurtosis. The fundamental issue of disagreement is what exactly kurtosis measures. Statistics books usually use the term kurtosis to determine the peakedness of a data distribution. Kurtosis measures whether the sample data distribution is sharp or flat relative to a normal distribution. Sometimes kurtosis is referred to as "a measure of the degree of fat tails" according to Bodie, Kane and Markus (Joanes and Gill, 1998; Bodie et al., 2008).

The following formula is used to calculate kurtosis:

$$Kurtosis = \left\{\frac{n(n+1)}{(n-1)(n-2)(n-3)}\sum\left(\frac{x_j-\bar{x}}{s}\right)^4\right\} - \frac{3(n-1)^2}{(n-2)(n-3)}$$

Equation 6.5 The equation for kurtosis (from STATGRAPHICS Centurion XVI User Manual, 2009).

where $\bar{x}$ is the mean; *s* is the sample standard deviation; *n* is the sample size and x_j is a set of sample data.

There exist different approaches to compute excess kurtosis. Some statistical software use formulas which compute a normal distribution to have kurtosis equals 3. Further, deviations are considered from this number. If excess kurtosis is greater than 3, then it's a case of positive excess kurtosis. If it's less than 3, then it's a negative excess kurtosis.

Our statistical software uses an approach, where a value close to zero would correspond to normal distribution (i.e. 3 being substracted) (STATGRAPHICS Centurion XVI Statistical Procedures, 2009).

Normal distribution has a kurtosis which equals zero (mesokurtic kurtosis). If excess kurtosis is greater than zero, then we have a case of positive excess kurtosis which is called leptokurtic. Leptokurtic kurtosis is characterized by a sharper, higher peak compared to normal distributions. This results from the fact that the data are more concentrated around its mean, which causes fat tails on both sides. Fat tails can indicate whether there are a lot of values and events that stray widely from the average, displaying higher or lower values than expected. In other words, kurtosis describes how distribution is spread in around the center and at endpoints of a bell curve. Fat tails are often looked at as an unexpected result and therefore are undesirable in finance as they bear the notion of additional risk and volatility (Kerns, 2010).

When the distribution has fat tails, there is more probability mass in the tails than predicted by the normal distribution. This results from the fact that there is less probability mass near the center of the distribution. Even though the symmetry of the distribution can be preserved compared to the normal distribution, standard deviation will underestimate the likelihood of extreme events, both large losses and large gains. Information about kurtosis is used by investors to make volatility assessments. In the market fat-tailed distributions can have a behavioral origin such as investor's excessive pessimism or optimism causing large moves on the market (Bodie et al., 2008).

If excess kurtosis is less than zero, then we deal with the case of negative excess kurtosis called platykurtic. Platykurtic kurtosis is characterized by flatter, wider peak as a result of the data being less concentrated around its mean. This leads to thin tails on both sides of the distribution. (Kerns, 2010).

Figure 6.1 below is a graphical presentation of the three types of excess kurtosis.

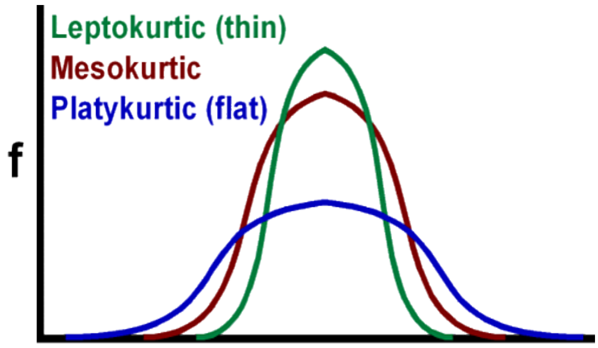

Figure 6.1 Excess kurtosis(from Excess kurtosis, 2012).

6.1.6 Descriptive statistics results

The results of the descriptive statistics are displayed in Appendix 3 Table 1 for the full period, in Appendix 3 Table 2 for GDP, C and CPI for the period of 1900-47, and in Appendix 3 Table 3 for 1948-2011 period. The reason for splitting the full period for GDP, C and CPI in two sub-periods is that these factors have the longest analyzed time period, and our goal is to see if this division should have any impact on the results after splitting the data samples into two sub-periods where the first one includes WWII and the second one is post WWII. We should also note that 1923-24 years are excluded from the empirical analysis for CPI avg for Global, OECD and Europe country categories in the first period (1900-47). Our aim in doing so is to study if there are other realizations of disasters except for German hyperinflation, which achieved tremendous values during these years, which has influenced the results in the full period drastically. Yet, these years are represented in the full period analysis. The beginning and end dates for all factors included into the full period of our empirical analysis are presented in Table 5.1.

The results of the descriptive statistics include information on average, median, variance, standard deviation, skewness, and kurtosis (Appendix 3).

We base our study on annual changes as mentioned in the chapter concerning the sample construction. When dwelling upon the results of standard deviation for pc GDP avg and pc C avg, we can state that the standard deviations are the highest for The South America, Asia, and non-OECD among all country categories in the full sample (Appendix 3 Table 1). This reflects mainly the realization of the subprime mortgage crisis disaster (2008), the savings and loan crisis (1980-1990), WWI and WWII disasters.

It's also worth noting that standard deviations for *pc C avg* in those country categories are higher than for GDP avg, which is obviously due to WWII consequences as then consumption decreases more. The realizations of these disasters are also reflected by the outliers in the normal probability plots (Appendix 7). The outliers as well indicate high kurtosis and fat-tailed distributions.[5]

We can observe cases of positive excess kurtosis for *pc GDP avg* for all country categories in the full period, except for Oceania (-0,1941). Positive excess kurtosis for pc C avg occurs for all country categories in the full sample period, with the highest excess kurtosis values for Europe (14.4957), Asia (12.6392), and non-OECD (8.7433) (Appendix 3 Table 1).

Excess kurtosis shows that there are a lot of values and events that stray widely from the average. This is most likely reflecting the mentioned earlier in the chapter disasters that occurred in the countries included into these country categories, namely the subprime mortgage crisis disaster (2008), the savings and loan crisis (1980-1990), WWI and WWII disasters.

When comparing the kurtosis results for *pc GDP and C avg* in the two sub-periods 1900-47 and 1948-2011 with the full period, we should note that positive excess kurtosis for pc C avg in the 1948-2011 period occurs in the same country categories as for the full period, but with even higher values. See Appendix 3 Tables 1-3.

As for *pc GDP avg*, positive excess kurtosis in the second sub-period is displayed in the same country categories as in the full period, though OECD (12.7542), The North America (5.4020), and Europe (12.0571) get higher values for excess kurtosis in the former. We should also note that excess kurtosis values for pc GDP and C avg are higher in general for the 1948-2011 period than for the 1900-47 period, resulting in fatter tails in distributions. The same observation also

[5] We dwell upon distribution results in the chapter "Probability Distributions Results".

involves standard deviations. This specifically concerns Europe (1.0674), Asia (1.7054), and OECD (0.9911) (Appendix 3 Tables 2, 3).

The higher excess kurtosis values in the second sub-period may be explained as a result of greater annual changes in pc GDP and C indexes, which may signal a greater impact of the disasters occurred in the second sub-period (1948-2011) than in the first one (1900-47).

In 1900-47 period the highest excess kurtosis for pc C avg occurs in Global, non-OECD, and Asia country categories, which reflects such disasters realizations as The Great Depression (1929-40), WWI and WWII. The outliers in the normal probability plots, confirming the above mentioned disasters for both periods, are presented in Appendix 8 and 9 for 1900-47 and 1948-2011, respectively.

Excess kurtosis is positive for *CPI avg* for all country categories in all 3 periods Appendix 3. The highest values occur in the full period sample for Global (55.5), OECD (55.5), Europe (55.5), and The South America (53.4721). The high values for the first three country categories are explained by German hyperinflation disaster.

Positive excess kurtosis for CPI avg is observed to be higher for the 1900-47 period in general as compared to the 1948-2011 period, though it has higher values for The South America and non-OECD in the latter period. This is consistent with the disasters performance displayed by the years outliers in the normal probability plots (Appendices 8,9). The dominant disasters involve WWI, WWII, The Great Depression and the beginning of German hyperinflation for the first sub-period and Asian Financial Crisis (1997), Venezuelan Banking Crisis (1994), “Black Wednesday” (1992), Finnish Crisis (1990) in the second sub-period.

Standard deviations for CPI avg are the highest for The South America and non-OECD for the 1948-2011 period as the main disasters occurred in The South America during this time span. We also can observe high, yet somewhat lower, values, for the same country categories in the full period. In the 1900-47 period the highest values happen to be for Europe (48. 3564), OECD (31.8729) and Asia (37. 5432) (Appendix 3 Tables 2, 3). We refer to the same disasters related to the excess kurtosis, as mentioned above.

When analyzing the results of *Stock PI avg*, we should note that the highest values of positive excess kurtosis occur for Europe (2. 6488), OECD (1. 7322), and The North America (2,0382) (Appendix 3 Table 1). This results in fatter tails what can also be seen in histograms and normal probability plots for those country categories (Appendix 7).

Yet, we need to admit that the obtained distributions are not as fat-tailed as we could anticipate for Stock PI avg. This could come as a consequence of the data frequency for Stock PI as we use annual data on Stock PI and the averaged values, which can lead to "smoothing out" of the extreme values. We may suppose the results would be more accurate and could retrieve better disasters performance if we used monthly data, which could be a subject for future research and data modification.

The highest values of standard deviations for Stock PI avg appear to be for The South America (0. 4878), non-OECD (0. 3129), and Asia (0. 2927) country categories. The numerically distant from the rest of the data observations occur in 2008 during the subprime mortgage crisis n USA, that has affected counties worldwide, 1980-90 during savings and loan crisis in USA, stock market crash "Black Monday" of 1987 in China which spread to West Europe and USA, East Asian financial crisis of 1997.

LT GVNT Bond Yield avg results show positive excess kurtosis for all country categories except for The South America (-0. 0226), with the highest value for Asia (1. 9526)and non-OECD (1.7407) and the lowest for Oceania (0.1374). The highest standard deviation values occur for Africa (1. 4520) and non-OECD (1. 3131) (Appendix 3 Table 1).

The results may provide the proof of the fact that even though government bonds are considered to be risk free and secure, there also occur examples of a government default on its domestic currency debt (Siegel , 2008). Such examples are Russian financial crisis (1998) and European sovereign debt crisis (2010). The outlaid years observations are displayed in the normal probability plots (Appendix 7).

The kurtosis results for *NI avg* reveal high positive excess kurtosis with the highest values for non-OECD (53. 6023), The South America (46. 9328), Asia (43. 3032), Global (33. 2408) and Oceania (30.7419) country categories. The results of standard deviation take the highest values for The South America (42. 8773), non-OECD (13. 3644), and Oceania (8. 0419) (Appendix 3 Table 1).

It is also worth noting that we can observe a tendency of rather high values for positive excess kurtosis for all country categories which signals fatter tails in distribution. This tendency may suggest an idea that net import is rather sensitive and volatile to fluctuations on the market and in economy.

The empirical analysis of *FX avg* shows positive excess kurtosis for all country categories, with the exception of Global (-1. 0075), OECD (-0. 5633) and non-OECD (-0. 7144). The highest kurtosis values occur for Oceania (11. 9505) and The North America (4. 6372) , while the highest standard deviation values are found in Oceania (0. 1612), Africa (0. 1273) and The South America (0. 1225) (Appendix 3 Table 1). The denoted by years observations, which spread away distantly from the rest of the data, are displayed in the normal probability plots (Appendix 7).

The results of skewness, the same as the results of kurtosis, also confirm that the assumption of the data coming from normal distribution is violated.

The skewness results for *Stock PI avg* indicate right-tailed distributions (positive skewness) for all country categories, except for Oceania where it is left-skewed (negative skewness) (-0.0672). For the former country categories the positive skewness shows that the mass of the distribution is concentrated on the left of the histogram, while for the latter country categotry it is concentrated on the right side of the histograms.The highest positive skewness value is for The South America (0.8562). See Appendix 3 Table 1.

The results for *LT GVNT Bond Yield avg* and *FX avg* reveal positive skewness for all country categories with the highest value for Asia (0.9703) for the former variable, and for Oceania (2.4467) for the latter variable , respectively. FX avg for Oceania also has the highest excess kurtosis (11.9505) among all country categories. The same concerns LT GVNT Bond Yield avg for Asia, where excess kurtosis is 1.9526. See Appendix 3 Table 1.

The skewness results for *NI avg* detect positive skewness for all country categories, with the exception of Africa and Asia. The highest skewness values occurs for non-OECD (7.3077), which also has the highest excess kurtosis value (53.6023) (Appendix 3 Table 1).

The results for *CPI avg* show negative skewness for all country categories except for Asia (3.4782) in the full period, while the distributions are mostly right-skewed in the 1900-47 period with the highest value for Europe (6.1786) and predominantly left-skewed in the 1948-2011 period with the highest value for The South America (-3.3827) (Appendix 3 Tables 1-3).

The skewness results for *GDP avg* reveal that the distributions are mostly equally split between right-tailed and left-tailed in the full period with the highest positive value of 1.4124 for Asia and the highest negative value of -0.9581 for Europe. In the 1900-47 period the dominant pattern of negative skewness is revealed with the the highest value of -1.8043 for Asia, while in the 1948-2011 period the distributions are again mostly equally split between right-skewed and left-skewed, with the highest value of - 2.4851 for OECD for the left-skewed distribution and the highest positive value of 1.5252 for non-OECD for the right-skewed distribution (Appendix 3 Tables 1-3).

The results of skewness analysis for *C avg* detect right-skewed distributions for all country categories except for non-OECD and Europe in the full period. The highest positive value (1.8813) occurs for non-OECD. In the first sub-period the dominant skewness is negative, with the exception of Africa. The highest negative value (-1.0021)occurs for Asia. In contrast, in the second sub-period the dominant skewness is positive with the highest value of 2.8982 for Asia. See Appendix 3 Tables 1-3.

6.2 Distributions

6.2.1 Normal probability distribution theory

The normal distribution is considered to be the most important and commonly used distribution pattern in statistics as it occurs in many natural phenomena and has some convenient properties (Weisstein E.W.). A normal distribution is a continuous distribution that is symmetric and has a bell shape with a single peak (Snyder and Nicholson, 2008). Data with unknown distributions are often assumed to be normal. This can be a dangerous assumption, but it can be a good approximation due to some reasons. First, normal distribution is drawn from the central limit theorem. This theorem states that the mean of any set of random variates with any distribution having a finite mean and variance is distributed approximately normally. This approximation gives a very wide application. Second, the normal distribution can be easily detected analytically, which means the results coming from this distribution can be obtained in a clear form (Weisstein E.W.).

Figure 6.2 presents a typical normal distribution curve. Normal distributions can estimate probabilities over a continuous interval of data samples.

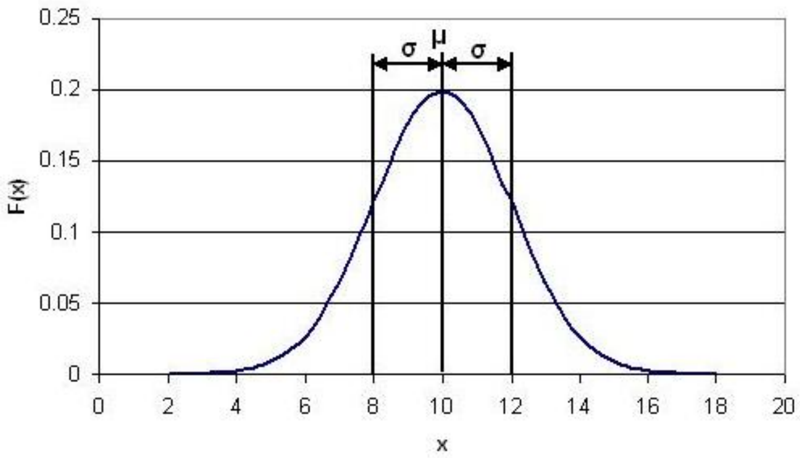

Figure 6.2 Generic Normal Distribution curve (from Bora et al., 2006).

whereFigure μ is the mean, which is the location of the peak, $\sigma^2$is variance and σ is standard deviation, which measures the spread of the sample from the mean. These must be particularly specified when talking about distribution. Different values of μ, σ^2 and σ yield different density curves and hence different distributions. In a normal distribution data are assumed to be at the mean and less likely to spread farther away from the mean. The distribution with μ = 0 and σ^2 = 1 is called the standard normal distribution. (Newbold et al., 2010).The probability density function for a normally distributed random variable X is

$$F(x) = \frac{1}{\sqrt{2\,\pi 6^2}}\ e^{-(x-\mu)^2/26^2)} \text{ for all } -\infty < x < \infty$$

Equation 6.6 The probability density function for a normally distributed random variable (from Newbold et al., 2010).

"where μ and σ^2 are any numbers such that $-\infty < \mu < \infty$ and $0 < \sigma^2 < \infty$, and where e and π and physical constants, e = 2.71828… and π = 3.14159…" (Newbold et al., 2010, p. 224).

6.2.2 Normal ptobability plot: theory

In order to judge whether or not a sample of our data comes from a normal distribution we use the normal probability plot. In case if data are not normally distributed we examine the way in which the data deviate from the normal reference line helping us to determine the type of departure from normality.

In Statgraphics the plot is constructed in the following manner:

“The data are sorted from smallest to largest and the order statistics are determined. By definition, the j-th order statistic is the j-th smallest observation in the sample, denoted by $x_{(j)}$.

Then the data are plotted at the positions

$$x_{(j)}, \Phi^{-1}\left(\frac{j-0.375}{n+0.25}\right)$$

Equation 6.7 Normal probability plot construction (from STATGRAPHICS Centurion XVI Statistical Procedures, 2009).

where $\Phi^{-1}(u)$ indicates the inverse standard normal distribution evaluated at *u*.” (STATGRAPHICS Centurion XVI Statistical Procedures, 2009)

The deviation of the values from the reference line is an indication of a not normal distribution. (STATGRAPHICS Centurion XVI Statistical Procedures, 2009)

The normal probability plot procedure is used in our analysis in order to determine and show if any of our data deviate from the reference line indicating any longer tail than a normal distribution.

6.2.3 Anderson-Darling Test

The Anderson-Darling test is a statistical test for normality which was developed in 1952 by Theodore Anderson and Donald Darling. It is designed to detect from which probability distribution comes a given data sample. The test can also be used to assess how well the data sample fits various distributions. The value of Anderson-Darling statistic is smaller the better the distribution fits the data. The Anderson-Darling test rejects the hypothesis of normality in the data sample when the p-value is less or equal 0.05. If the normality test fails, then we can conclude that the data don’t fit the normal distribution at a chosen confidence interval. The case when the normality hypothesis is not rejected, allows us to state that there is no significant deviation from normality found (McNeese, 2011).

The Anderson-Darling statistic is given by the following formula:

$$AD = -n - \frac{1}{n}\sum_{i=1}^{n}(2i-1) \times \left[\ln F(X_i) + \ln\left(1 - F(X_{n-i+1})\right)\right]$$

Equation 6.8 Anderson-Darling statistic equation (from McNeese, 2011).

where n is sample size, $F(X)$ is cumulative distribution function for the specified distribution and i is the i^{th} sample when the data are sorted in ascending order. The Anderson-Darling statistic is often referred to as A^2 (McNeese, 2011).

6.2.4 Kolmogorov-Smirnov Test

The Kolmogorov-Smirnov (KS) Test is one of the most well-known tests for normality. KS test is a means of testing whether a set of observations are from a completely specified distribution. It is widely used in most statistical software packages. There are certain advantages of Kolmogorov-Smirnov test: it can be used with small sample sizes and it appears to be a more powerful test for any sample size (Lilliefors, 1967; Drezner et al., 2008).

For a given mean μ and variance 6^2, the cumulative normal distribution at $x_k$is $\Phi\left(\frac{x_k-\mu}{6}\right)$ The KS statistics is given by

$$KS\ (\mu,\sigma) = \max_{1\leq k\leq n} \{\frac{k}{n} - \Phi\left(\frac{x_k-\mu}{\sigma}\right), \Phi\left(\frac{x_k-\mu}{\sigma}\right) - \frac{k-1}{n}\}$$

Equation 6.9 Kolmogorov-Smirnov statistic equation (from Drezner et al., 2008).

The traditional KS statistics is simply KS ($\bar{x}$, s) where $\mu = \bar{x}$ and σ = s. (Drezner et al., 2008)

KS test has also an application as a Goodness-of-Fit test (GoF). GoF tests are based on either of two distribution elements: the cumulative distribution function (CDF) or the probability density function (PDF). KS GoF test uses CDF approach and therefore belongs to the class of "distance tests" (Romeu, 2003).

The implementation of KS GoF test consists of several steps. First, the assumed (theoretical) distribution is to be established (usually normal distribution). Secondly, the distribution parameters such as mean and variance are to be estimated. Thirdly, the null distribution hypothesis (H_0) is set, with several elements that must be jointly true, and the alternative hypothesis (H_1), which is opposite to the null hypothesis and negates the assumed distribution and its parameters. Then the assumed distribution is tested and H_0 is rejected if any of the several elements in the null hypothesis are not supported by the data. If the assumed distribution is correct, then it closely follows the empirical distribution. The logic of KS GoF test is that if the maximum departure between the theoretical CDF and the empirical one is small, then the theoretical distribution is most likely the correct one. If the difference is large, then the assumed distribution is not the implied distribution for this data sample (Romeu, 2003).

We use KS test as GoF test for our data samples.

6.2.5 Probability distributions results

As mentioned in the chapter about normal probability theory, data with unknown distributions are believed to be normal, though it is very seldom in practice that data are normally distributed.

Our empirical analysis reveals that the analyzed variables in our data samples occur to be distributed within four main probability distributions. These are logistic distribution, Laplace distribution, largest extreme value and smallest extreme value distributions.[6] Although, these are the most frequent probability distributions observed in our analysis, yet some cases of normal distribution can also be observed.

The logistic distribution is a continuous probability distribution. Its distribution function is the logistic function. It resembles the normal distribution in shape but more peaked and as a result has heavier tails (Kareema, 2011).

The logistic distribution has the following function:

$$F(x) = \frac{1}{b} \times e^{\left[\frac{-(x-a)}{b}\right]} \times \left\{1 + e^{\left[\frac{-(x-a)}{b}\right]}\right\}^2, for - \infty < x < \infty, b > 0$$

Equation 6.10 Logistic distribution function (from Hill and Lewicki, 2007).

where a is the location parameter (mean); b is the scale parameter and e is the base of the natural logarithm, sometimes called Euler's *e* (Hill and Lewicki, 2007).

The Laplace distribution on the other hand is a double exponential distribution. It is the distribution of differences between two independent random variables with identical exponential distributions (Weisstein, 2012).

Laplace distribution has a density function:

$$F(x) = \frac{1}{2\beta} e^{-|(x-\alpha)/\beta|}, for\ all - \infty < x < \infty, -\infty < a < \infty, 0 < \beta < \infty$$

Equation 6.11 Laplace distribution function (from Abramowitz and Stegun, 1972).

where α is the mean; $2\beta^2$ is variance; e is a physical constant, e = 2.71828 (Abramowitz and Stegun, 1972, p. 930).

[6] The theoretical description of extreme value distributions is presented in the chapter "Extreme Value Theory".

Compared to normal distribution, the Laplace distribution has an unusual, symmetric curve shape with a sharp peak and tails that are longer than the tails of a normal distribution. The Laplace distribution is rather popular when modeling financial variables, for example, stock price changes, currency exchange rate, interest rate because they are characterized to be fat-tailed and high peaked (Kotz et al., 2007).

In order to investigate how our data samples are spread relative to normal probability curve, we perform Kolmogorov-Smirnov test for normality. Further, we use Anderson-Darling test to check for the best fitted distribution among alternative probability distributions in each category and for each variable, and then Kolmogorov-Smirnov test to check for goodness-of-fit. Hence, in each histogram there are two curves – one for normal distribution (normal distribution curve is red colored when there is an alternative distribution, and blue colored if it is the only one true) , and the other one is for the best fitted alternative distribution (blue colored). The results of the best fitted distributions are presented in histograms, which follow attached in the Appendices 7-9.

When describing the results of the distributions, we can note that there can be observed a certain consistency in distributions for certain variables. For example, we can see that *pc GDP avg* is either logistically or Laplace distributed for both the full period and for 1900-47 period. Yet, we can witness the results of largest extreme value distribution for Asia and non-OECD, smallest extreme value distribution for The North America in the 1948-2011 period, and smallest extreme value distribution for OECD for the 1900-47 period. The most outliers depicted in the normal probability plots in Appendices 7-9 are spread within the periods of 2000-2010 and 1920-1941.

The years of 2000-2010 involve a number of extreme events such as stock market downturn of 2002, which started in USA and spread across Europe and Asia, Chinese stock bubble of 2007, Icelandic financial crisis of 2008, Subprime mortgage crisis of 2008, European sovereign debt crisis of 2009. The years of 1920-1941 include The Great Depression and World War II. These disasters are reflected by years outliers in the normal probability plots for all the categories.

The results of the analysis of the best fitted distribution for *pc C avg* also shows that the most frequent distribution for all country categories is the logistic distribution, with the exception of Asia and non-OECD in the full period. The latter two show the Laplace distribution, which indicates sharper peaks and longer tails. Again, in the 1948-2011 period we witness two cases of largest extreme value distribution for pc C avg for Asia and non-OECD, and two cases of smallest extreme value distribution for Europe and OECD (Appendices 7-9). The most outliers for pc C avg depicted in the normal probability plots (Appendices 7-9) concern the same years and same disasters in all the categories as for pc GDP avg.

The results for *CPI avg* indicate that the Laplace distribution is dominant for the full period. Yet, there is observed a case of normal distribution in the data sample for Europe, which most evidently comes as a result of tremendously large values (positive in 1923 and negative in 1923) in the data sample as a consequence of German hyperinflation in 1923-24.

With 1923-24 removed from the from the analysis in the first sub-period, Laplace distribution comes as the best fitted distribution. The same result is achieved in the second period. See Appendices 7-9 for the results for three periods.

The distribution analysis for *Stock PI* shows largest extreme value distribution for The South America, Asia and Africa, which comes as a result of high positive values in 1991, 1972 and 1980, respectively for these country categories. The outcome is displayed in the normal probability plots (Appendix 7). Apart from largest extreme value distribution, we also observe logistic distribution for The North America, Europe, and OECD, and normal distribution for Global and Oceania avg.

The observations, which are numerically distant from the rest of the data, occur in 2008 during Subprime mortgage crisis n USA, that has affected counties worldwide, 1980-90 during savings and loan crisis in USA, stock market crash “Black Monday” of 1987, Mexican peso crisis (1994), and East Asian financial crisis of 1997.

The analysis of *LT GVNT Bond Yield avg* reveals several types of distributions. These are Laplace distribution for Global, OECD, non-OECD, logistic distribution for The North America, Africa, and Asia country categories. We can also observe a case of normal distribution for The South America and largest extreme value distribution for Oceania.

The results in the latter category could be explained by insufficient data on LT GVNT Bond Yield, which prevents us from retrieving extreme changes in the data samples. The results in the former category come from high positive values in 1994, 1973 and 1980’s, which are depicted by the outliers in normal probability plots for LT GVNT Bond Yield Appendix 7.

When analyzing distributions for *Net Import avg*, we can observe the Laplace distribution as the best fitted distribution in all country categories. The outcome is graphically verified by the histograms in Appendix 7. The histograms display that the data samples for all country categories are Laplace distributed, which signals longer, fatter tails and higher peaks. The high peaks result from the higher values in 1974 (Brazil), 1989 (Oceania), 1960 (Finland), 1987 (France). The lowest value comes from 1969 (Japan) and 1988 (New Zealand), which can also be seen in normal probability plots in Appendix 7. These years reflect the realization of such disasters as World Oil Shock (1973), Banking Crisis New Zealand (1988), "Black Monday" (1987), U.S Recession (1969-1970).

The most frequent probability distribution for *FX avg* is the Largest Extreme Value. It is detected in data samples for The North America, The South America, Asia, and non-OECD country categories. The extreme values can be observed in 1997-1999 during Debt and the Global Economic Crisis, 1998 – the Ruble Crisis in Russia, 1997- East Asian Financial Crisis. These years are as well displayed as the outliers in the normal probability plots in Appendix 7.

Apart from the largest extreme value distribution, we can also state cases of the logistic distribution in the data samples for Europe, Oceania, and Global. We also note a case of the Laplace distribution for Africa and normal distribution for OECD. The latter may be explained by the "smoothing out" effect of high values as a result of averaging.

6.2.6 Correlation results

We have performed the correlation analysis for each country category and for all three data sample periods: full period, 1900-47 period, and 1948-2011 period. The resultant correlation matrixes for each category are depicted in the Appendix 4 Table 1, Table 2, Table 3, respectively. In order to give a visual presentation of the relationship in changes among the analyzed macro-financial variables, graphs of annual changes are also included in the Appendix 6. In the correlation matrix, we specially highlighted in red the p-values of those variables that have a statistical significant estimated correlations i.e. the p-value lower than 0.05. In our analysis description we neglect those correlation coefficients that have p-values above the statistically significant level.

The highest positive correlation coefficient of 0.9285 with the p-value of 0.0000 is for the pair pc GDP avg and pc C avg in the country category Global which indicates the strong linear relationship between GDP and consumption. We can observe the constant pattern of pc GDP avg and pc C avg having a strong positive correlation in all data samples, in each country category in all periods which is consistent with the macroeconomic theory since consumption is the largest constituent of GDP by definition, and fluctuations in C have an immediate effect on GDP (refer to Appendix 6).

In the full period sample CPI avg is negatively correlated with both pc GDP and C avg within The South America category. In correlation matrix, there exists the deviance from the negative correlation pattern. We observe the statistically significant a positive correlation of CPI avg with pc GDP and C avg which is only present in the period 1900-47 (the first sub-period) in non-OECD and The North America country categories. Also, CPI avg positively correlates with pc C avg for Oceania, both in the full period sample and in the first sub-period sample.

The correlation matrix also shows the existence of statistically significant estimated negative correlation of the real exchange rate with the pc C avg (correlation coefficient is -0.5441, p-value is 0.0003 in the Global category). The estimated negative correlation is consistent with the fact that while there is an appreciation of real exchange rate there is increase in consumption (Jönsson) .

The mentioned above positive relationship between consumption and GDP can suggest the fact that GDP should also be negatively correlated with the real exchange rate. This negatively correlation is reflected in the results in the Appendix 4 and Appendix 6. In the second sub-period (1948-2011) we observe that correlation coefficients are not statistically significant (with the p-value more than 0.05) in the country categories such as Africa, Europe and Oceania. Also real exchange rate is negatively correlated only with the consumption in the OECD category.

In the full sample and in the second sub-periods the long term government bond yield has a positive correlation coefficient with the CPI (Global and Europe country categories) which confirms previous research findings of "…positive response of long term rates to unpredicted price increases" (Subhani, 2009, pp. 12-13).

The statistically significant negative correlation of long term government bond yield with the stock price index shown in our correlation matrix for Global, OECD and Europe country categories can be, probably, an empirically proof of the simplified framework for stock yield-bond yield relationships presented in the European Central Bank Working Paper Series no.515 giving that the decline in bond yield, i.e. interest rates, leads to higher stock prices (Durre and Giot, 2005).

LT GVNT Bond Yield avg is positively correlated with the NI avg (Global and The South America). Refer to the graphs presented in Appendix 6 and correlation matrix in the Appendix 4. As an explanation of this fact, China's active purchase of US government bonds is aimed to keep the demand for China’s export high at the same time keeping bond yields low. Net import falls (China exports more than imports) and the bond yields are decreasing (The Relationship Between the Dollar and the Bond Market, 2009).

The existence of statistically significant negative correlation of NI avg with FX avg is observed in the country categories such as Asia and Europe. This may by explained by the fact that the importing country benefits from the low real exchange rate (strong domestic currency) as the imported goods are cheaper to buy. (The Relationship Between the Dollar and the Bond Market, 2009).

In the full data sample period the only country category that has the statistically significant negative correlation of CPI avg with GDP, pc C avg and Stock PI avg is the category The South America.

Negative correlation of FX avg with Stock PI avg exists only in Europe country category. Also, this is the only country category in the full data sample period which has the statistically significant positive correlation of stock prices with pc GDP and C avg.

In the second sub-period country categories as The North America and Europe have the highest number of pairs of variables that have either positive or negative statistically significant correlations at the 95% confidence level. For The North America the pairs of values are:

- GDP avg & C avg (positive correlation);
- GDP avg & LT GVNT Bond Yield avg (positive correlation);
- GDP avg & FX avg (negative correlation);
- C avg & FX avg (negative correlation);
- CPI avg & Net Import avg (negative correlation);
- CPI avg & FX avg (positive correlation);
- LT GVNT Bond Yield avg & FX avg (negative correlation).

For Europe:

- GDP avg and C avg (positive correlation);
- GDP avg and Stock PI avg (positive correlation);
- C avg and Stock PI avg (positive correlation);
- CPI avg and LT GVNT Bond Yield avg (positive correlation);
- Stock PI avg and LT GVNT Bond Yield avg (negative correlation);
- Stock PI avg and FX avg (negative correlation);

- Net Import avg and FX avg (negative correlation).

The availability of data could impact the number of statistically significant correlation estimates. The North America and Europe categories have the least amount of missing data in all analyzed variables.

6.3 Logistic regression

6.3.1 Theory and assumptions

Any data analysis aimed to describe the relationship between a response (dependent) variable and one or more explanatory (independent) variables uses the regression methods. In our paper we use the logistic regression model. The main difference of a logistic regression model from the well-known and widely used linear regression model is that the outcome variable in logistic regression is binary or dichotomous (the outcome variable consists of a set of 0's and 1's). (Hosmer and Lemeshow, 2000). Predictor variables in the logistic regression may be either quantitative or categorical (STATGRAPHICS Centurion XVI Statistical Procedures, 2009).

As other types of regressions logistic regression also has assumptions that one has to pay attention to. There is not necessary to have a linear relationship between dependent variable and predictors. The reason for this is that logistic regression applies a non-linear log transformation to the predicted odds ratio. Also, it is not necessary for independent variables (predictors) to be multivariate normal as well as the residuals (error terms) don't need to be multivariate normally distributed. The predictors don't have to be interval or ratio scaled as logistic regression can handle ordinal and nominal data as predictors (Assumptions of Logistic Regression).

However logistic regression has some *key assumptions* that still apply and they presented below.

1. It was mentioned already in this chapter that the dependent variable in the logistic regression has to be binary (dichotomous). Setting the dependent variable as a binary causes the loss of a lot of information. This procedure makes the test poorer compared to ordinal regression.
2. The probability of the event occurring in the logistic regression is set to P(Y=1). Therefore, it is necessary that the dependent variable is coded properly with the factor level one representing the desired outcome.

3. In the fitted model neither over fitting nor under fitting should occur. Therefore, the best approach is to ensure that the model is fitted correctly is stepwise method for logistic regression estimation.

4. It is required that the residuals are independent. The model itself should have little or no multicollinearity (the predictors should be independent from each other). However, there is an option to include interaction effects of categorical variable in the analysis and in the model.

5. Logistic regression assumes linearity of log odds and predictors. Otherwise, the strength of the relationship will be underestimated and the relationship will be rejected easily (being not significant). In order to avoid this problem the categorization of the predictors or discriminant analysis can be performed.

6. The last assumption is in order to perform logistic regression large sample sizes are required as maximum likelihood estimates are less powerful that ordinary least squares (Assumptions of Logistic Regression).

The procedure in Statgraphics fits a logistic regression model using maximum likelihood estimation and performs analysis of deviance. To test the significance of the model coefficients, the likelihood ratio tests are performed.

The logistic model which relates the probability of occurrence P of the outcome counted by Y (dependent variable) to the independent variables X takes the following form with the left hand side being referred to as the logit transformation:

$$\log\left(\frac{P(X)}{1-P(X)}\right) = \exp\left(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k\right)$$

Equation 6.12 Logit transformation in the logistic model (from STATGRAPHICS Centurion XVI Statistical Procedures, 2009).

where β is a regression coefficient.

The maximum likelihood estimation evaluates the coefficients in the regression model with standard errors and estimated odds rations. The odds ratio represents the percentage increase in the odds of an outcome for each unit increase in *X* and is calculated from the model coefficients β_j by $exp(\beta_j)$.

Analysis of deviance that is performed by Statgraphics decomposes the deviance of the data into an explained component – “Model”, and an unexplained component – “Residual”. By itself, deviance compares the likelihood function for a model to the largest value that the likelihood function could achieve, in a manner such that a perfect model would have a deviance equal to zero. In the table of deviance analysis there are three lines: model – the reduction in the deviance due to the predictor variables, $\lambda(\beta_1,\beta_2,\ldots,\beta_k|\beta_0)$, equal to the difference between the other two components; residual – the deviance remaining after the model has been fit; total (corr.) – the deviance containing only a constant terms, $\lambda(\beta_0)$. The "Model's" p-value that is less than 0.05 indicates that the model is useful for predicting the probability of the studied outcome as it has significantly reduced the deviance. The "Residual's" p-value tests whether there is a significant lack-of-fit. Therefore, a small p-value (less than 0.05) will indicate that a better model might be possible and that significant deviance remains in the residuals (STATGRAPHICS Centurion XVI Statistical Procedures, 2009).

As in multiple regression, in the logistic regression there is a statistics that is similar to R-squared statistics – percentage of deviance that is explained by the model that ranges from 0% to 100% and calculated by

$$R^2 = \frac{\lambda(\beta 1, \beta 2, \ldots, \beta k|\beta 0)}{\lambda(\beta 0)}$$

Equation 6.13 Percentage of deviance from (STATGRAPHICS Centurion XVI Statistical Procedures, 2009)**.**

To assess the significance of the variables in the model the standard feature of the logistic regression in Statgraphics is used – the likelihood ratio test (Hosmer and Lemeshow, 2000) .

In order to get an effective means to screen variables and to fit a number of logistic regression simultaneously, a stepwise procedure is performed (Hosmer and Lemeshow, 2000).

A backward Stepwise procedure in Statgraphics begins with including all variables in the model. The stepwise procedure is based on algorithm that removes from the model the least statistically significant variable with the p-value more than 0.05. The stepwise procedure stops when all remaining variables have p-value less than 0.05.

6.3.2 Empirical results

In our analysis the dependent variable pc GDP avg (Y) in the logistic regression model is considered to be related to six independent variables (predictors) X's such as pc C avg, CPI avg, Stock PI avg, LT GVNT Bond Yield avg, NI avg, and FX avg. This approach has been applied to all analyzed country and continent categories.

It was mentioned above that the outcome variable consists of a set of 0's and 1's, the predictors maybe either continuous or binary values. We decided that both dependent variable Y and independent variables X's are set as binary values to perform the logistic regression analysis. Therefore, all variables are coded with a value of one to indicate the negative annual growth rate in our data sample or zero to indicate that there is a positive annual growth rate in our data sample. When assigning codes one and zero we agreed on concentrating on "negative" extreme events (once the values of annual growths are less than zero) rather than on immensely high "positive" extreme events (once the values of annual growths are greater or much greater than zero). The reasoning of our choice is that "negative" extreme events are strongly undesirable in economics and have immediate effect on all economic areas, whereas "positive" extreme events may also have a negative influence on economy, yet, in the long run.

After having performed the logistic regression analysis in the statistical software "Statgraphics", we should note that all the requirements for the logistic regression cited above are met, with the exception of assumption 5. The obtained results are discussed below.

First, we estimate the model for the country category *Global*.

The relationship between pc GDP avg and 6 independent variables is described by the equation of the fitted model:

$$GDP\ avg = \frac{exp\,(-3.61092\ +\ 20.177\ *\ \mathrm{C\ avg})}{1 + exp\,(-3.61092\ +\ 20.177\ *\ \mathrm{C\ avg})}$$

Equation 6.14 Fitted logistic regression model for country category Global.

The results show that there is a statistically significant positive relationship between the pc C avg and pc GDP avg at the 95.0% confidence level because the p-value for the model is less than 0.05 Appendix 5 Table 2. In addition, the p-value for the residual is greater than 0.05, indicating that the obtained model is the best possible model for this data at the 95.0%.

The regression explains about 56.6 % of the deviance in GDP avg.

The significance of the coefficients is determined by running the Likelihood Ratio Test with the help of backward stepwise procedure.

In the first step of the procedure LT GVNT Bond Yield avg is removed because the p-value equals 1.0, which is greater than the maximum statistically significant p-value of 0.05 to consider the variable's significance for the model.

In the second step, the model is estimated using the five independent variables, with LT GVNT Bond Yield avg removed. Stock PI avg is removed in the second run as the p-value is 0.276351.

In the third step the model is estimated using the four independent variables, with LT GVNT Bond Yield avg and Stock PI Global avg removed. FX avg is removed in the third run due to the p-value of 0.221033.

In the fourth step, a three factor model is estimated, with LT GVNT Bond Yield avg, Stock PI avg, and FX avg removed. In the fourth run CPI avg is removed because of the higher p-value of 0.248156.

In the final step, a two factor model is estimated, with LT GVNT Bond Yield avg, Stock PI avg, FX avg, and CPI avg removed. In the final run of the analysis NI avg is removed from the model due to the higher p-value = 0.234503 resulting in a model with only one variable left – pc C avg (see Equation 6.14 and Appendix 5 Table 3).

According to the final model selected, the log odds of pc GDP avg is positively related to pc C avg as estimate for binary pc C avg is greater than zero (20.177). The odds of a negative annual change in consumption to lead to the negative annual change in GDP is 5.79 times greater than the odds of a positive annual change in consumption causing the positive annual change in pc GDP avg (see Appendix 5 Table 1).

Second, we estimate the model for the country category *OECD.*

The relationship between pc GDP avg and 6 independent variables is described by the equation of the fitted model:

$$GDP\ avg = \frac{exp\ (-1.7346\ -\ 15.8315 * \text{FX avg})}{1 + exp\ (-1.7346\ -\ 15.8315 * \text{FX avg})}$$

Equation 6.15 Fitted logistic regression model for country category OECD.

The results show that there is a statistically significant relationship between FX and GDP at the 95.0% confidence level because the p-value for the model is less than 0.05 Appendix 5 Table 2. In addition, the p-value for the residual is 0.9988, indicating that the obtained model is the best possible model for this data at the 95.0% confidence level.

The regression explains about 20.6581 % of the deviance in GDP.

The significance of the coefficients is determined by running the Likelihood Ration Test with the help of backward stepwise procedure.

Step 1:pc C avg is removed with the p-value=0.544699.

Step 2: NI avg is removed as the p-vaue=0.123707.

Step 3: Stock PI avg is excluded with the p-value= 0.0895237.

Step 4: CPI avg is removed due to the p-value=0.282638.

Step 5: LT GVNT Bond Yield avg is excluded because of the p-value= 0.0906315.

The final result of stepwise procedure is presented in Equation 6.15 and Appendix 5 Table 3.

According to the final model selected, the log odds of GDP is negatively related to FX avg as estimate for FX avg is less than zero (-15.8315). The odds of a negative annual change in FX leading to the positive annual change in GDP is 1.3318E-7 times greater than the odds of a positive annual change in FX causing the negative annual change in GDP avg (refer to Appendix 5 Table 1).

Third, we estimate the model for the country category *non-OECD.*

The relationship between GDP avg and 6 independent variables is described by the equation of the fitted model:

$$GDP\ avg = \frac{exp\ (-3.3673\ +\ 5.15906 * \mathrm{C\ avg})}{1 + exp\ (-3.3673\ +\ 5.15906 * \mathrm{C\ avg})}$$

Equation 6.16 Fitted logistic regression model for country category non-OECD.

The results show that there is a statistically significant relationship between pc C and GDP avg at the 95.0% confidence level because the p-value for the model is 0.0000. In addition, the p-value for the residual is 0.9991, indicating that the obtained model is the best possible model for this data at the 95.0% (Appendix 5 Table 2).

The regression explains about 59.5738 % of the deviance in GDP.

The significance of the coefficients is determined by running the Likelihood Ration Test with the help of backward stepwise procedure.

Step1: LT GVNT Bond Yield is removed because the p-value equals 0.898774

Step2: Stock PI is excluded as the p-value is 0.76457.

Step 3 CPI is removed due to the p-value=0.59139.

Step 4: NI is excluded because of the high p-value=0.354932.

Step 5: FX is removed due to the p-value=0.169807.

The result of stepwise procedure is shown Equation 6.16 and Appendix 5 Table 3

According to the final model selected, the log odds of GDP avg is positively related to pc C avg as estimate for binary pc C avg is 5.15906. The odds of a negative annual change in consumption leading to the negative annual change in GDP is 174 times greater than the odds of a positive annual change in pc C avg causing the positive annual change in pc GDP avg (Appendix 5 Table 1).

Fourth, we estimate the model for the country category *The North America*.

The relationship between pc GDP avg for The North America and 6 independent variables is described by the equation of the fitted model:

$$GDP\ avg = \frac{exp\ (\beta)}{1 + exp\ (\beta)}$$

Equation 6.17 Fitted logistic regression model for country category The North America.

where $\beta = -16.397 + 51.8598 * C\ \ avg - 13.0772 * CPI\ \ avg + 27.8648 * LT\ GVNT\ Bond\ Yield\ avg - 32.9481 * FX\ \ avg$

The results show that there is a statistically significant relationship of pc C avg, CPI avg, LT GVNT Bond Yield avg, FX avg with pc GDP avg at the 95.0% confidence level because the p-value for the model is 0.0000. In addition, the p-value for the residual is greater than 0.05, indicating that the obtained model is the best possible model for this data at the 95.0% (Appendix 5 Table 2).

The regression explains about 86.4939 % of the deviance in GDP avg.

The significance of the coefficients is determined by running the Likelihood Ration Test with the help of backward stepwise procedure.

Step1: NI avg is excluded because of the high p-value=0.997545.

Step 2: Stock PI avg is removed due to the high p-value= 0.207665.

In the final model with four predictors, the highest p-value in the conventional range of 0.05 belongs to CPI avg (0.0229). See Equation 6.17and Appendix 5 Table 3.

According to the final model selected, the log odds of pc GDP avg is positively related to two predictors whose estimates are greater than zero and negatively related to the two predictors whose estimated values are less than zero. The odds of a negative annual change in C avg and LT GVNT Bond Yield avg leading to the negative annual change in GDP are respectively 3.32991E22 and 1.26332E12 times greater than the odds of a positive annual change in those predictors causing the positive annual change in pc GDP avg.. The odds of a negative annual change in FX avg leading to the positive annual change in pc GDP avg is 4.90712E-15 times greater than the odds of a positive annual change in FX avg causing the negative annual change in GDP avg. The same logic applies to interpretation of odds ratio for CPI avg. See Appendix 5 Table 1.

Fifth, we estimate the model for the country category *The South America*.

The relationship between pc GDP avg and 6 independent variables is described by the equation of the fitted model:

$$GDP\ avg = \frac{exp\ (-30.5662\ +\ 61.1325 * \mathrm{C\ avg})}{1 + exp\ (-30.5662\ +\ 61.1325 * \mathrm{C\ avg})}$$

Equation6.18 Fitted logistic regression model for country category The South America.

The results show that there is a statistically significant relationship between pc C and GDP avg at the 95.0% confidence level because the p-value for the model is 0.0000 (Appendix 5 Table 2). In addition, the p-value for the residual is greater than 0.05, indicating that the obtained model is the best possible model for this data.

The regression explains about 100 % of the deviance in GDP.

The significance of the coefficients is determined by running the Likelihood Ration Test with the help of backward stepwise procedure.

Step1: FX avgis removed because the p-value equals 1.0.

Step2: NI avg is excluded as the p-value is 1.0.

Step 3 LT GVNT Bond Yield avgis removed due to the p-value=1.0.

Step 4: Stock PI avgis excluded because of the high p-value=1.0.

Step 5: CPI avg is removed due to the p-value=1.0.

The result of stepwise procedure is shown in Equation 6.18 and Appendix 5 Table 3.

The log odds of GDP is positively related to C as estimate for binary C is greater than zero (61.1325). See Appendix 5 Table 1.

Sixth, we estimate the model for the country category *Africa*.

The relationship between pc GDP avg and 6 independent variables is described by the equation of the fitted model:

$$GDP\ avg = \frac{exp\ (\beta)}{1 + exp\ (\beta)}$$

Equation 6.19 Fitted logistic regression model for country category Africa

where $\beta = -9.58248 + 6.17839 * C\ avg + 3.20695 * CPI\ avg + 3.8149 * Net\ Import\ avg + 3.36294 * FX\ avg$

The results show that there is a statistically significant relationship of pc C avg, CPI avg, NI avg, FX avg with pc GDP avg at the 95.0% confidence level because the p-value for the model is 0.0007 (Appendix 5 Table 2). In addition, the p-value for the residual is greater than 0.05, indicating that the obtained model is the best possible model for this data at the 95.0%.

The regression explains about 50.1999 % of the deviance in GDP.

The significance of the coefficients is determined by running the Likelihood Ration Test with the help of backward stepwise procedure.

Step1: Stock PI avg is removed because the p-value equals 0.966854.

Step2: LT GVNT Bond Yield avg is excluded as the p-value is 0.567077.

In the final model with four predictors, the highest p-value in the allowed range of 0.05 belongs to CPI (0.0281). The model is presented in Equation 6.19 and Appendix 5 Table 3.

According to the final model selected, the log odds of GDP is positively related to all four predictors with the estimate values greater than zero presented in (Appendix 5 Table 1). The higher odds ratio belongs to C (482.215), indicating that pc C avg is the best positively related predictor to the dependent variable GDP.

Seventh, we estimate the model for the country category *Asia*.

The relationship between pc GDP avg and 6 independent variables is described by the equation of the fitted model:

$$GDP\ avg = \frac{exp\ (-30.5662\ +\ 61.1325 * \mathrm{C\ avg})}{1 + exp\ (-30.5662\ +\ 61.1325 * \mathrm{C\ avg})}$$

Equation 6.20 Fitted logistic regression model for country category Asia.

The results show that there is a statistically significant relationship between pc C and GDP avg at the 95.0% confidence level because the p-value for the model is 0.0001(Appendix 5 Table 2). In addition, the p-value for the residual is greater than 0.05, indicating that the obtained model is the best possible model for this data.

The regression explains about 100 % of the deviance in GDP.

The significance of the coefficients is determined by running the Likelihood Ration Test with the help of backward stepwise procedure.

Step1: FX avg is removed because the p-value equals 1.0.

Step2: NI avg is excluded as the p-value is 1.0.

Step 3 LT GVNT Bond Yield avg is removed due to the p-value=1.0.

Step 4: Stock PI avg is excluded because of the high p-value=1.0.

Step 5: CPI avg is removed due to the p-value=1.0.

The result of stepwise procedure is shown in Equation 6.20 and Appendix 5 Table 3.

The log odds of GDP is positively related to C as estimate for C is greater than zero (61.1325). See Appendix 5 Table 1.

Eighth, we estimate the model for the country category *Europe*.

The relationship between pc GDP avg and 6 independent variables is described by the equation of the fitted model:

$$GDP\ avg = \frac{exp\ (-35.0716\ +\ 19.8835 * \mathrm{C\ avg}\ +\ 32.299 * \mathrm{Net\ Import\ avg})}{1 + exp\ (-35.0716\ +\ 19.8835 * \mathrm{C\ avg}\ +\ 32.299 * \mathrm{Net\ Import\ avg})}$$

Equation 6.21 Fitted logistic regression model for country category Europe.

The results show that there is a statistically significant relationship of pc C avg and NI avg with pc GDP avg at the 95.0% confidence level because the p-value for the model is 0.0001 (Appendix 5 Table 2). In addition, the p-value for the residual is 1.0, indicating that the obtained model is the best possible model for this data .

The regression explains about 70.752 % of the deviance in GDP.

The significance of the coefficients is determined by running the Likelihood Ration Test with the help of backward stepwise procedure.

Step1: FX avg is removed because the p-value equals 0.477163.

Step2: LT GVNT Bond Yield avg is excluded as the p-value is 0.390431.

Step 3 Stock PI avg is removed due to the p-value=0.383318.

Step 4: CPI avg is excluded because of the high p-value=0.293223.

The final model is presented in Equation 6.21 and Appendix 5 Table 3.

According to the final model selected, the log odds of GDP is positively related to pc C avg and NI avg as the estimates for C and NI are greater than zero (19.8835 and 32.299, respectively). The odds of a negative annual change in C leading to the negative annual change in GDP is 4.31796E8 times greater than the odds of a positive annual change in consumption causing the positive annual change in GDP. The same logic applies to NI with odds ratio equals 1.06486E14. See Appendix 5 Table 1

Ninth, we estimate the model for the country category *Oceania.*

The relationship between pc GDP avg and 6 independent variables is described by the equation of the fitted model:

$$GDP\ avg = \frac{exp\ (\beta)}{1 + exp\ (\beta)}$$

Equation 6.22 Fitted logistic regression model for country category Oceania

where $\beta = -41.9743 + 77.1842 * C\ avg - 22.535 * CPI\ avg - 45.8975 * Stock\ PI\ avg + 22.6976 * LT\ GVNT\ Bond\ Yield$

The results show that there is a statistically significant relationship of pc C avg, CPI avg, Stock PI avg, LT GVNT Bond Yield avg with pc GDP avg at the 95.0% confidence level because the p-value for the model is 0.0000 (Appendix 5 Table 2). In addition, the p-value for the residual is 1.0, indicating that the obtained model is the best possible model for this data.

The regression explains about 99.9996 % of the deviance in GDP.

The significance of the coefficients is determined by running the Likelihood Ration Test with the help of backward stepwise procedure.

Step 1: NI avg is removed due to the p-value=1.0

Step 2: FX avg is excluded with the p-value = 0.999151.

According to the final model selected, the log odds of GDP is positively related to two predictors whose estimates are greater than zero and negatively related to two predictors whose estimated values are less than zero. The odds of a negative annual change in pc Cavg and LT GVNT Bond Yield avg leading to the negative annual change in GDP are respectively 3.31649E33 and 7.20149E9 times greater than the odds of a positive annual change in those predictors causing the positive annual change in pc GDP avg (Appendix 5 Table 3). The odds of a negative annual change in CPI avg leading to the positive annual change in pc GDP avg is 1.63378E-10 times greater than the odds of a positive annual change CPI avg causing the negative annual change in pc GDPavg . The same logic applies to interpretation of odds ratio for Stock PI.avg. See Appendix 5 Table 1.

7 DISCUSSION OF RESULTS

The purpose of our thesis was to study extreme events in the stock market and economy. With the help of certain statistical procedures applied to our massive, carefully compiled macro-financial data sample, we have made an attempt to retrieve the realization of extreme events and to determine a model of their prediction using a set of seven selected macro-financial factors.

First, we have performed descriptive statistics analysis to discover the essential characteristics of the data. The descriptive statistics included analysis of distributions, kurtosis, skewness, and standard deviation. These were further used to determine the best fitted distributions. The outcome of the descriptive statistics analysis is represented in tables, histograms and normal probability plots attached in Appendices 3,7-9. Correlation analysis performance was to reveal the relationships between pairs of macro-financial factors. Appendix 4 contains the results of the correlation analysis. Further, we have attempted to detect the mechanism of extreme events prediction with the help of logistic regression. In order to do so, we have performed logistic regression analysis to study if growth rate in one variable could be predicted by growth rates in the others. The results are found in Appendix 5.

Based on the results of the descriptive statistics analysis, we have come to the following conclusions.

The results of skewness and kurtosis summarized in the tables Summary Statistics for all three periods Appendix 3 Tables 1-3 indicate some significant non-normality in the data, which violates the assumption that the data come from normal distribution. The best fitted distribution for each data sample in each country category was detected after performing Anderson Darling test and Kolmogorov-Smirnov test for goodness-of-fit (Appendices 7-9).

After having performed these tests, we can state that our data samples occur to be distributed within the four main probability distributions: logistic distribution, Laplace distribution, largest extreme value and smallest extreme value distributions.

Though these are the most frequent probability distributions in our empirical analysis, we have also encountered some cases of normal distribution in the data samples. It specifically involves the data samples for Stock PI avg for Global and Oceania, LT GVNT Bond Yield avg for The South America, CPI avg for Europe, and FX avg for OECD in the full period.

As for normal distribution for Stock PI avg, we assume that this could appear as a consequence of the data frequency for Stock PI. We use annual data on Stock PI and the averaged values, which could have led to “smoothing out” effect of the extremely high and extremely low values. We may suppose the results would have been more accurate and we would have been able to retrieve better disasters performance if we had used monthly data on Stock PI. The same logic can be applied to the explanation of normal distribution result for FX avg for OECD. Even though, suggesting an idea that the monthly data could provide more accurate results, we have chosen to use annual data on Stock PI in our empirical analysis in order to preserve the consistency in data frequency with other variables.

The results of normal distribution for LT GVNT Bond Yield avg for The South America could be explained by insufficient number of observations for LT GVNT Bond Yield, which prevents us from extracting extreme changes in the data for this variable. We suggest that this could be a subject for future data modification.

The positive excess kurtosis results for LT GVNT Bond Yield avg may provide the proof of the fact that even though government bonds are considered to be risk free and rather secure, there have occurred some examples of a government default on its domestic currency debt (Siegel, 2008). Such examples are Russian financial crisis (1998) and European sovereign debt crisis (2010).

The observed case of normal distribution for CPI avg in the data sample for Europe most evidently has come as a result of tremendously large values in the data sample for CPI avg as a consequence of German hyperinflation in 1923-24. Therefore, we have excluded these years from the empirical analysis in the second period in order to see if there would appear a significant difference in results. After doing so, we got Laplace distribution as the best fitted distribution for this data sample, and more examples of disasters realization were extracted from the data on CPI avg in the first period.

The results of kurtosis for NI avg have revealed considerably high values of positive excess kurtosis for all country categories, which has led to heavy tails in distribution (Laplace). The results may suggest an idea that net import is rather sensitive and volatile to fluctuations on the market and in economy.

On the basis of the correlation analysis, we have discovered that there exists a strong statistically significant non-zero correlation at the 95.0 % confidence level between pc GDP and C avg variables. This relationship can be observed in the data samples for all country categories in both full period and two sub-periods (Appendix 4 Tables 1-3). The strong relationship between those two variables is consistent with the macroeconomic theory consumption being one of the biggest GDP constituents.

An interesting finding in our correlation analysis relates to the relationship between CPI avg and pc C avg, and between CPI avg and pc GDP avg. According to macroeconomic theory, CPI is inversely correlated with both GDP and C. The results of our empirical analysis have revealed the negative correlation between CPI avg and pc GDP avg, CPI avg and pc C avg in the full period. The only statistically significant negative correlation has occurred, though, only for The South America country category (Appendix 4 Table 1).

However, the correlation matrix for the first sub-period (1900-47) shows that non-OECD and The North America country categories have statistically significant positive correlation of CPI avg with pc GDP avg, CPI avg and C avg (Appendix 4 Table 2). The first sub-period involves such disasters as WWI, The Great Depression and WWII. Unfortunately, not every country had kept data on inflation during this period, and data on inflation often do not exist before WWII.

As per our data set, there are gaps in the inflation data for some countries which were affected the most during WWII, such as Russia. We may connect the result of positive correlation with the consequences of the mentioned above disasters occurred during this period when consumption tends to decrease more than GDP during war times, and spending on military goods increases (Barro and Ursua , 2011). It may also be connected with some particular political tendencies or consumer sentiment in the mentioned above country categories. Yet, we are not able to state specifically why it led to the positive relationship between those two pairs of variables.

In our correlation matrix we could as well detect an interesting case of the statistically significant negatively correlated (-0.3383) real exchange rate is with CPI avg for OECD country category in both the full period and the second sub-period, yet, it is statistically significant positively correlated (0.3738) in The North America for the same periods (Appendix 4 Table 1,3). The negative correlation in OECD may result from that fact that certain countries included into this country category are Euro Zone, which means that the real exchange rates were calculated in their national currencies to USD before 2000 and in Euro to USD after 2000. Therefore, we can't state that the result of negative correlation of FX avg with CPI avg is absolutely robust.

Also, we have observed a case of statistically significant negative correlation of real exchange rate with pc C for Global, OECD, non-OECD, The North America, The South America, and Asia country categories (Appendix 4 Tables 1,3). According to Jønsson, the estimated negative correlation is consistent with the fact that while there is an appreciation of real exchange rate there is an increase in consumption (Jönsson).

The result of statistically significant positive correlation of LT GVNT Bond Yield avg with CPI avg obtained from our data analysis for Global (0.2521) and Europe (0.3625) country categories in both the full period and the 1948-2011 period (Appendix 4 Tables 1, 3), may be an empirical proof of Smirlock's research finding who had discovered a significant positive response of long-term rates to unpredicted price increases, i.e that there is a consistency with either increases in expected inflation or potential of a tighter monetary policy (Smirlock, 1986).

The statistically significant negative correlation of LT GVNT Bond Yield avg with Stock PI avg for Global (-0.3085), OECD (-0.3699) and Europe (-0.3532) country categories in both full period and the 1948-2011 period (Appendix 4 Tables 1, 3) could, probably, be an empirical proof of the previous research that "substitution effect between stocks and bonds which is strongly shaped by the relationship of the dividend yield to the bond yield", which means that a decrease in bond yield leads to higher stock prices (Durre and Giot, 2005).

We have also observed a case of statistically significant negative correlation of NI avg and FX avg for Asia (-0.4259) and Europe (-0.3407) country categories (Appendix 4 Tables 1, 3). It is worth noting that such statistically significant correlation exists not in Global country category, but in the country category which includes exporting countries, for example China, as it is one of the largest exporters of goods. Therefore, the exporting countries benefit from a high real exchange rate (weak domestic currency), if opposite, it can lead to the reduction in export as the prices of their goods in the country they export to will be high, leading to less import in those countries (The Relationship Between the Dollar and the Bond Market, 2009).

After having performed the backward stepwise logistic regression analysis for all country categories, we could observe a consistent pattern of pc C avg predicting pc GDP avg growth rate. As the p-values for the models are less than 0.05, hence, these are useful for predicting the probability of the studied outcome. In addition, the p-value for the residual is considerably greater than 0.05, which indicates that the obtained model is the best possible model for the data at 95.0 % confidence level. The pc C avg estimate is greater than zero and the log odds of pc GDP avg is positively related to pc C avg. This is true for all country categories, except for OECD (Appendix 5 Tables 1-3).

The most number of predictors fitted in the regression models are observed in the following country categories:The North America(4 predictors), Africa (4 predictors), Oceania (4 predictors). The percentage of deviance in pc GDP avg explained by the models for the mentioned above country categories are 86.49 %, 50.2 % and 99.99 %, respectively (Appendix 5 Table 2). For instance, for Africa at a negative value of NI avg the predicted odds for negative pc GDP avg are $e^{3.8149}$= 45.3724, meaning it is 45 times more likely to get a negative response of pc GDP avg caused by negative value of NI avg than a positive response of pc GDP avg caused by a positive value of NI avg.

8 CONCLUSION

In our thesis, we have employed several statistical approaches in order to study the occurrence of extreme events and to determine a model of their prediction with the application to the uniquely constructed macro-financial data set. Our empirical analysis was conducted using the data which embraces not only the recent global economic and financial crises, but also such great disasters as WWI, German hyperinflation, The Great Depression, and WWII.

We have performed our empirical analysis using three timeline periods: the full period (1900-2011), the 1900-47 period for GDP, C and CPI variables, and the 1948-2011 period for the same variables.

The existence of either positive or negative correlations between several pairs of variables, specifically in such country categories as Europe and The North America in the second sub-period, may confirm the interdependence between macroeconomic and financial factors in our extreme events study. For instance, the previous research discovery by Smirlock (1986) that long term rates respond with a positive significance to unpredicted price increases is confirmed by our finding of positive statistically significant correlation of CPI avg with LT GVNT Bond Yield avg for Europe. Though, in some cases it is rather difficult to observe the interdependence between the factors as sometimes it should involve a study of cross-country or international linkages to arrive to more robust conclusions about the impact size of economic and financial disasters. It namely concerns one of our analyzed factors - Net Import.

The previous research of Dungey and Tambakis (2005) empirically confirms that there finds place transmission of financial crises through different mechanisms both financial and political on both cross-country and international levels.

Our logistic regression analysis has revealed poorer prediction efficiency than we could have expected for some country categories, specifically Global. We can assume that the reason for such performance might be the process of constructing binary data. Therefore, we may suggest that the logistic regression can be improved by establishing more accurate thresholds for micro-financial crises; further, variables may get codes of 1 and 0 assigned on the ground of the established thresholds results. In order to minimize the underestimated relationship between predictors and log odds, it would be useful to perform either discriminant analysis or categorization of the independent variables.

Yet, there has been detected the consistent pattern of good prediction ability of C avg for GDP avg, which is consistent with the macroeconomic theory as discussed earlier. This is true for all country categories, with the exception of OECD, where the best predictor is FX avg. Apart from this pattern, in some models we have obtained the results with four best predictors. These are The North America (4 predictors), Africa (4 predictors), Oceania (4 predictors). Along with C avg, the best predictors include CPI avg, LT GVNT Bond Yield avg, Stock PI avg, FX rate avg, and NI avg.

The results of kurtosis and skewness have revealed some significant non-normality in the data, which indicates that the data do not come from normal distribution. Even though, the best fitted distributions for our data samples are logistic, Laplace, largest extreme value and smallest extreme value distributions, yet, in our empirical analysis, there have occurred several cases of normal distribution, which wasn't consistent with our expectations as we have discussed earlier. Namely, it concerns Stock PI, FX rate and CPI. This may be explained by the following arguments:

1. We used annual data on all seven variables to preserve frequency consistency in all data samples. For a more accurate analysis, it would be more advisable to use data of a higher frequency, for example monthly, specifically for Stock P. This would probably have provided us with more robust results.
2. When constructing data samples, the averaging process could have involved "smoothing out" effect of extremely high and low values for some country categories, which hindered from detecting more precise and robust results.
3. As we have discussed in the chapter "Discussion of results", not all countries had kept records on inflation before WWII, therefore, there are some gaps of missing data for CPI in our data sample. We may assume that the fact of some data missing could have affected the robustness of some results. Hence, this part of the analysis can offer a certain challenge for further research constructing the missing values. Such techniques as interpolation or imputation can be applied.

As such, our macro-financial data set may be modified, and accompanied by more advanced statistical tools, may be used for further research as it has a great potential for further experimental work in order to obtain a more thorough understanding and knowledge of extreme events in economics.

As we mentioned in our research overview conclusion, the topic of extreme events has areas which require more thorough investigation, which ought to be taken into consideration when studying the nature, occurrence and impact of extreme and rare events on socioeconomic life.

Reinhart and Rogoff (2009) confirm the importance of finding answers to these questions because extreme and rare events have a tendency to reoccur.

In connection with the importance of finding answers, receiving new questions and starting a new quest, we would like to conclude our work with Albert Einstein's quotation *"Learn from yesterday, live for today, hope for tomorrow. The most important thing is not to stop questioning"*.

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APPENDIX 1 SAMPLE DATA CONSTRUCTION

Global	OECD countries	non-OECD
Argentina	Australia	Argentina
Australia	Austria	Brazil
Austria	Belgium	China
Belgium	Canada	Colombia
Brazil	Chile	Egypt
Canada	Denmark	India
Chile	Finland	Indonesia
China	France	Malaysia
Colombia	Germany	Peru
Denmark	Greece	Philippines
Egypt	Iceland	Russia
Finland	Italy	South Africa
France	Japan	Singapore
Germany	Korea	Sri Lanka
Greece	Mexico	Taiwan
Iceland	The Netherlands	Uruguay
India	Norway	Venezuela
Indonesia	New Zealand	
Italy	Portugal	
Japan	Spain	
Korea	Sweden	
Malaysia	Switzerland	
Mexico	Turkey	
The Netherlands	United Kingdom	
Norway	United States	
New Zealand		
Peru		
Philippines		
Portugal		
Russia		
South Africa		
Singapore		
Spain		
Sri Lanka		
Sweden		
Switzerland		
Taiwan		
Turkey		
United Kingdom		
Uruguay		
United States		
Venezuela		

Table 1 Country categories.

Note: The division into OECD and non-OECD is based on the information from www.oecd.org.

Europe	Asia	South America	North America	Africa	Oceania
Austria	China	Argentina	Canada	Egypt	Australia
Belgium	India	Brazil	Mexico	South Africa	New Zealand
Denmark	Indonesia	Chile	United States		
Finland	Japan	Colombia			
France	Korea	Peru			
Germany	Malaysia	Uruguay			
Greece	Philippines	Venezuela			
Iceland	Russia				
Italy	Singapore				
The Netherlands	Sri Lanka				
Norway	Turkey				
Portugal	Taiwan				
Spain					
Sweden					
Switzerland					
United Kingdom					

Table 2 Continents categories.

Note:Division by continets is based on information from http://www.worldatlas.com

GDP & Consumption	Net Import Data	CPI	FX	Stock Prices Index	LT Gvnt Bond Yield
Argentina	-	Argentina	Argentina	Argentina	-
Australia	Australia	Australia	Australia	Australia	Australia
Austria	Austria	Austria	Austria	-	Austria
Belgium	Belgium	Belgium	Belgium	Belgium	Belgium
Brazil	Brazil	Brazil	Brazil	Brazil	-
Canada	Canada	Canada	Canada	Canada	Canada
Chile	Chile	Chile	Chile	Chile	Chile
China	China	China	China	China	-
Colombia	-	Colombia	Colombia	Colombia	-
Denmark	Denmark	Denmark	Denmark	Denmark	Denmark
Egypt	-	Egypt	Egypt	-	-
Finland	Finland	Finland	Finland	Finland	Finland
France	France	France	France	France	France
Germany	Germany	Germany	Germany	Germany	Germany
Greece	Greece	Greece	Greece	Greece	Greece
Iceland	Iceland	Iceland	Iceland	Iceland	Iceland
India	India	India	India	India	India
Indonesia	Indonesia	Indonesia	Indonesia	Indonesia	-
Italy	Italy	Italy	Italy	Italy	Italy
Japan	Japan	Japan	Japan	Japan	Japan
Korea	Korea	Korea	Korea	Korea	Korea
Mexico	Mexico	Mexico	Mexico	Mexico	Mexico
Malaysia	-	Malaysia	Malaysia	Malaysia	Malaysia
Netherlands	Netherlands	Netherlands	Netherlands	Netherlands	Netherlands
New Zealand	New Zealand	New Zealand	New Zealand	New Zealand	New Zealand
Norway	Norway	Norway	Norway	Norway	Norway
Peru	-	Peru	Peru	-	-
Philippines	-	Philippines	Philippines	Philippines	Philippines
Portugal	Portugal	Portugal	Portugal	Portugal	Portugal
Russia	Russia	Russia	Russia	-	-
South Africa	South Africa	South Africa	South Africa	South Africa	South Africa
Singapore	-	Singapore	Singapore	-	Singapore
Spain	Spain	Spain	Spain	Spain	Spain
Sri Lanka	-	Sri Lanka	Sri Lanka	Sri Lanka	-
Sweden	Sweden	Sweden	Sweden	Sweden	Sweden
Switzerland	Switzerland	Switzerland	Switzerland	Switzerland	Switzerland
Taiwan	-	Taiwan	Taiwan	Taiwan	Taiwan
Turkey	Turkey	Turkey	Turkey	Turkey	-
United Kingdom	United Kingdom	United Kingdom	United Kingdom	United Kingdom	United Kingdom
Uruguay	-	Uruguay	Uruguay	-	-
United States	United States	United States	United States	United States	United States
Venezuela	-	Venezuela	Venezuela	-	-

Table 3 Data availability by country.

APPENDIX 2 EXTREME EVENTS OVERVIEW

Date	Event	Location	Comments
1907	Banker's Panic of 1907	USA	A U.S. economic recession with bank failures
1914-1918	World War I		
1918-1924	German Hyperinflation	Germany	
1929-1940	Great Depression	USA	Worldwide economic depression
1939-1941	World War II		
1969-1970	Recession	USA	Increased deficits resulted in inflation rising.
1973	Oil Crisis	Middle East	
1973-1975	Secondary banking crisis	UK	
1980s-1990s	Savings and loan crisis	USA	
1982	External Bank Debt Crisis	Mexico	All countries in Latin America are affected with the exception of Chile, Colombia and Costa Rica.
1987	Black Monday (stock market crash)	China	Spread to West Europe and USA
1990-2000	Japan's "Lost Decade"	Japan	Share and property price bubble
1990s	Finnish banking crisis	Finland	
1990s	Swedish banking crisis	Sweden	
1992	Black Wednesday	UK	Withdrawal of GBP from the European Exchange Rate Mechanism
1994	Venezuelan banking crisis	Venezuela	
1994	Mexican Peso Crisis	Mexico	Most affected countries are Argentina and Brazil.
1997-1999	Debt and the Global Economic Crisis		
1997	East Asian Financial Crisis	Thailand	Global stock market crash caused by an economic crisis in Asia. Most affected countries are Indonesia, South Korea, Philippines, South-East Asia and Japan
1998	Ruble crisis	Russia	
1998-1999	Ecuador banking crisis	Ecuador	
1999-2002	Argentine economic crisis	Argentina	

Table 1 Table of extreme events (from http://antiworldnews.wordpress.com, http://news.bbc.co.uk/2/hi/business/6958091.stm)

Date	Event	Location	Comments
2001	Economic effects arising from the September 11 attacks	USA	The September 11 attacks caused global stock markets to drop sharply
2002	Stock market downturn	USA	Downturn in stock prices during 2002 in stock exchanges across the United States, Canada, Asia, and Europe
2002	Uruguay banking crisis	Uruguay	
2007	Chinese stock bubble	China	
2008	Icelandic financial crisis	Iceland	
2008	Subprime mortgage crisis	USA	
2009 Onward	European sovereign debt crisis	Europe	Most affected countries are Greece, Ireland, Spain, and Portugal

Table 1 Continued.

APPENDIX 3 DESCRIPTIVE STATISTICS

Summary Statistics (Full period)	Count	Average	Median	Variance	Standard deviation	Skewness	Excess kurtosis
GDP avg							
Global	112	0,8722	0,7695	1,1608	1,0774	0,6641	2,0859
OECD	112	0,8081	0,7102	0,9683	0,9840	-0,9445	4,5950
non-OECD	112	0,9655	0,7297	2,4728	1,5725	1,6612	4,5363
N.America	112	0,7864	0,8263	1,6170	1,2716	-0,8220	2,7012
S.America	112	0,9433	0,8709	3,8552	1,9634	0,0678	1,3712
Africa	112	0,7675	0,7123	2,1180	1,4553	0,2194	1,8438
Asia	112	0,9920	0,6187	2,6381	1,6242	1,4124	4,8823
Europe	112	0,7921	0,7343	1,1338	1,0648	-0,9581	4,1977
Oceania	112	0,7598	0,8655	1,5680	1,2522	-0,0076	-0,1941
Consumption avg							
Global	111	0,8119	0,7040	0,9282	0,9634	0,2794	1,1822
OECD	111	0,7387	0,6446	0,8601	0,9274	-0,3170	0,1594
non-OECD	111	0,9123	0,7199	2,6691	1,6337	1,8813	8,7433
N.America	111	0,8184	0,7411	1,7527	1,3239	0,8031	5,7452
S.America	111	0,8859	0,9837	4,2477	2,0610	0,0382	1,0211
Africa	111	0,7197	0,5979	2,8718	1,6946	0,9381	3,4778
Asia	111	0,9366	0,7107	3,1196	1,7662	1,8213	12,6392
Europe	111	0,6789	0,6665	1,6333	1,2780	-2,5511	14,4957
Oceania	111	0,7719	0,8767	2,7441	1,6565	0,5545	3,0230
CPI avg							
Global	112	0,1448	0,5457	5,8833E17	7,6703E8	-2,743E-7	55,5
OECD	112	-0,1318	-0,0836	1,2886E18	1,1352E9	-2,8059E-7	55,5
non-OECD	112	0,7682	0,9186	7463,0	86,3887	-4,3330	51,6369
N.America	112	0,0218	0,0825	29,274	5,4105	-1,7477	10,5704
S.America	112	0,1180	0,7640	38341,6	195,81	-4,4293	53,4721
Africa	112	0,0886	0,1575	60,8778	7,8024	-1,7424	14,4771
Asia	112	1,3674	-0,0814	776,335	27,8628	3,4782	25,5318
Europe	112	-0,2056	0,0070	3,1462E18	1,7737E9	-2,83616E-7	55,5
Oceania	112	0,0018	0,0185	11,1491	3,3390	-0,3152	1,9484
Stock PI avg							
Global	61	0,1206	0,1056	0,0333	0,1827	0,0238	0,2267
OECD	61	0,1124	0,0974	0,0326	0,1806	0,2748	1,7322
non-OECD	38	0,1813	0,1773	0,0979	0,3129	0,0932	-1,0790
N.America	61	0,1182	0,1227	0,0530	0,2304	0,7022	2,0382
S.America	29	0,3141	0,3539	0,2380	0,4878	0,8562	1,0632
Africa	38	0,1139	0,0800	0,0776	0,2785	0,5180	-0,2952
Asia	54	0,1569	0,0953	0,0856	0,2927	0,7724	0,5960
Europe	54	0,1048	0,0864	0,0364	0,1910	0,6010	2,6488
Oceania	39	0,0829	0,0948	0,0713	0,2671	-0,0672	-0,5220

Table 1 Descriptive Statistic for full period sample data.

Note: "Count" column in tables of Summary Statistics denotes the amount of data analyzed for each data sample. The results are presented for each of the seven variables in each country category included into the empirical analysis.

Summary Statistics (Full period)	**Count**	**Average**	**Median**	**Variance**	**Standard deviation**	**Skewness**	**Excess kurtosis**
LT GVNT Bond Yield avg							
Global	61	-0,0074	-0,0240	0,5068	0,7119	0,2458	1,3175
OECD	61	-0,0085	-0,023	0,5376	0,7332	0,2278	0,8877
non-OECD	54	0,0771	0	1,7243	1,3131	0,5078	1,7407
N.America	60	-0,0125	-0,0025	0,6960	0,8342	0,1361	1,2182
S.America	16	-0,2131	-0,185	0,2549	0,5049	0,2770	-0,0226
Africa	54	0,0688	0,055	2,1084	1,4520	0,2955	0,5288
Asia	44	-0,2109	-0,2110	0,5087	0,7132	0,9703	1,9526
Europe	61	-0,0003	-0,02	0,6964	0,8345	0,3297	0,8708
Oceania	41	-0,0971	-0,37	1,7890	1,3375	0,5079	0,1374
NI avg							
Global	57	0,5212	-0,0043	9,0890	3,0148	5,4034	33,2408
OECD	56	0,3237	0,0246	3,1448	1,7733	3,7030	17,1914
non-OECD	54	1,6223	-0,0333	178,608	13,3644	7,3077	53,6023
N.America	56	0,1189	0,0162	0,9718	0,9858	2,6659	10,3615
S.America	47	6,0717	-0,0451	1838,46	42,8773	6,8484	46,9328
Africa	53	-0,7862	-0,06	15,1593	3,8935	-5,4381	34,0824
Asia	54	-0,1657	-0,0270	1,6775	1,2952	-6,2445	43,3032
Europe	54	0,56021	0,0750	6,3044	2,5108	4,8407	25,8228
Oceania	54	0,08740	-0,1420	64,6721	8,0419	4,6364	30,7419
FX Rate avg							
Global	41	0,0034	0,0116	0,0037	0,0613	0,1903	-1,0075
OECD	41	-0,0016	-0,0029	0,0049	0,0706	0,0314	-0,5633
non-OECD	41	0,0109	-0,0028	0,0047	0,0691	0,4363	-0,7144
N.America	41	0,0058	-0,0093	0,0032	0,0569	1,8762	4,6372
S.America	41	0,0123	-0,0214	0,0150	0,1225	1,5887	2,3718
Africa	41	0,0100	-0,0059	0,0162	0,1273	0,8568	2,726
Asia	41	0,0091	0,0025	0,0038	0,0622	1,1201	3,0190
Europe	41	-0,0061	-0,0142	0,0080	0,0896	0,0959	0,0252
Oceania	41	0,0048	0,0144	0,0260	0,1612	2,4467	11,9505

Table 1 Continued.

Summary Statistics (1900-1947)	Count	Average	Median	Variance	Standard deviation	Skewness	Excess Kurtosis
				GDP avg			
Global	48	0,2089	0,2696	0,3299	0,5744	-0,1946	0,4665
OECD	48	0,1890	0,3124	0,2852	0,5340	-0,9860	1,1587
non-OECD	48	0,2357	0,3588	0,8030	0,8961	-0,4780	1,2458
N.America	48	0,3146	0,2532	0,9751	0,9874	0,0255	0,6402
S.America	48	0,5051	0,5514	1,3850	1,1769	-0,9570	3,12231
Africa	48	0,1432	0,0645	1,7705	1,3306	-0,3017	3,0074
Asia	48	0,0601	0,1228	0,7798	0,8830	-1,8043	8,2975
Europe	48	0,1530	0,2070	0,4202	0,6482	-0,199	2,3227
Oceania	48	0,3744	0,3596	1,4063	1,1858	0,3991	0,9493
				Consumption avg			
Global	48	0,1839	0,2916	0,5016	0,7082	-0,1878	4,3642
OECD	48	0,1755	0,2565	0,4144	0,6437	-0,1779	1,0221
non-OECD	48	0,1825	0,3256	1,2305	1,1092	-0,3883	7,2888
N.America	48	0,2867	0,2033	0,7842	0,8855	-0,0242	1,1233
S.America	48	0,4476	0,7345	1,8879	1,3740	-0,5469	0,5304
Africa	48	0,0768	-0,2171	2,4714	1,5720	0,5375	2,0799
Asia	48	-0,0017	0,0870	1,5558	1,2473	-1,0021	13,7085
Europe	48	0,1460	0,2183	0,6785	0,8237	-0,2170	1,9913
Oceania	48	0,2780	0,2234	2,2451	1,4983	-0,2492	1,5906
				CPI avg			
Global	46	4.2906	1.4556	481.226	21.9369	5.4735	34.479
OECD	46	4.7201	0.3093	1015.88	31.8729	5.6967	36.3475
non-OECD	48	3,2291	2,0792	179,405	13,3942	3,00985	16,1781
N.America	48	0,2746	0,7749	23,2209	4,8188	-1,5040	5,5262
S.America	48	0,4704	0,8017	50,5919	7,1128	-0,5098	2,7213
Africa	48	0,0915	0,3361	133,606	11,5588	-1,2942	6,0509
Asia	48	6,2522	0,5381	1409,49	37,5432	3,2229	15,9446
Europe	46	7.04586	0.4537	2338.34	48.3564	6.1786	40.7128
Oceania	48	0,0012	-0,0454	16,6487	4,0802	-0,4227	0,9394

Table 2 Descriptive Statistic for 1900-1947 period

Note: 1923-24 years are excluded from the CPI analysis for the first sub-period (1900-1947) because of German hyperinflation. The removal concerns Global, OECD, and Europe country categories as Germany is included in all three country categories. 1923-1924 years are included in the full- period analysis.

Summary Statistics (1948-2011)	**Count**	**Average**	**Median**	**Variance**	**Standard deviation**	**Skewness**	**Excess Kurtosis**
			GDP avg				
Global	64	1,3697	1,2314	1,2123	1,1010	0,1866	2,9528
OECD	64	1,2724	1,4015	0,98241	0,9911	-2,4851	12,7542
non-OECD	64	1,5129	1,0962	3,0476	1,7457	1,5252	2,8032
N.America	64	1,1403	1,33	1,8247	1,3508	-1,5976	5,4020
S.America	64	1,2719	1,4516	5,5032	2,3459	-0,1627	0,4275
Africa	64	1,2357	1,1464	1,8913	1,3752	0,6257	1,2026
Asia	64	1,6909	1,2108	2,9084	1,7054	1,4899	3,6446
Europe	64	1,2715	1,4133	1,1395	1,0674	-2,4724	12,0571
Oceania	64	1,0489	1,0990	1,5155	1,2310	-0,3231	-0,2004
			Consumption avg				
Global	63	1,2904	1,2353	0,7286	0,8536	0,3900	1,5364
OECD	63	1,1679	1,3258	0,7791	0,8826	-1,2319	2,8488
non-OECD	63	1,4684	1,0738	3,0761	1,7539	2,2426	7,8820
N.America	63	1,2234	1,2678	2,1295	1,4593	0,5543	6,0475
S.America	63	1,2199	1,3520	5,8431	2,4172	-0,1704	0,4390
Africa	63	1,2096	1,1321	2,6578	1,6303	1,4851	5,0240
Asia	63	1,6516	1,1991	3,1541	1,7759	2,8982	14,8679
Europe	63	1,0849	1,2412	1,9962	1,4128	-3,9365	22,1526
Oceania	63	1,1482	1,2512	2,8340	1,6834	0,9445	3,4885
			CPI				
Global	64	-0,6824	0,2298	1988,01	44,5872	-3,3377	29,5302
OECD	64	-0,3603	-0,3433	13,6283	3,6916	1,4671	6,9752
non-OECD	64	-1,0775	0,7905	13007,2	114,049	-3,3179	29,6916
N.America	64	-0,1678	-0,0460	34,1692	5,8454	-1,8213	12,1897
S.America	64	-0,1461	0,6762	67516,3	259,839	-3,3827	30,3235
Africa	64	0,0865	0,1575	7,5868	2,7544	-0,2009	0,7666
Asia	64	-2,2961	-0,5708	284,486	16,8667	-0,8740	13,1081
Europe	64	-0,2710	-0,0786	6,7349	2,5951	-0,4427	4,6133
Oceania	64	0,0022	0,0521	7,22317	2,6876	0,0124	2,97

Table 3 Descriptive Statistic for the 1948-2011 period for GDP, Consumption and CPI

Note: The data for pc C ends in 2010 for the second sub-period. Stock price index, long term government bond, net import and real exchange data are already present in the full period descriptive statistics as the data for those variables are available from the second sub-period.

APPENDIX 4 CORRELATION MATRIX

Correlation the full period							
			Global				
	GDP avg	C avg	CPI avg	Stock PI avg	LT GVNT Bond Yield avg	Net Import avg	FX avg
GDP avg	1	0.9285	-0.0171	0.0596	0.1304	-0.0281	-0.5217
p-value		0.0000	0.8578	0.6480	0.3164	0.8371	0.0005
C avg	0.9285	1	-0.0235	0.1498	0.0578	-0.0031	-0.5441
p-value	0.0000		0.8064	0.2532	0.6611	0.9822	0.0003
CPI avg	-0.0171	-0.0235	1	-0.0124	0.2521	0.1084	0.0306
p-value	0.8578	0.8064		0.9247	0.0500	0.4264	0.8493
Stock PI avg	0.0596	0.1498	-0.0124	1	-0.3085	-0.2187	-0.1964
p-value	0.6480	0.2532	0.9247		0.0156	0.1054	0.2183
LT GVNT Bond Yield avg	0.1304	0.0578	0.2521	-0.3085	1	0.3488	-0.1283
p-value	0.3164	0.6611	0.0500	0.0156		0.0084	0.4241
Net Import avg	-0.0281	-0.0031	0.1084	-0.2187	0.3488	1	-0.1282
p-value	0.8371	0.9822	0.4264	0.1054	0.0084		0.4244
FX avg	-0.5217	-0.5441	0.0306	-0.1964	-0.1283	-0.1282	1
p-value	0.0005	0.0003	0.8493	0.2183	0.4241	0.4244	
			OECD				
	GDP avg	C avg	CPI avg	Stock PI avg	LT GVNT Bond Yield avg	Net Import avg	FX avg
GDP avg	1	0.8057	-0.0050	0.1085	0.1451	0.0914	-0.2627
p-value		0.0000	0.9579	0.4054	0.2645	0.5027	0.0971
C avg	0.8057	1	-0.0314	0.2473	0.0520	0.1340	-0.3173
p-value	0.0000		0.7439	0.0568	0.6932	0.3294	0.0460
CPI avg	-0.0050	-0.0314	1	0.1206	0.1416	-0.0880	-0.3383
p-value	0.9579	0.7439		0.3544	0.2763	0.5189	0.0305
Stock PI avg	0.1085	0.2473	0.1206	1	-0.3699	-0.0179	-0.2577
p-value	0.4054	0.0568	0.3544		0.0033	0.8956	0.1038
LT GVNT Bond Yield avg	0.1451	0.0520	0.1416	-0.3699	1	0.1589	-0.0907
p-value	0.2645	0.6932	0.2763	0.0033		0.2422	0.5728
Net Import avg	0.0914	0.1340	-0.0880	-0.0179	0.1589	1	-0.2117
p-value	0.5027	0.3294	0.5189	0.8956	0.2422		0.1838
FX avg	-0.2627	-0.3173	-0.3383	-0.2577	-0.0907	-0.2117	1
p-value	0.0971	0.0460	0.0305	0.1038			

Table 1 Correlation matrix for the full data period

Correlation the full period							
				non-OECD			
	GDP avg	C avg	CPI avg	Stock PI avg	LT GVNT Bond Yield avg	Net Import avg	FX avg
GDP avg	1	0.8944	-0.0433	0.1228	-0.1239	0.0080	-0.7083
p-value		0.0000	0.6500	0.4625	0.3722	0.9542	0.0000
C avg	0.8944	1	-0.0818	0.1913	-0.0759	0.0512	-0.6588
p-value	0.0000		0.3932	0.2568	0.5889	0.7158	0.0000
CPI avg	-0.0433	-0.0818	1	-0.1153	-0.0445	0.0035	0.0928
p-value	0.6500	0.3932		0.4907	0.7495	0.9801	0.5640
Stock PI avg	0.1228	0.1913	-0.1153	1	0.1664	-0.1335	-0.2238
p-value	0.4625	0.2568	0.4907		0.3180	0.4243	0.1767
LT GVNT Bond Yiel avg	-0.1239	-0.0759	-0.0445	0.1664	1	0.1463	0.0342
p-value	0.3722	0.5889	0.7495	0.3180		0.2912	0.8320
Net Import avg	0.0080	0.0512	0.0035	-0.1335	0.1463	1	-0.1723
p-value	0.9542	0.7158	0.9801	0.4243	0.2912		0.2815
FX avg	-0.7083	-0.6588	0.0928	-0.2238	0.0342	-0.1723	1
p-value	0.0000	0.0000	0.5640	0.1767	0.8320	0.2815	
				North America			
	GDP avg	C avg	CPI avg	Stock PI avg	LT GVNT Bond Yield avg	Net Import avg	FX avg
GDP avg	1	0.7688	-0.0239	-0.1399	0.3618	0.2088	-0.5376
p-value		0.0000	0.8023	0.2823	0.0045	0.1224	0.0003
C avg	0.7688	1	-0.0821	-0.0353	0.1873	0.2129	-0.6007
p-value	0.0000		0.3918	0.7890	0.1555	0.1187	0.0000
CPI avg	-0.0239	-0.0821	1	-0.0790	0.0030	-0.4656	0.3738
p-value	0.8023	0.3918		0.5449	0.9820	0.0003	0.0161
Stock PI avg	-0.1399	-0.0353	-0.0790	1	-0.2206	0.0188	-0.1829
p-value	0.2823	0.7890	0.5449		0.0903	0.8905	0.2523
LT GVNT Bond Yield avg	0.3618	0.1873	0.0030	-0.2206	1	-0.0339	-0.3109
p-value	0.0045	0.1555	0.9820	0.0903		0.8041	0.0479
Net Import avg	0.2088	0.2129	-0.4656	0.0188	-0.0339	1	-0.2159
p-value	0.1224	0.1187	0.0003	0.8905	0.8041		0.1752
FX avg	-0.5376	-0.6007	0.3738	-0.1829	-0.3109	-0.2159	1
p-value	0.0003	0.0000	0.0161	0.2523	0.0479	0.1752	

Table 1 Continued.

Correlation the full period							
				South America			
	GDP avg	C avg	CPI avg	Stock PI avg	LT GVNT Bond Yield avg	Net Import avg	FX avg
GDP avg	1	0.9073	-0.2045	-0.0063	0.3978	0.0791	-0.6447
p-value		0.0000	0.0305	0.9740	0.1270	0.5970	0.0000
C avg	0.9073	1	-0.2549	0.1133	0.4110	0.0138	-0.6627
p-value	0.0000		0.0069	0.5658	0.1280	0.9273	0.0000
CPI avg	-0.2045	-0.2549	1	-0.5334	-0.3003	-0.0188	0.1815
p-value	0.0305	0.0069		0.0029	0.2584	0.9003	0.2560
Stock PI avg	-0.0063	0.1133	-0.5334	1	-0.2208	-0.2219	-0.0481
p-value	0.9740	0.5658	0.0029		0.4112	0.2472	0.8042
LT GVNT Bond Yield avg	0.3978	0.4110	-0.3003	-0.2208	1	0.7307	-0.4869
p-value	0.1270	0.1280	0.2584	0.4112		0.0013	0.0558
Net Import avg	0.0791	0.0138	-0.0188	-0.2219	0.7307	1	0.0215
p-value	0.5970	0.9273	0.9003	0.2472	0.0013		0.8940
FX avg	-0.6447	-0.6627	0.1815	-0.0481	-0.4869	0.0215	1
p-value	0.0000	0.0000	0.2560	0.8042	0.0558	0.8940	
				Africa			
	GDP avg	C avg	CPI avg	Stock PI avg	LT GVNT Bond Yield avg	Net Import avg	FX avg
GDP avg	1	0.7589	-0.0467	0.1513	0.0641	0.0545	-0.1843
p-value		0.0000	0.6251	0.3646	0.6449	0.6983	0.2487
C avg	0.7589	1	0.0624	0.3788	0.1297	-0.0073	-0.0971
p-value	0.0000		0.5150	0.0208	0.3547	0.9587	0.5512
CPI avg	-0.0467	0.0624	1	0.3187	-0.0672	0.0086	-0.1274
p-value	0.6251	0.5150		0.0512	0.6294	0.9512	0.4272
Stock PI avg	0.1513	0.3788	0.3187	1	0.0513	-0.0056	-0.2158
p-value	0.3646	0.0208	0.0512		0.7597	0.9737	0.1933
LT GVNT Bond Yield avg	0.0641	0.1297	-0.0672	0.0513	1	0.0674	0.0252
p-value	0.6449	0.3547	0.6294	0.7597		0.6314	0.8757
Net Import avg	0.0545	-0.0073	0.0086	-0.0056	0.0674	1	-0.0769
p-value	0.6983	0.9587	0.9512	0.9737	0.6314		0.6373
FX avg	-0.1843	-0.0971	-0.1274	-0.2158	0.0252	-0.0769	1
p-value	0.2487	0.5512	0.4272	0.1933	0.8757	0.6373	

Table 1 Continued.

Correlation the full period							
				Asia			
	GDP avg	C avg	CPI avg	Stock PI avg	LT GVNT Bond Yield avg	Net Import avg	FX avg
GDP avg	1	0.8597	-0.1197	0.0850	-0.0472	0.0796	-0.6452
p-value		0.0000	0.2087	0.5413	0.7611	0.5672	0.0000
C avg	0.8597	1	-0.0124	0.0709	-0.0372	0.0934	-0.5689
p-value	0.0000		0.8971	0.6137	0.8130	0.5057	0.0001
CPI avg	-0.1197	-0.0124	1	0.0320	0.1065	0.0127	0.0628
p-value	0.2087	0.8971		0.8184	0.4914	0.9272	0.6967
Stock PI avg	0.0850	0.0709	0.0320	1	-0.1643	-0.1851	-0.1566
p-value	0.5413	0.6137	0.8184		0.2866	0.1803	0.3283
LT GVNT Bond Yield avg	-0.0472	-0.0372	0.1065	-0.1643	1	0.0704	0.0776
p-value	0.7611	0.8130	0.4914	0.2866		0.6499	0.6296
Net Import avg	0.0796	0.0934	0.0127	-0.1851	0.0704	1	-0.4259
p-value	0.5672	0.5057	0.9272	0.1803	0.6499		0.0055
FX avg	-0.6452	-0.5689	0.0628	-0.1566	0.0776	-0.4259	1
p-value	0.0000	0.0001	0.6967	0.3283	0.6296	0.0055	
				Europe			
	GDP avg	C avg	CPI avg	Stock PI avg	LT GVNT Bond Yield avg	Net Import avg	FX avg
GDP avg	1	0.6327	-0.0288	0.2691	0.1820	0.1003	-0.1930
p-value		0.0000	0.7630	0.0491	0.1605	0.4703	0.2267
C avg	0.6327	1	-0.0514	0.2770	0.0299	0.1069	-0.2345
p-value	0.0000		0.5918	0.0446	0.8203	0.4460	0.1453
CPI avg	-0.0288	-0.0514	1	-0.2313	0.3625	0.0870	-0.0746
p-value	0.7630	0.5918		0.0924	0.0041	0.5314	0.6429
Stock PI avg	0.2691	0.2770	-0.2313	1	-0.3532	0.0303	-0.3262
p-value	0.0491	0.0446	0.0924		0.0088	0.8278	0.0374
LT GVNT Bond Yield avg	0.1820	0.0299	0.3625	-0.3532	1	0.1588	-0.0717
p-value	0.1605	0.8203	0.0041	0.0088		0.2513	0.6559
Net Import avg	0.1003	0.1069	0.0870	0.0303	0.1588	1	-0.3407
p-value	0.4703	0.4460	0.5314	0.8278	0.2513		0.0293
FX avg	-0.1930	-0.2345	-0.0746	-0.3262	-0.0717	-0.3407	1
p-value	0.2267	0.1453	0.6429	0.0374	0.6559	0.0293	

Table 1 Continued.

Correlation the full period							
				Oceania			
	GDP avg	C avg	CPI avg	Stock PI avg	LT GVNT Bond Yield avg	Net Import avg	FX avg
GDP avg	1	0.6447	0.0441	0.0080	0.2663	0.1073	-0.0845
p-value		0.0000	0.6446	0.9616	0.0924	0.4398	0.5995
C avg	0.6447	1	0.2244	0.0768	0.2232	0.0562	-0.2313
p-value	0.0000		0.0179	0.6468	0.1662	0.6896	0.1510
CPI avg	0.0441	0.2244	1	-0.2617	0.2397	0.0674	-0.1115
p-value	0.6446	0.0179		0.1075	0.1312	0.6281	0.4877
Stock PI avg	0.0080	0.0768	-0.2617	1	0.0814	-0.1497	-0.0553
p-value	0.9616	0.6468	0.1075		0.6221	0.3632	0.7379
LT GVNT Bond Yield avg	0.2663	0.2232	0.2397	0.0814	1	0.0411	-0.0594
p-value	0.0924	0.1662	0.1312	0.6221		0.7987	0.7122
Net Import avg	0.1073	0.0562	0.0674	-0.1497	0.0411	1	0.0418
p-value	0.4398	0.6896	0.6281	0.3632	0.7987		0.7955
FX avg	-0.0845	-0.2313	-0.1115	-0.0553	-0.0594	0.0418	1
p-value	0.5995	0.1510	0.4877	0.7379	0.7122	0.7955	

Table 1 Continued.

Correlation 1900-1947 period			
	Global		
	GDP avg	C avg	CPI avg
GDP avg	1	0.8369	0.1378
p-value		0.0000	0.3610
C avg	0.8369	1	0.1067
p-value	0.0000		0.4805
CPI avg	0.1378	0.1067	1
p-value	0.3610	0.4805	
	OECD		
	GDP avg	C avg	CPI avg
GDP avg	1	0.6582	-0.0026
p-value		0.0000	0.9865
C avg	0.6582	1	-0.0298
p-value	0.0000		0.8442
CPI avg	-0.0026	-0.0298	1
p-value	0.9865	0.8442	
	non-OECD		
	GDP avg	C avg	CPI avg
GDP avg	1	0.6698	0.2883
p-value		0.0000	0.0469
C avg	0.6698	1	0.4349
p-value	0.0000		0.0020
CPI avg	0.2883	0.4349	1
p-value	0.0469	0.0020	
	North America		
	GDP avg	C avg	CPI avg
GDP avg	1	0.5401	0.3476
p-value		0.0001	0.0155
C avg	0.5401	1	0.3023
p-value	0.0001		0.0368
CPI avg	0.3476	0.3023	1
p-value	0.0155	0.0368	

Table 2 Correlation matrix for the first sub-period (1900-1947)

Note: 1923-24 years are excluded from the CPI analysis for the first sub-period because of German hyperinflation. The removal applies to Global, OECD, and Europe country categories as Germany is included in three country categories.

South America			
	GDP avg	C avg	CPI avg
GDP avg	1	0.7557	0.0056
p-value		0.0000	0.9697
C avg	0.7557	1	-0.0650
p-value	0.0000		0.6609
CPI avg	0.0056	-0.0650	1
p-value	0.9697	0.6609	
Africa			
	GDP avg	C avg	CPI avg
GDP avg	1	0.6513	-0.1148
p-value		0.0000	0.4373
C avg	0.6513	1	0.0812
p-value	0.0000		0.5830
CPI avg	-0.1148	0.0812	1
p-value	0.4373	0.5830	
Asia			
	GDP avg	C avg	CPI avg
GDP avg	1	0.5166	-0.1186
p-value		0.0002	0.4221
C avg	0.5166	1	0.2121
p-value	0.0002		0.1478
CPI avg	-0.1186	0.2121	1
p-value	0.4221	0.1478	
Europe			
	GDP avg	C avg	CPI avg
GDP avg	1	0.6592	0.1513
p-value		0.0000	0.3156
C avg	0.6592	1	0.1826
p-value	0.0000		0.2244
CPI avg	0.1513	0.1826	1
p-value	0.3156	0.2244	
Oceania			
	GDP avg	C avg	CPI avg
GDP avg	1	0.5272	0.1490
p-value		0.0001	0.3122
C avg	0.5272	1	0.3648
p-value	0.0001		0.0108
CPI avg	0.1490	0.3648	1
p-value	0.3122	0.0108	

Table 2 Continued.

Correlation 1948-2011

	GDP avg	C avg	CPI avg	Stock PI avg	LT GVNT Bond Yield avg	Net Import avg	FX avg
Global							
GDP avg	1	0.9426	0.0375	0.0596	0.1304	-0.0281	-0.5217
p-value		0.0000	0.7688	0.6480	0.3164	0.8371	0.0005
C avg	0.9426	1	-0.0561	0.1498	0.0578	-0.0031	-0.5441
p-value	0.0000		0.6621	0.2532	0.6611	0.9822	0.0003
CPI avg	0.0375	-0.0561	1	-0.0124	0.2521	0.1084	0.0306
p-value	0.7688	0.6621		0.9247	0.0500	0.4264	0.8493
Stock PI avg	0.0596	0.1498	-0.0124	1	-0.3085	-0.2187	-0.1964
p-value	0.6480	0.2532	0.9247		0.0156	0.1054	0.2183
LT GVNT Bond Yield avg	0.1304	0.0578	0.2521	-0.3085	1	0.3488	-0.1283
p-value	0.3164	0.6611	0.0500	0.0156		0.0084	0.4241
Net Import avg	-0.0281	-0.0031	0.1084	-0.2187	0.3488	1	-0.1282
p-value	0.8371	0.9822	0.4264	0.1054	0.0084		0.4244
FX avg	-0.5217	-0.5441	0.0306	-0.1964	-0.1283	-0.1282	1
p-value	0.0005	0.0003	0.8493	0.2183	0.4241	0.4244	
OECD							
	GDP avg	C avg	CPI avg	Stock PI avg	LT GVNT Bond Yield avg	Net Import avg	FX avg
GDP avg	1	0.7545	0.2298	0.1085	0.1451	0.0914	-0.2627
p-value		0.0000	0.0678	0.4054	0.2645	0.5027	0.0971
C avg	0.7545	1	0.1836	0.2473	0.0520	0.1340	-0.3173
p-value	0.0000		0.1498	0.0568	0.6932	0.3294	0.0460
CPI avg	0.2298	0.1836	1	0.1206	0.1416	-0.0880	-0.3383
p-value	0.0678	0.1498		0.3544	0.2763	0.5189	0.0305
Stock PI avg	0.1085	0.2473	0.1206	1	-0.3699	-0.0179	-0.2577
p-value	0.4054	0.0568	0.3544		0.0033	0.8956	0.1038
LT GVNT Bond Yield avg	0.1451	0.0520	0.1416	-0.3699	1	0.1589	-0.0907
p-value	0.2645	0.6932	0.2763	0.0033		0.2422	0.5728
Net Import avg	0.0914	0.1340	-0.0880	-0.0179	0.1589	1	-0.2117
p-value	0.5027	0.3294	0.5189	0.8956	0.2422		0.1838
FX avg	-0.2627	-0.3173	-0.3383	-0.2577	-0.0907	-0.2117	1
p-value	0.0971	0.0460	0.0305	0.1038	0.5728	0.1838	
non-OECD							
	GDP avg	C avg	CPI avg	Stock PI avg	LT GVNT Bond Yield avg	Net Import avg	FX avg
GDP avg	1	0.9298	-0.0531	0.1228	-0.1239	0.0080	-0.7083
p-value		0.0000	0.6772	0.4625	0.3722	0.9542	0.0000
C avg	0.9298	1	-0.1142	0.1913	-0.0759	0.0512	-0.6588
p-value	0.0000		0.3727	0.2568	0.5889	0.7158	0.0000
CPI avg	-0.0531	-0.1142	1	-0.1153	-0.0445	0.0035	0.0928
p-value	0.6772	0.3727		0.4907	0.7495	0.9801	0.5640
Stock PI avg	0.1228	0.1913	-0.1153	1	0.1664	-0.1335	-0.2238
p-value	0.4625	0.2568	0.4907		0.3180	0.4243	0.1767
LT GVNT Bond Yield avg	-0.1239	-0.0759	-0.0445	0.1664	1	0.1463	0.0342
p-value	0.3722	0.5889	0.7495	0.3180		0.2912	0.8320

Table 3 Correlation matrix for the second sub-period (1948-2011).

Correlation 1948-2011							
				non-OECD			
	GDP avg	C avg	CPI avg	Stock PI avg	LT GVNT Bond Yield avg	Net Import avg	FX avg
Net Import avg	0.0080	0.0512	0.0035	-0.1335	0.1463	1	-0.1723
p-value	0.9542	0.7158	0.9801	0.4243	0.2912		0.2815
FX avg	-0.7083	-0.6588	0.0928	-0.2238	0.0342	-0.1723	1
p-value	0.0000	0.0000	0.5640	0.1767	0.8320	0.2815	
				North America			
	GDP avg	C avg	CPI avg	Stock PI avg	LT GVNT Bond Yield avg	Net Import avg	FX avg
GDP avg	1	0.8096	-0.1729	-0.1399	0.3618	0.2088	-0.5376
p-value		0.0000	0.1720	0.2823	0.0045	0.1224	0.0003
C avg	0.8096	1	-0.2138	-0.0353	0.1873	0.2129	-0.6007
p-value	0.0000		0.0924	0.7890	0.1555	0.1187	0.0000
CPI avg	-0.1729	-0.2138	1	-0.0790	0.0030	-0.4656	0.3738
p-value	0.1720	0.0924		0.5449	0.9820	0.0003	0.0161
Stock PI avg	-0.1399	-0.0353	-0.0790	1	-0.2206	0.0188	-0.1829
p-value	0.2823	0.7890	0.5449		0.0903	0.8905	0.2523
LT GVNT Bond Yield avg	0.3618	0.1873	0.0030	-0.2206	1	-0.0339	-0.3109
p-value	0.0045	0.1555	0.9820	0.0903		0.8041	0.0479
Net Import avg	0.2088	0.2129	-0.4656	0.0188	-0.0339	1	-0.2159
p-value	0.1224	0.1187	0.0003	0.8905	0.8041		0.1752
FX avg	-0.5376	-0.6007	0.3738	-0.1829	-0.3109	-0.2159	1
p-value	0.0003	0.0000	0.0161	0.2523	0.0479	0.1752	
				South America			
	GDP avg	C avg	CPI avg	Stock PI avg	LT GVNT Bond Yield avg	Net Import avg	FX avg
GDP avg	1	0.9376	-0.2270	-0.0063	0.3978	0.0791	-0.6447
p-value		0.0000	0.0712	0.9740	0.1270	0.5970	0.0000
C avg	0.9376	1	-0.2884	0.1133	0.4110	0.0138	-0.6627
p-value	0.0000		0.0219	0.5658	0.1280	0.9273	0.0000
CPI avg	-0.2270	-0.2884	1	-0.5334	-0.3003	-0.0188	0.1815
p-value	0.0712	0.0219		0.0029	0.2584	0.9003	0.2560
Stock PI avg	-0.0063	0.1133	-0.5334	1	-0.2208	-0.2219	-0.0481
p-value	0.9740	0.5658	0.0029		0.4112	0.2472	0.8042
LT GVNT Bond Yield avg	0.3978	0.4110	-0.3003	-0.2208	1	0.7307	-0.4869
p-value	0.1270	0.1280	0.2584	0.4112		0.0013	0.0558
Net Import avg	0.0791	0.0138	-0.0188	-0.2219	0.7307	1	0.0215
p-value	0.5970	0.9273	0.9003	0.2472	0.0013		0.8940
FX avg	-0.6447	-0.6627	0.1815	-0.0481	-0.4869	0.0215	1
p-value	0.0000	0.0000	0.2560	0.8042	0.0558	0.8940	

Table 3 Continued.

Correlation 1948-2011							
				Africa			
	GDP avg	C avg	CPI avg	Stock PI avg	LT GVNT Bond Yield avg	Net Import avg	FX avg
GDP avg	1	0.7777	0.1018	0.1513	0.0641	0.0545	-0.1843
p-value		0.0000	0.4235	0.3646	0.6449	0.6983	0.2487
C avg	0.7777	1	0.0752	0.3788	0.1297	-0.0073	-0.0971
p-value	0.0000		0.5582	0.0208	0.3547	0.9587	0.5512
CPI avg	0.1018	0.0752	1	0.3187	-0.0672	0.0086	-0.1274
p-value	0.4235	0.5582		0.0512	0.6294	0.9512	0.4272
Stock PI avg	0.1513	0.3788	0.3187	1	0.0513	-0.0056	-0.2158
p-value	0.3646	0.0208	0.0512		0.7597	0.9737	0.1933
LT GVNT Bond Yield avg	0.0641	0.1297	-0.0672	0.0513	1	0.0674	0.0252
p-value	0.6449	0.3547	0.6294	0.7597		0.6314	0.8757
Net Import avg	0.0545	-0.0073	0.0086	-0.0056	0.0674	1	-0.0769
p-value	0.6983	0.9587	0.9512	0.9737	0.6314		0.6373
FX avg	-0.1843	-0.0971	-0.1274	-0.2158	0.0252	-0.0769	1
p-value	0.2487	0.5512	0.4272	0.1933	0.8757	0.6373	
				Asia			
	GDP avg	C avg	CPI avg	Stock PI avg	LT GVNT Bond Yield avg	Net Import avg	FX avg
GDP avg	1	0.9108	-0.0188	0.0850	-0.0472	0.0796	-0.6452
p-value		0.0000	0.8826	0.5413	0.7611	0.5672	0.0000
C avg	0.9108	1	-0.0789	0.0709	-0.0372	0.0934	-0.5689
p-value	0.0000		0.5390	0.6137	0.8130	0.5057	0.0001
CPI avg	-0.0188	-0.0789	1	0.0320	0.1065	0.0127	0.0628
p-value	0.8826	0.5390		0.8184	0.4914	0.9272	0.6967
Stock PI avg	0.0850	0.0709	0.0320	1	-0.1643	-0.1851	-0.1566
p-value	0.5413	0.6137	0.8184		0.2866	0.1803	0.3283
LT GVNT Bond Yield avg	-0.0472	-0.0372	0.1065	-0.1643	1	0.0704	0.0776
p-value	0.7611	0.8130	0.4914	0.2866		0.6499	0.6296
Net Import avg	0.0796	0.0934	0.0127	-0.1851	0.0704	1	-0.4259
p-value	0.5672	0.5057	0.9272	0.1803	0.6499		0.0055
FX avg	-0.6452	-0.5689	0.0628	-0.1566	0.0776	-0.4259	1
p-value	0.0000	0.0001	0.6967	0.3283	0.6296	0.0055	
				Europe			
	GDP avg	C avg	CPI avg	Stock PI avg	LT GVNT Bond Yield avg	Net Import avg	FX avg
GDP avg	1	0.5293	0.1811	0.2691	0.1820	0.1003	-0.1930
p-value		0.0000	0.1521	0.0491	0.1605	0.4703	0.2267
C avg	0.5293	1	0.0336	0.2770	0.0299	0.1069	-0.2345
p-value	0.0000		0.7939	0.0446	0.8203	0.4460	0.1453
CPI avg	0.1811	0.0336	1	-0.2313	0.3625	0.0870	-0.0746
p-value	0.1521	0.7939		0.0924	0.0041	0.5314	0.6429
Stock PI avg	0.2691	0.2770	-0.2313	1	-0.3532	0.0303	-0.3262
p-value	0.0491	0.0446	0.0924		0.0088	0.8278	0.0374

Table 3 Continued.

Correlation 1948-2011							
				Europe			
	GDP avg	C avg	CPI avg	Stock PI avg	LT GVNT Bond Yield avg	Net Import avg	FX avg
LT GVNT Bond Yield avg	0.1820	0.0299	0.3625	-0.3532	1	0.1588	-0.0717
p-value	0.1605	0.8203	0.0041	0.0088		0.2513	0.6559
Net Import avg	0.1003	0.1069	0.0870	0.0303	0.1588	1	-0.3407
p-value	0.4703	0.4460	0.5314	0.8278	0.2513		0.0293
FX avg	-0.1930	-0.2345	-0.0746	-0.3262	-0.0717	-0.3407	1
p-value	0.2267	0.1453	0.6429	0.0374	0.6559	0.0293	
				Oceania			
	GDP avg	C avg	CPI avg	Stock PI avg	LT GVNT Bond Yield avg	Net Import avg	FX avg
GDP avg	1	0.6767	-0.0645	0.0080	0.2663	0.1073	-0.0845
p-value		0.0000	0.6124	0.9616	0.0924	0.4398	0.5995
C avg	0.6767	1	0.1154	0.0768	0.2232	0.0562	-0.2313
p-value	0.0000		0.3677	0.6468	0.1662	0.6896	0.1510
CPI avg	-0.0645	0.1154	1	-0.2617	0.2397	0.0674	-0.1115
p-value	0.6124	0.3677		0.1075	0.1312	0.6281	0.4877
Stock PI avg	0.0080	0.0768	-0.2617	1	0.0814	-0.1497	-0.0553
p-value	0.9616	0.6468	0.1075		0.6221	0.3632	0.7379
LT GVNT Bond Yield avg	0.2663	0.2232	0.2397	0.0814	1	0.0411	-0.0594
p-value	0.0924	0.1662	0.1312	0.6221		0.7987	0.7122
Net Import avg	0.1073	0.0562	0.0674	-0.1497	0.0411	1	0.0418
p-value	0.4398	0.6896	0.6281	0.3632	0.7987		0.7955
FX avg	-0.0845	-0.2313	-0.1115	-0.0553	-0.0594	0.0418	1
p-value	0.5995	0.1510	0.4877	0.7379	0.7122	0.7955	

Table 3 Continued.

APPENDIX 5 LOGISTIC REGRESSION

Country Category	Parameter(s)	Estimate	Standard Error	Estimated Odds Ratio
Global	GDP avg (dependent variable)	-3.6109	1.0134	
	C avg	20.177	223.61	5.7912E8
OECD	GDP avg (dependent variable)	-1.7346	0.6262	
	FX avg	-15.8315	70.7138	1.3318E-7
non-OECD	GDP avg (dependent variable)	-3.3673	1.0171	
	C avg	5.1591	1.4836	174.0
North America	GDP avg (dependent variable)	-16.397	110.453	
	C avg	51.8598	149.309	3.3299E22
	CPI avg	-13.0772	96.393	2.0925E-6
	LT GVNT Bond Yield avg	27.8648	104.349	1.2633E12
	FX avg	-32.9481	81.4628	4.9071E-15
South America	GDP avg (dependent variable)	-30.5662	95.3467	
	C avg	61.1325	184.638	3.54407E26
Africa	GDP avg (dependent variable)	-9.5825	3.7137	
	C avg	6.1784	2.3640	482.215
	CPI avg	3.2069	1.7567	24.7035
	Net Import avg	3.8149	1.8993	45.3724
	FX avg	3.3629	1.6785	28.874
Asia	GDP avg (dependent variable)	-30.5662	51.2992	
	C avg	61.1325	229.417	3.5441E26
Europe	GDP avg (dependent variable)	-35.0716	72.1692	
	C avg	19.8835	144.34	4.318E8
	Net Import avg	32.299	72.1756	1.0649E14
Oceania	GDP avg (dependent variable)	-41.9743	96.5326	
	C avg	77.1842	116.997	3.3165E33
	CPI avg	-22.535	102.228	1.6338E-10
	Stock PI avg	-45.8975	111.433	1.1667E-20
	LT GVNT Bond Yield avg	22.6976	102.872	7.2015E9

Table 1 Estimated regression models (maximum likelihood) for all country categories.

Country Category	Source	Deviance	Df	P-Value
Global	Model	12.0621	1	0.0005
	Residual	9.2486	38	1.0000
	Total (corr.)	21.3108	39	
Percentage of deviance explained by model = 56.60%				
OECD	Model	4.4023	1	0.0359
	Residual	16.9084	38	0.9988
	Total (corr.)	21.3108	39	
Percentage of deviance explained by model = 20.66%				
non-OECD	Model	21.383	1	0.0000
	Residual	14.5103	35	0.9991
	Total (corr.)	35.8933	36	
Percentage of deviance explained by model = 59.57%				
North America	Model	34.6254	4	0.0000
	Residual	5.4067	35	1.0000
	Total (corr.)	40.0322	39	
Percentage of deviance explained by model = 86.49%				
South America	Model	17.3975	1	0.0000
	Residual	1.5920E-12	13	1.0000
	Total (corr.)	17.3975	14	
Percentage of deviance explained by model = 100%				
Africa	Model	19.3941	4	0.0007
	Residual	19.2396	32	0.9632
	Total (corr.)	38.6337	36	
Percentage of deviance explained by model = 50.20%				
Asia	Model	15.8812	1	0.0001
	Residual	4.2454E-12	38	1.0000
	Total (corr.)	15.8812	39	
Percentage of deviance explained by model = 100%				
Europe	Model	18.4002	2	0.0001
	Residual	7.6064	37	1.0000
	Total (corr.)	26.0066	39	
Percentage of deviance explained by model = 70.75%				
Oceania	Model	36.3065	4	0.0000
	Residual	0.0001	33	1.0000
	Total (corr.)	36.3066	37	
Percentage of deviance explained by model = 99.99%				

Table 2 Analysis of Deviance for all country categories.

Country Category	Predictor(s)	Df	P-Value
Global	C avg	1	0.0005
OECD	FX avg	1	0.0359
non-OECD	C avg	1	0.0000
North America	C avg	1	0.0000
	CPI avg	1	0.0229
	LT GVNT Bond Yield avg	1	0.0079
	FX avg	1	0.0021
South America	C avg	1	0.0000
Africa	C avg	1	0.0001
	CPI avg	1	0.0281
	Net Import avg	1	0.0087
	FX avg	1	0.0152
Asia	C avg	1	0.0001
Europe	C avg	1	0.0004
	Net Import avg	1	0.0042
Oceania	C avg	1	0.0000
	CPI avg	1	0.0339
	Stock PI avg	1	0.0025
	LT GVNT Bond Yield avg	1	0.0339

Table 3 Likelihood Ratio Tests for all country categories.

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APPENDIX 6 ANNUAL CHANGES IN ANALYZED MACRO-FINANCIAL VARIABLES

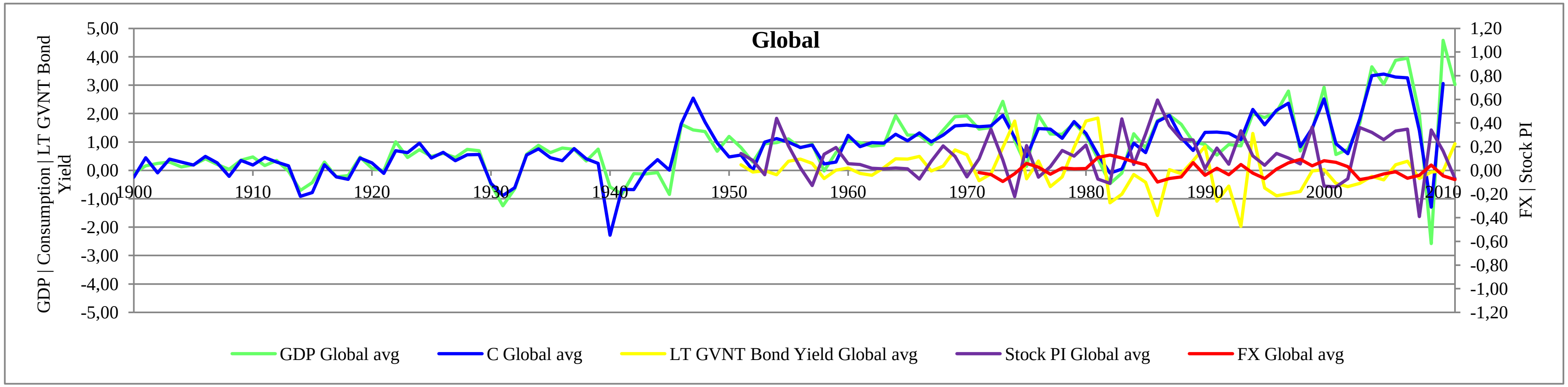


Figure 1 CPI & Net import excluded.

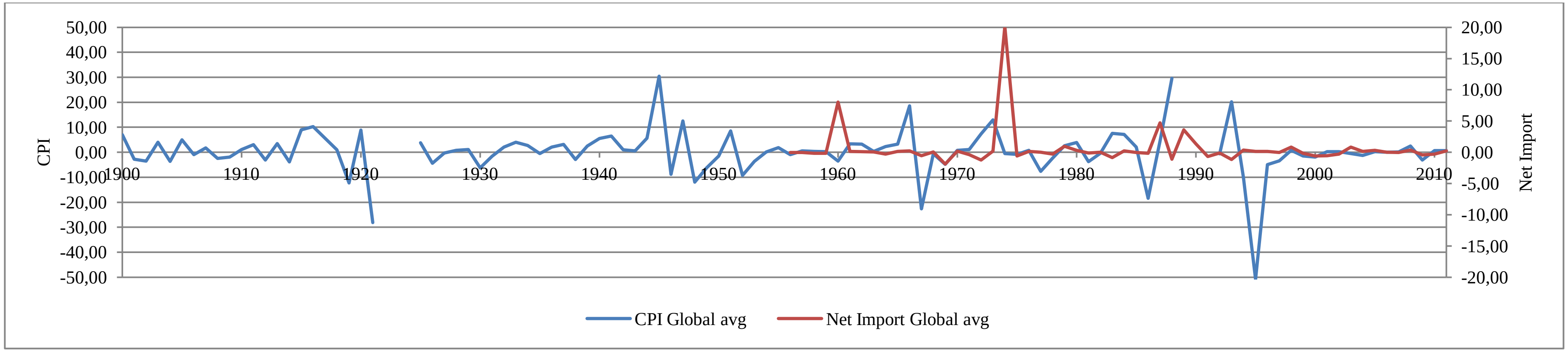


Figure 2 CPI & Net import. 1922-24 (140.28; 5714253947.29; -5714254084.76) & 1989-91 (152.64; 118.34; -286.10) years excluded from CPI.

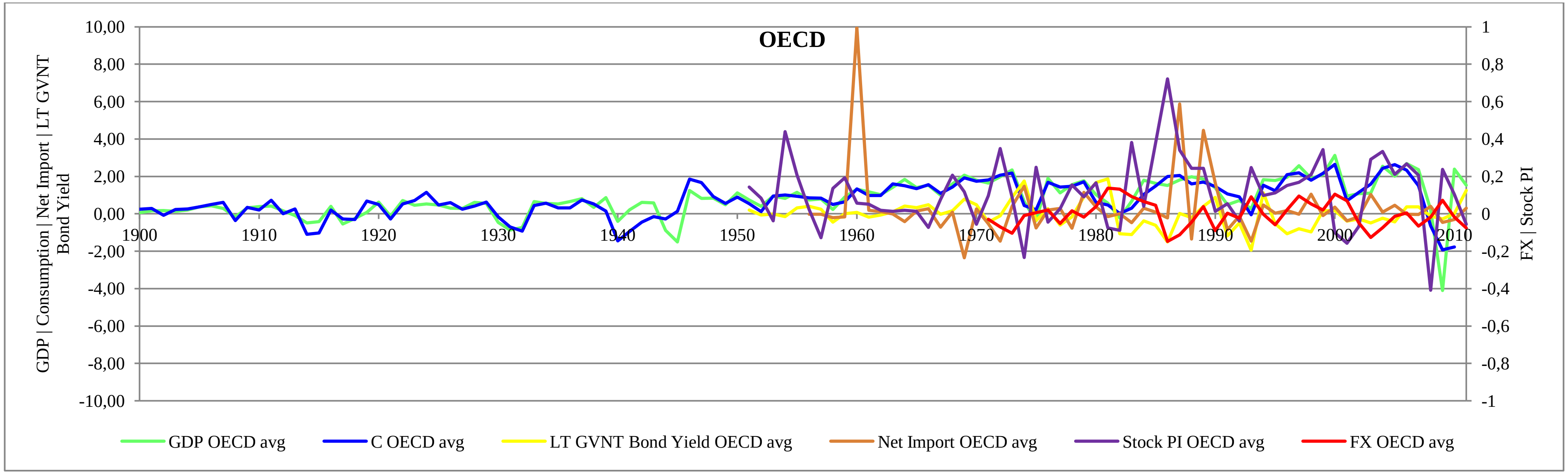


Figure 3 CPI excluded.

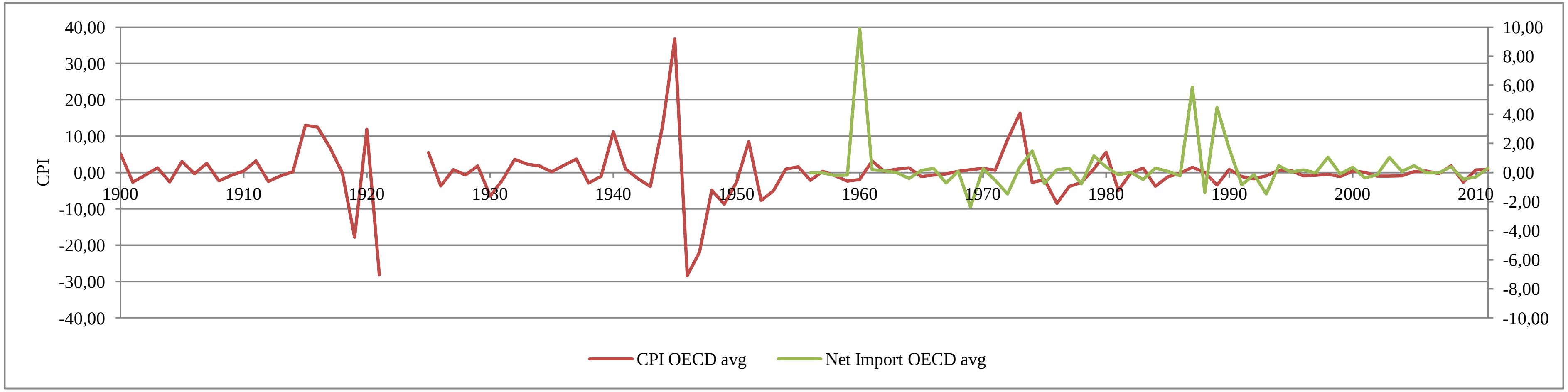


Figure 4 CPI 1922-1924 (204.83; 8457095839.42; -8457096048.25) years excluded.

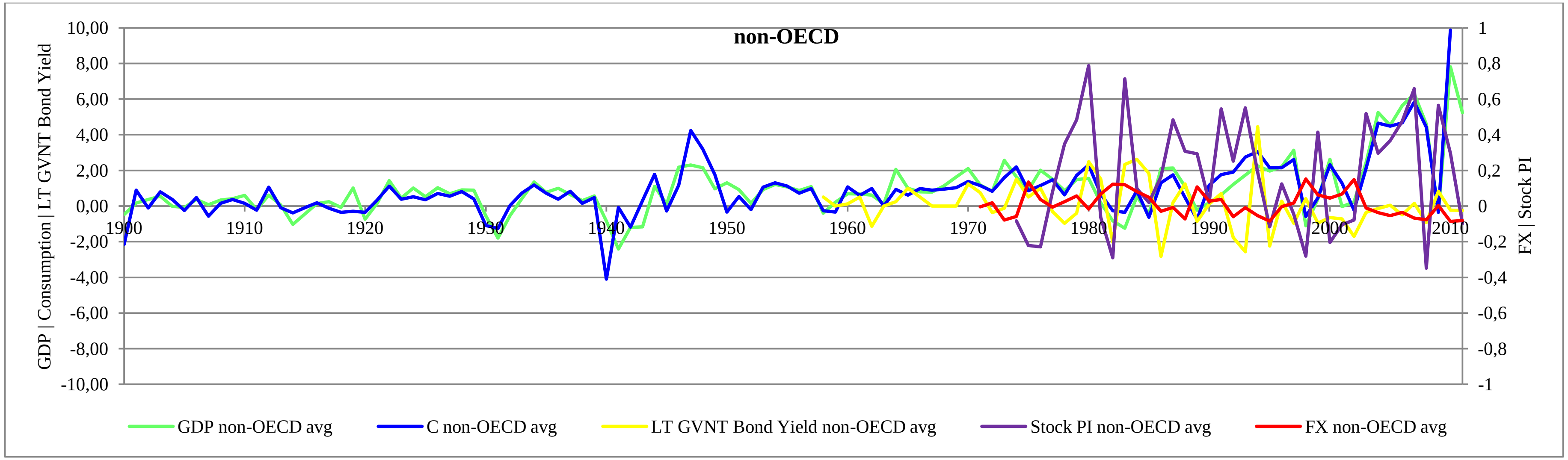


Figure 5 CPI & Net import excluded.

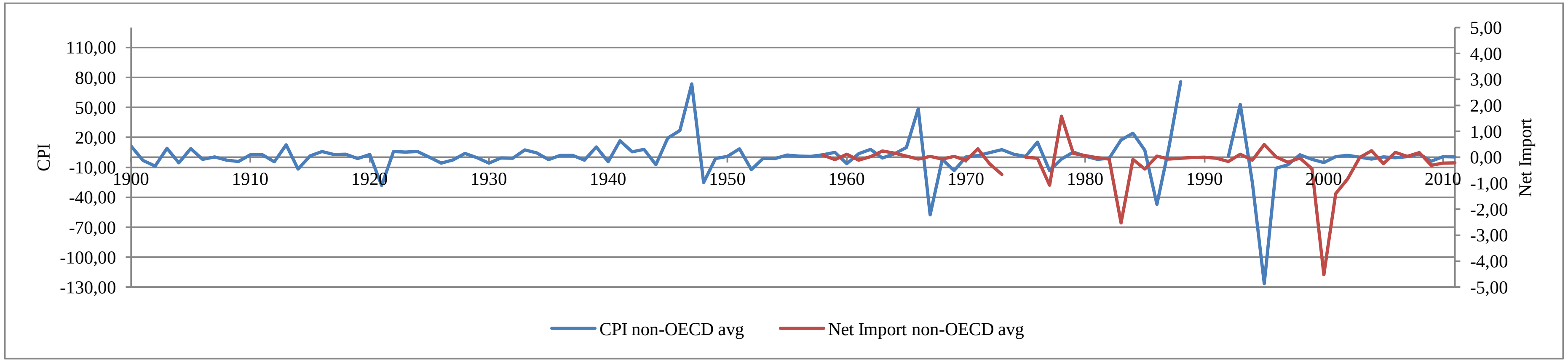


Figure 6 CPI: 1989-1991(369.52; 301.88; -731.41) years excluded; Net import: 1974 (97.84) year excluded.

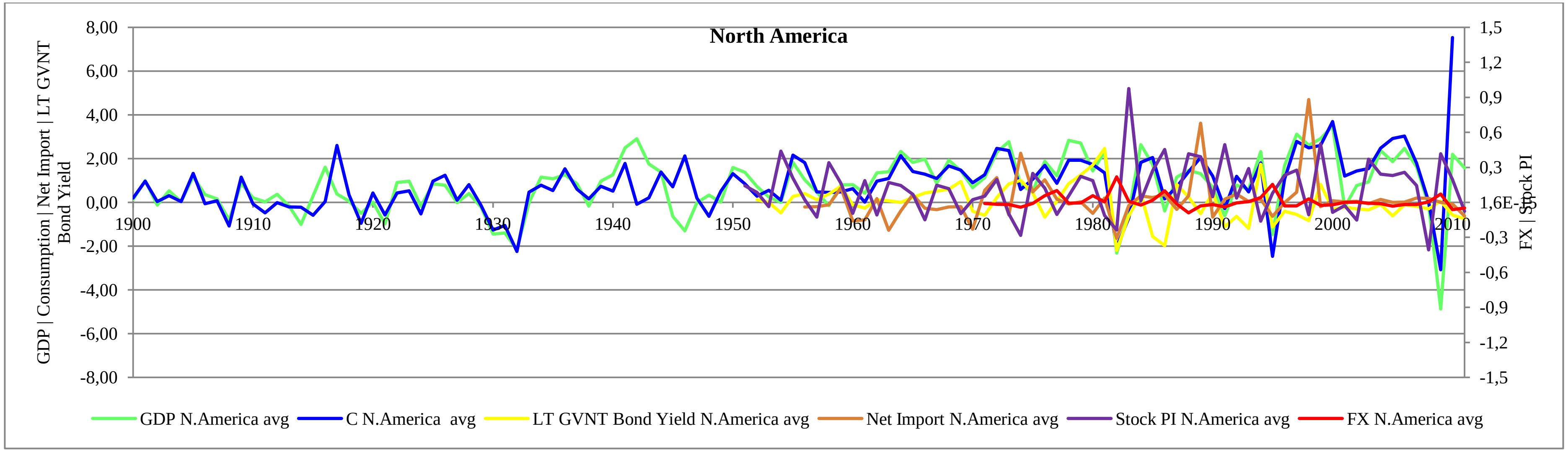


Figure 7 CPI excluded.

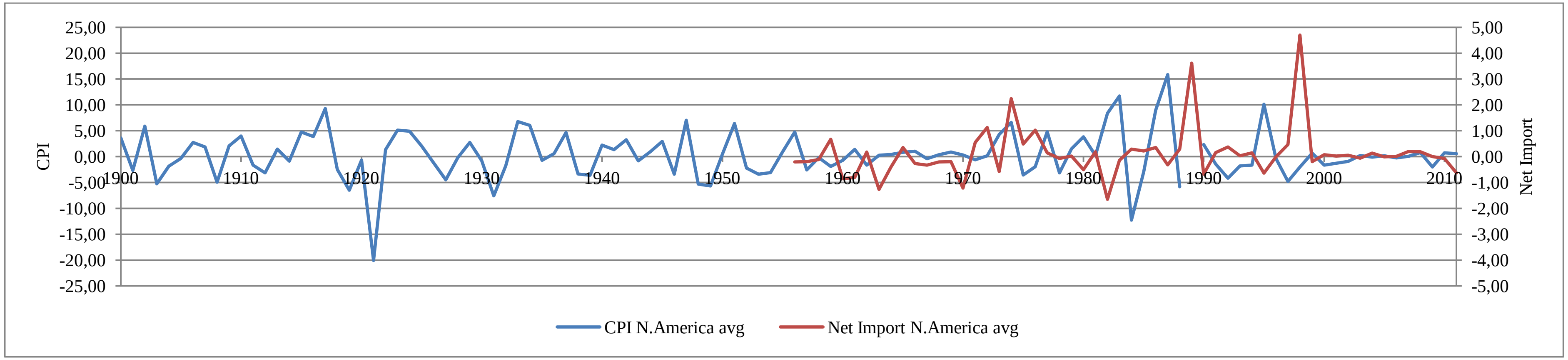


Figure 8 CPI: 1989 (-30.84) year excluded.

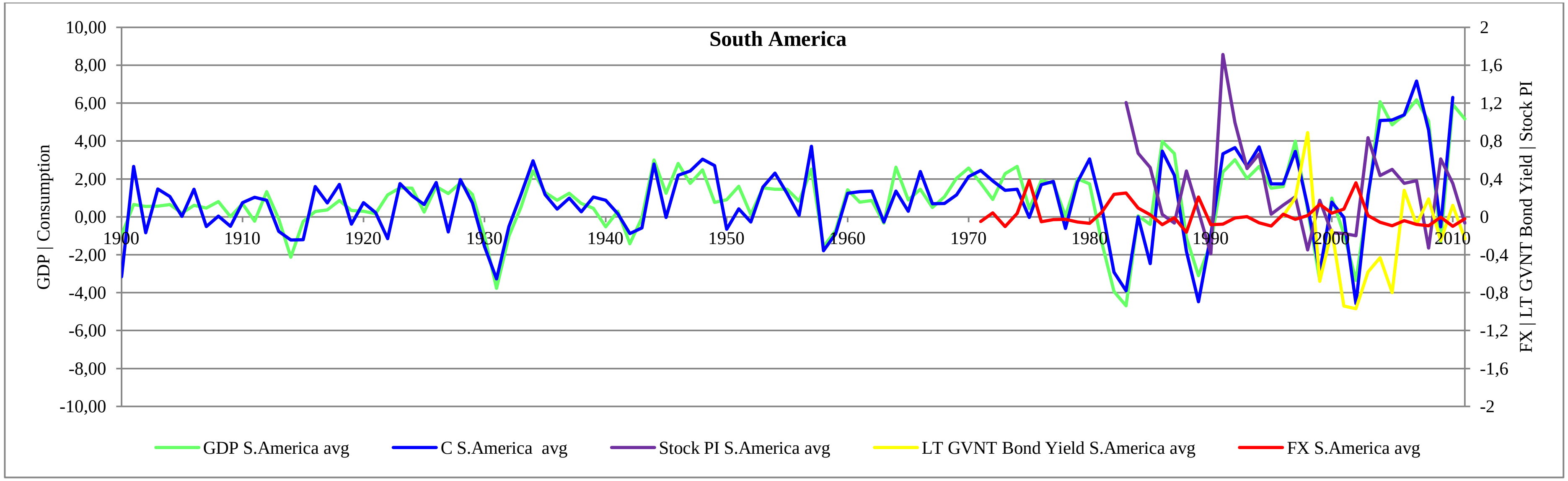


Figure 9 CPI & Net import excluded.

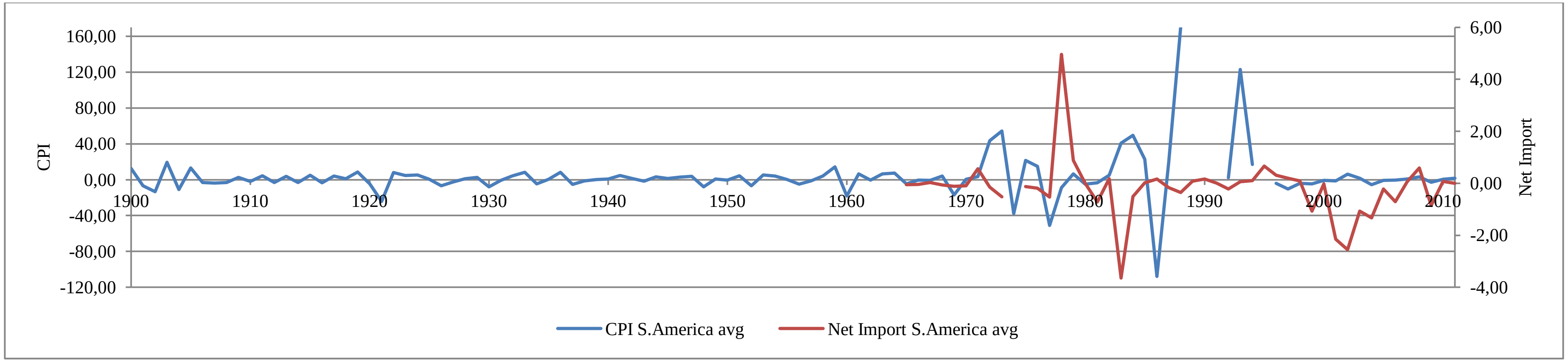


Figure 10 CPI: 1989-91 (907.03; 690.33; -1672.73); 1995 (-289.86) years excluded; Net import 1974(293.67) year excluded.

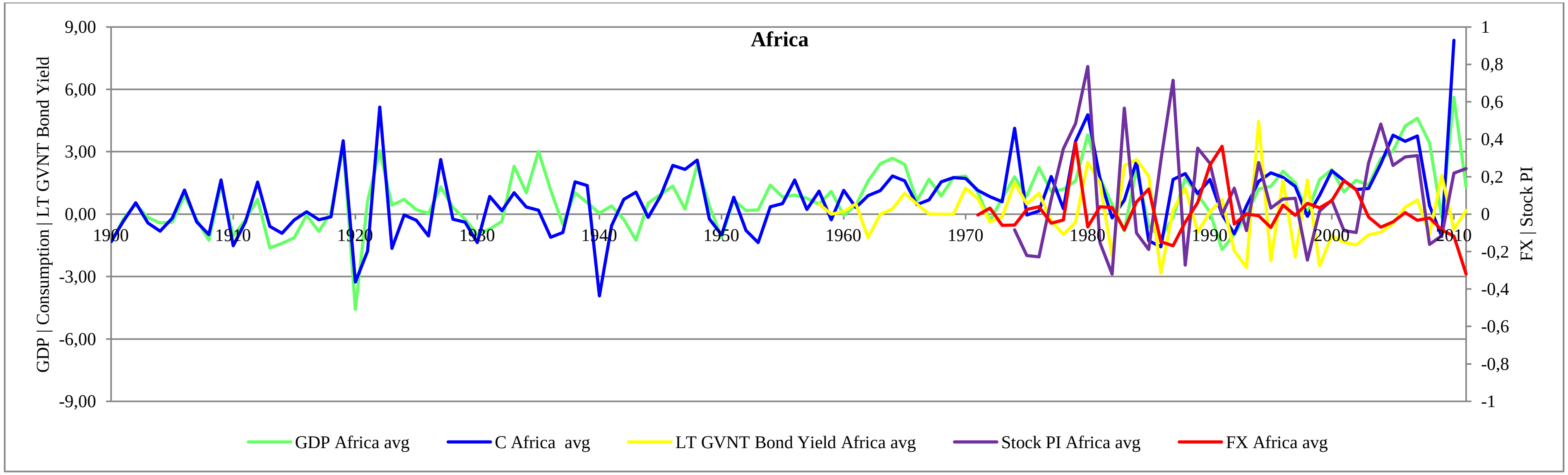


Figure 11 CPI & Net import excluded.

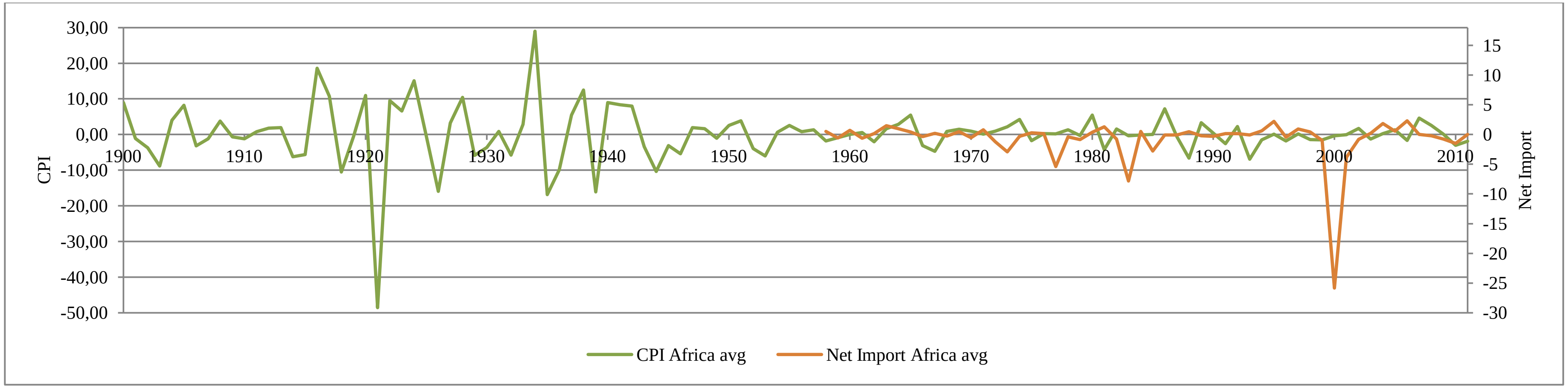


Figure 12 CPI & Net import: full period.

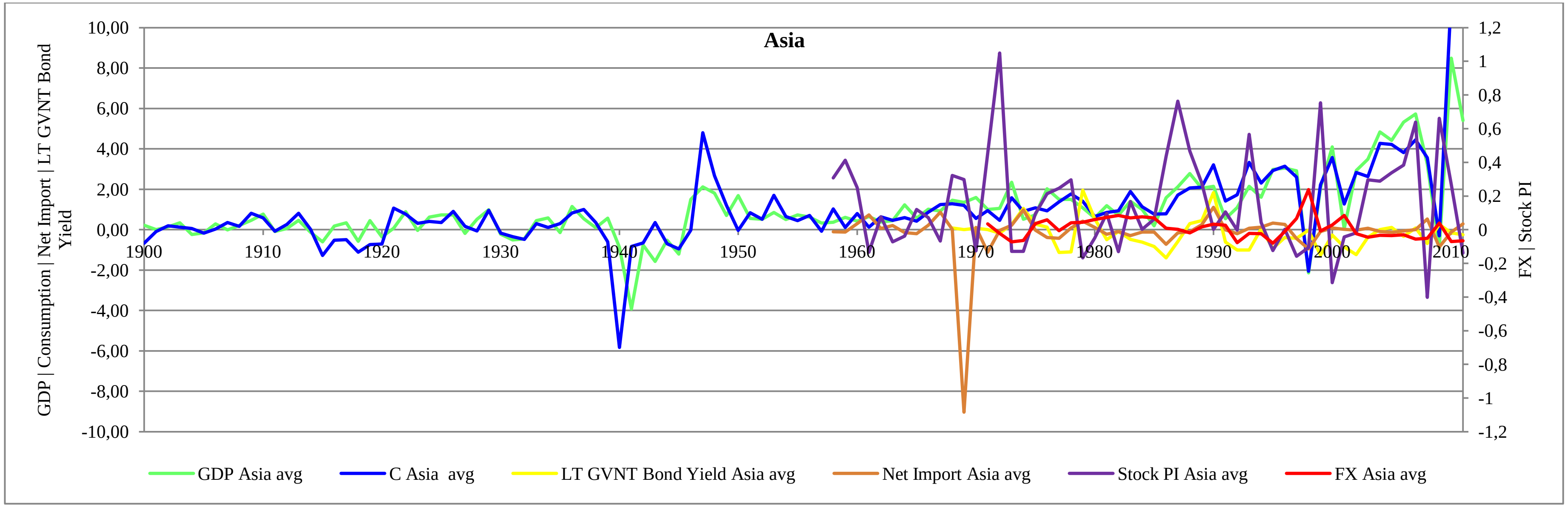


Figure 13 CPI excluded.

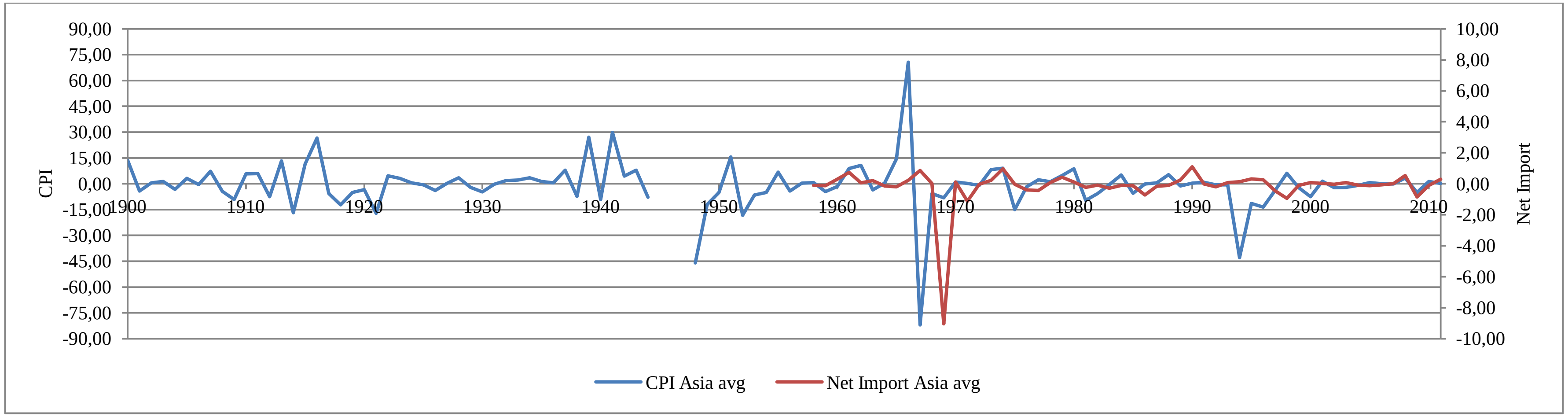


Figure 14 CPI: 1945 (192.39) & 1947 (135.85) years excluded.

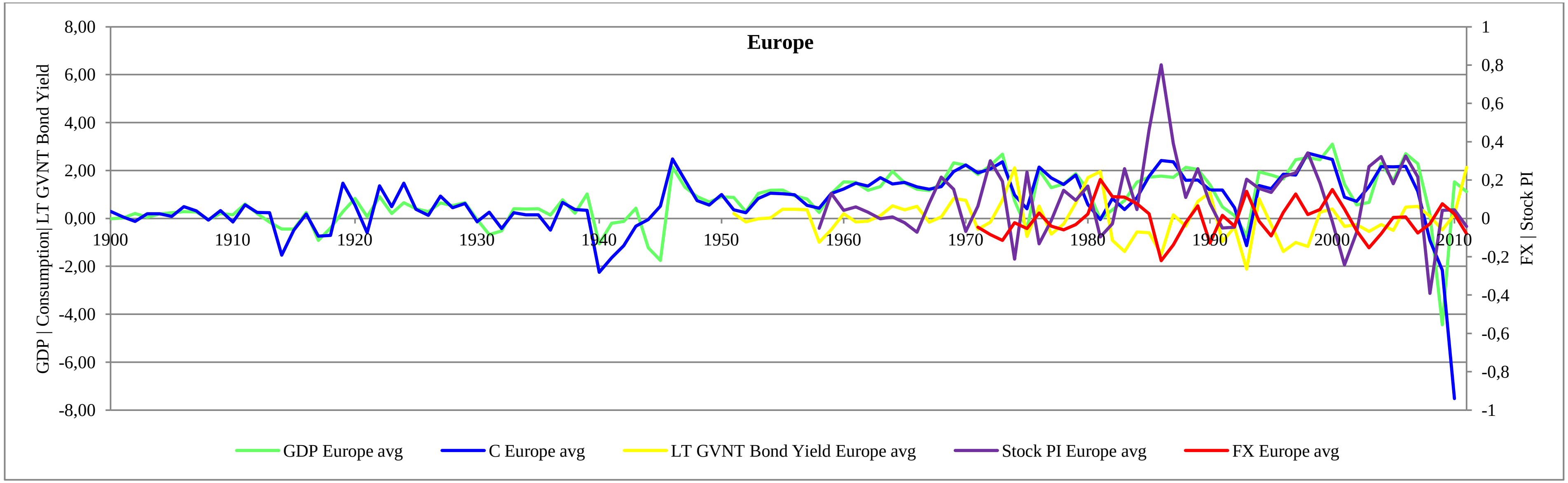


Figure 15 CPI & Net import excluded.

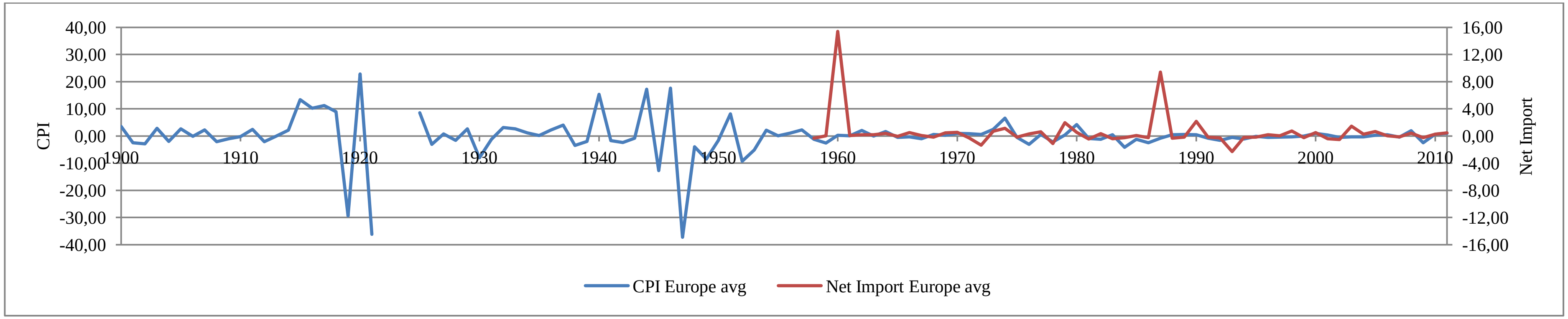


Figure 16 CPI 1922-24 (318.82; 13214212247.09; -13214212576.91) years excluded.

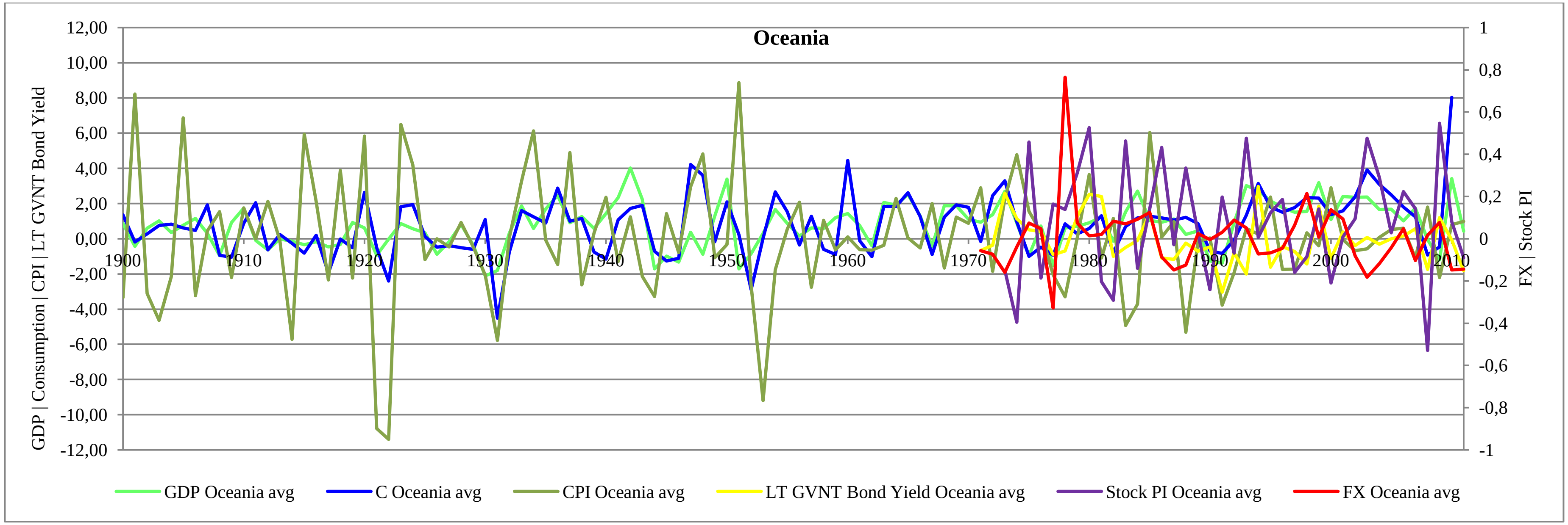


Figure 17 Net import excluded

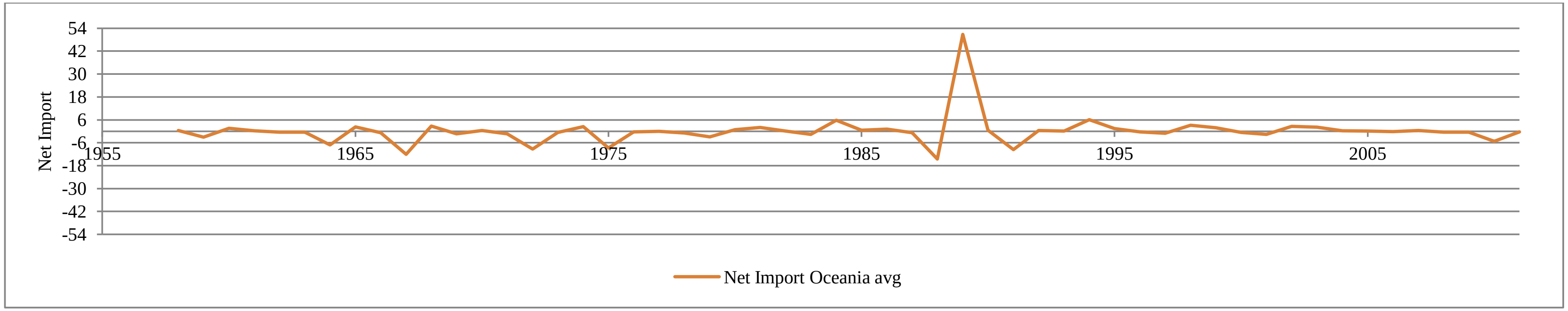
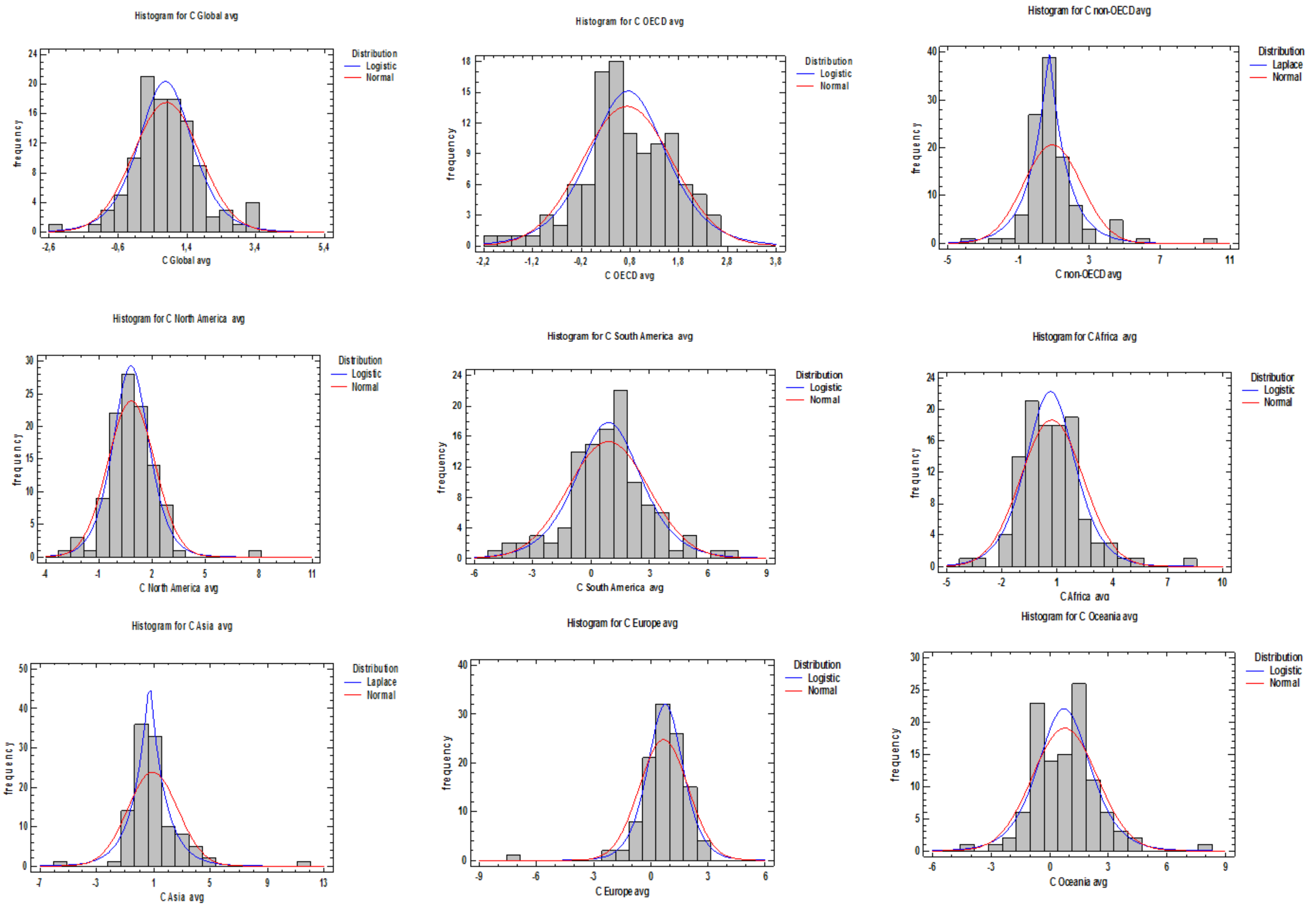
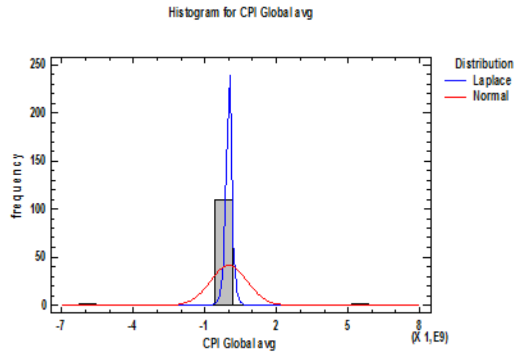
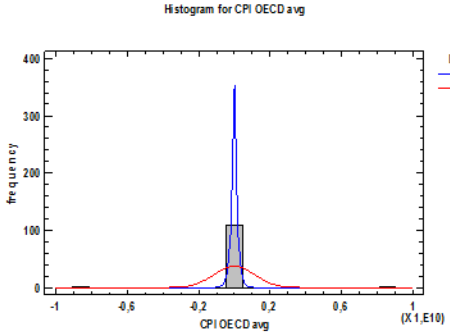


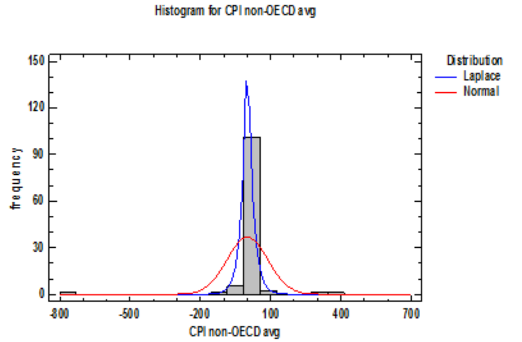
Figure 18 Net import full period

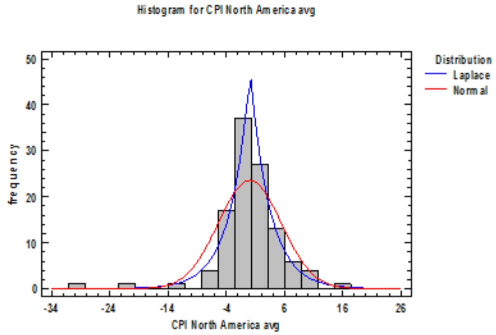
APPENDIX 7 HISTOGRAMS AND NORMAL PROBABILITY PLOTS FOR FULL PERIOD

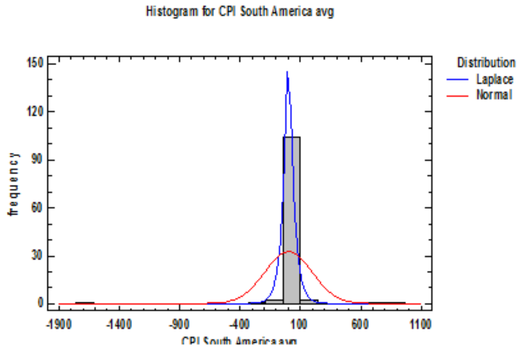


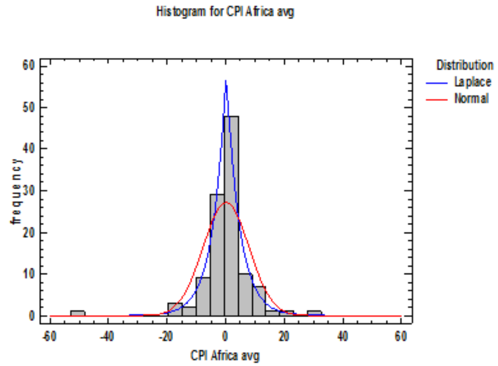

Histogram for CPI Global avg
frequency
CPI Global avg
(X 1,E9)
Distribution
Laplace
Normal

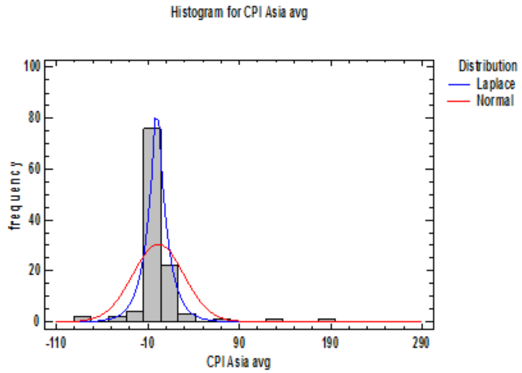

Histogram for CPI OECD avg
frequency
CPI OECD avg
(X 1,E10)
Distribution
Laplace
Normal

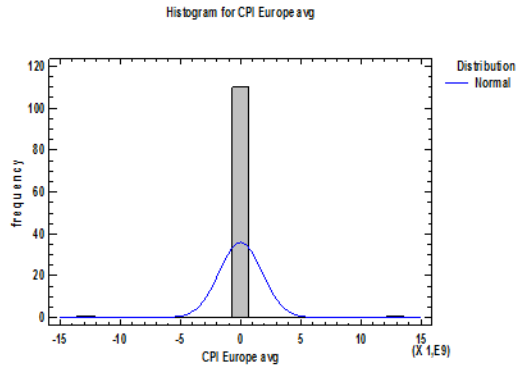

Histogram for CPI non-OECD avg
frequency
CPI non-OECD avg
Distribution
Laplace
Normal

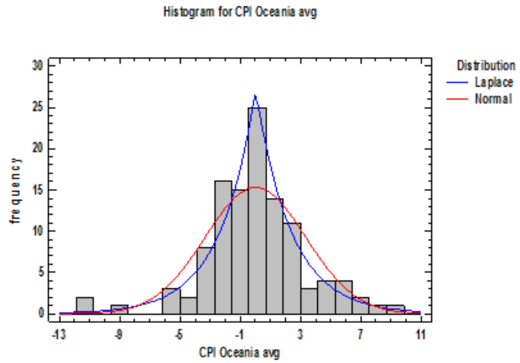

Histogram for CPI North America avg
frequency
CPI North America avg
Distribution
Laplace
Normal

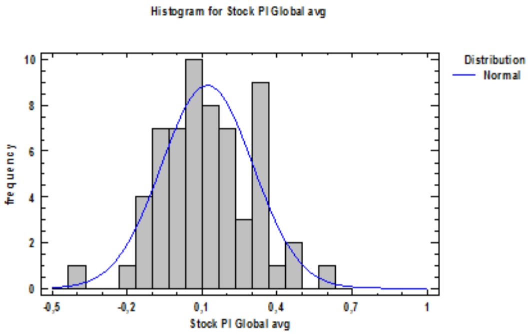

Histogram for CPI South America avg
frequency
Distribution
Laplace
Normal

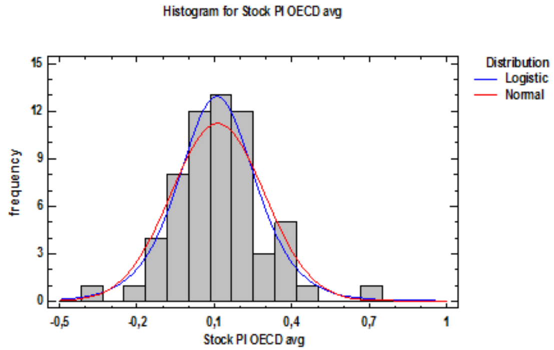

Histogram for CPI Africa avg
frequency
CPI Africa avg
Distribution
Laplace
Normal

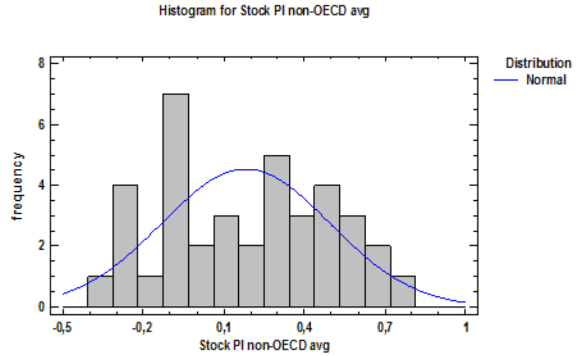

Histogram for CPI Asia avg
frequency
CPI Asia avg
Distribution
Laplace
Normal

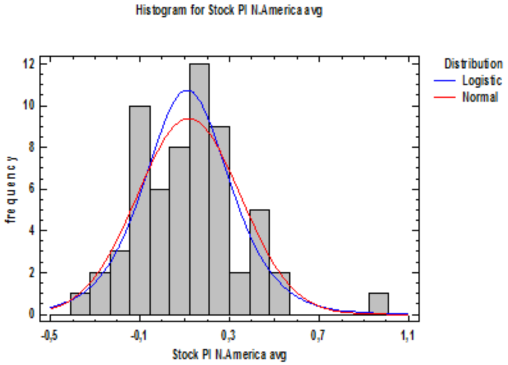

Histogram for CPI Europe avg
frequency
CPI Europe avg
(X 1,E9)
Distribution
Normal

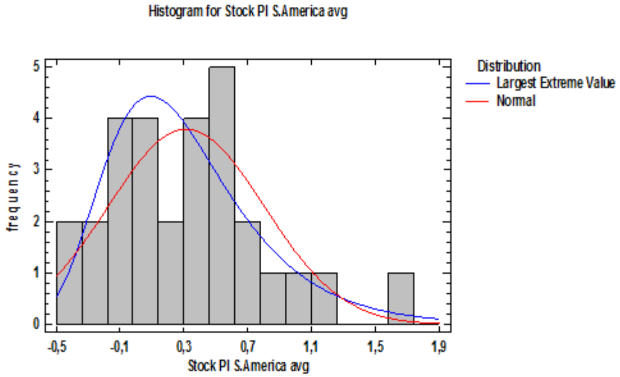

Histogram for CPI Oceania avg
frequency
CPI Oceania avg
Distribution
Laplace
Normal

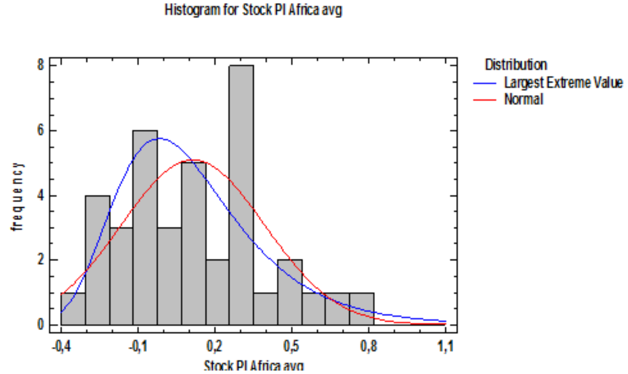

Histogram for Stock PI Global avg
frequency
Stock PI Global avg
Distribution
Normal

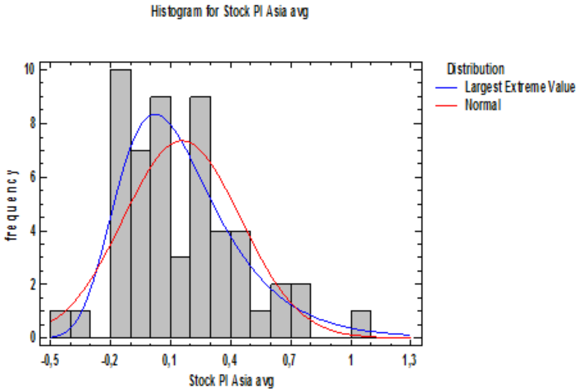

Histogram for Stock PI OECD avg
frequency
Stock PI OECD avg
Distribution
Logistic
Normal

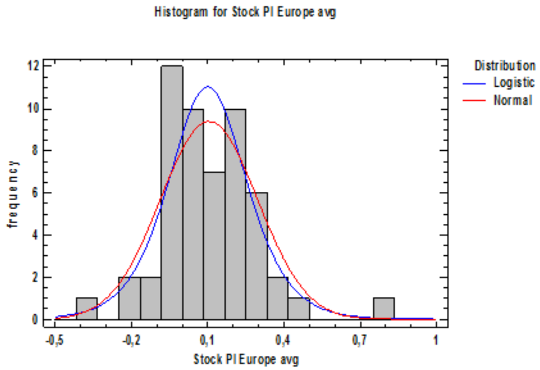

Histogram for Stock PI non-OECD avg
frequency
Stock PI non-OECD avg
Distribution
Normal

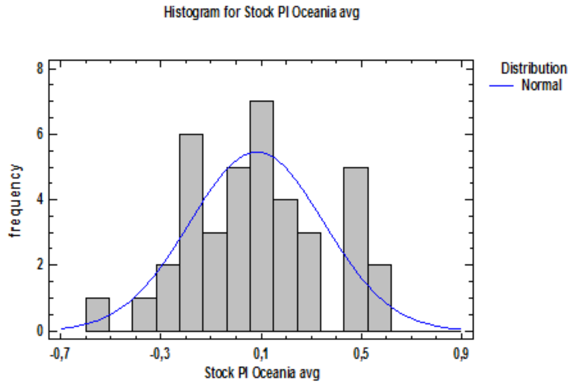

Histogram for Stock PI N.America avg
frequency
Stock PI N.America avg
Distribution
Logistic
Normal

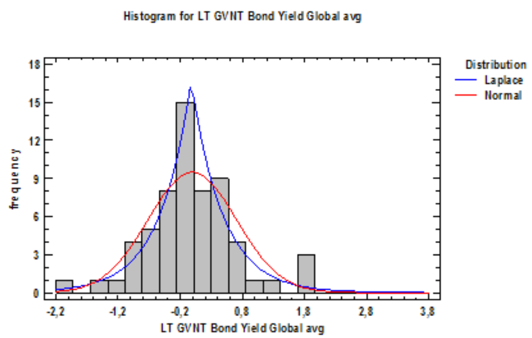

Histogram for Stock PI S.America avg
frequency
Stock PI S.America avg
Distribution
Largest Extreme Value
Normal

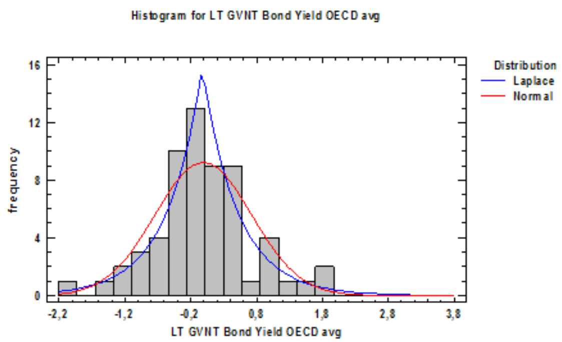

Histogram for Stock PI Africa avg
frequency
Distribution
Largest Extreme Value
Normal

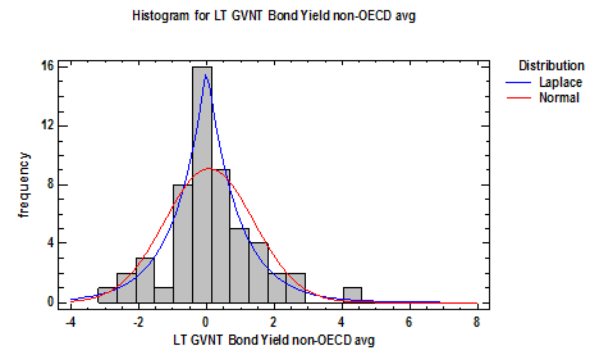

Histogram for Stock PI Asia avg
frequency
Stock PI Asia avg
Distribution
Largest Extreme Value
Normal

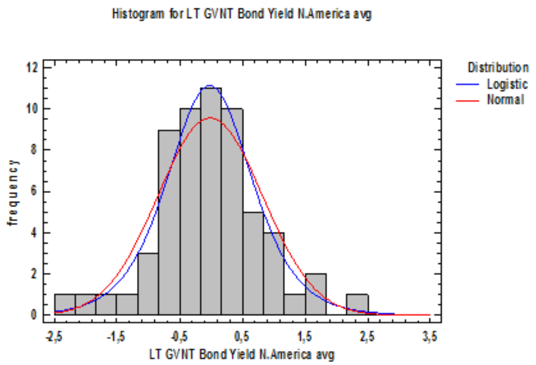

Histogram for Stock PI Europe avg
frequency
Stock PI Europe avg
Distribution
Logistic
Normal

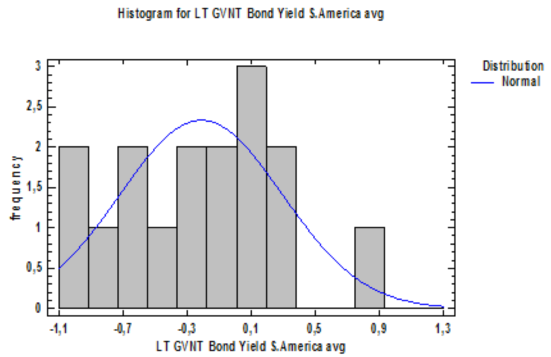

Histogram for Stock PI Oceania avg
frequency
Stock PI Oceania avg
Distribution
Normal

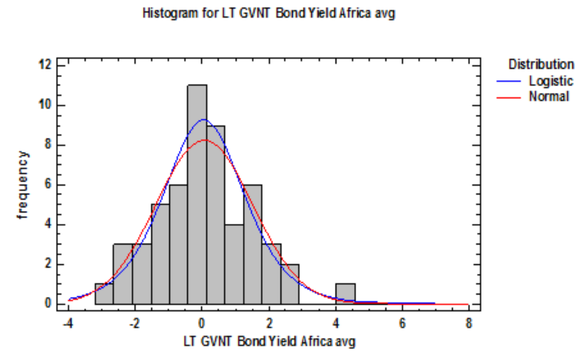

Histogram for LT GVNT Bond Yield Global avg
Distribution
Laplace
Normal
frequency
LT GVNT Bond Yield Global avg

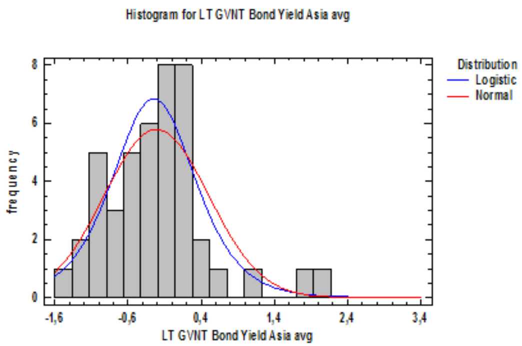

Histogram for LT GVNT Bond Yield OECD avg
Distribution
Laplace
Normal
frequency
LT GVNT Bond Yield OECD avg

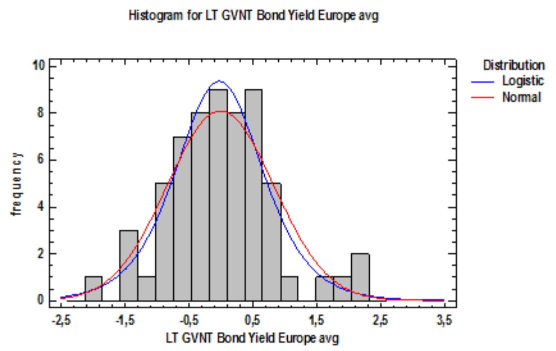

Histogram for LT GVNT Bond Yield non-OECD avg
Distribution
Laplace
Normal
frequency
LT GVNT Bond Yield non-OECD avg

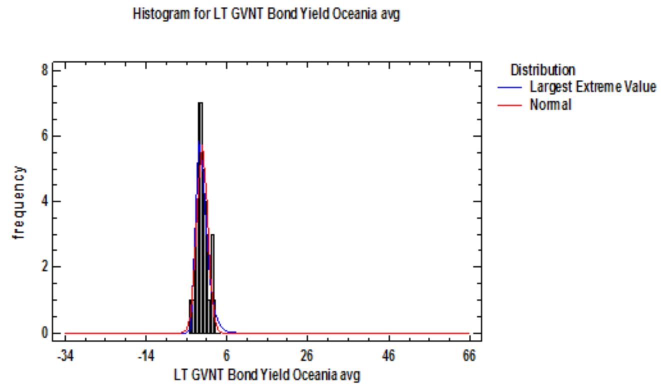

Histogram for LT GVNT Bond Yield N.America avg
Distribution
Logistic
Normal
frequency
LT GVNT Bond Yield N.America avg

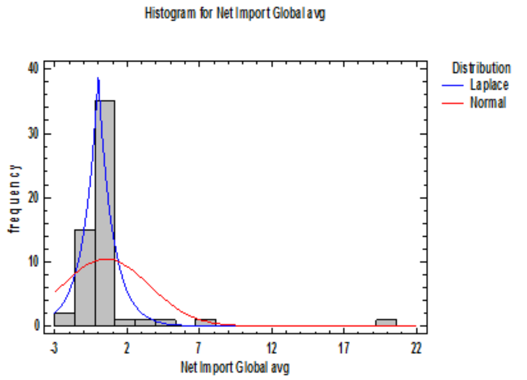

Histogram for LT GVNT Bond Yield S.America avg
Distribution
Normal
frequency
LT GVNT Bond Yield S.America avg

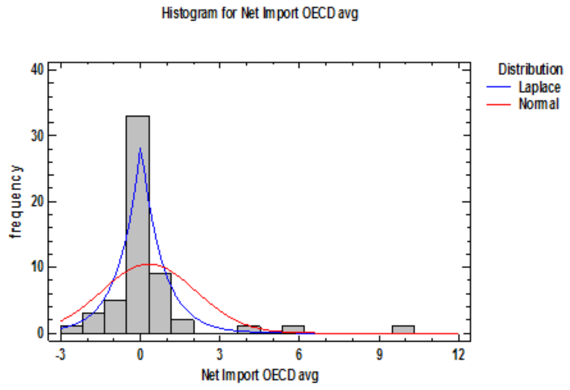

Histogram for LT GVNT Bond Yield Africa avg
Distribution
Logistic
Normal
frequency
LT GVNT Bond Yield Africa avg

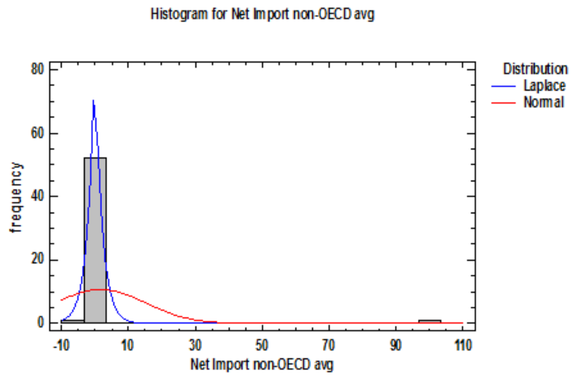

Histogram for LT GVNT Bond Yield Asia avg
Distribution
Logistic
Normal
frequency
LT GVNT Bond Yield Asia avg

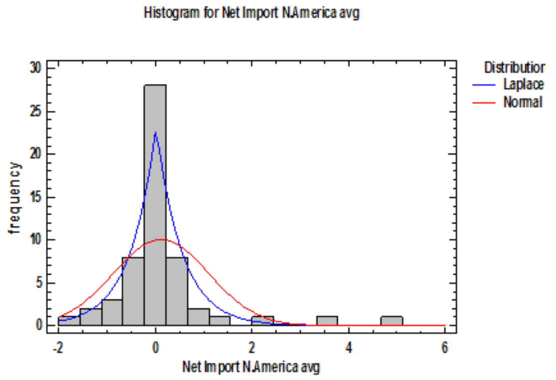

Histogram for LT GVNT Bond Yield Europe avg
Distribution
Logistic
Normal
frequency
LT GVNT Bond Yield Europe avg

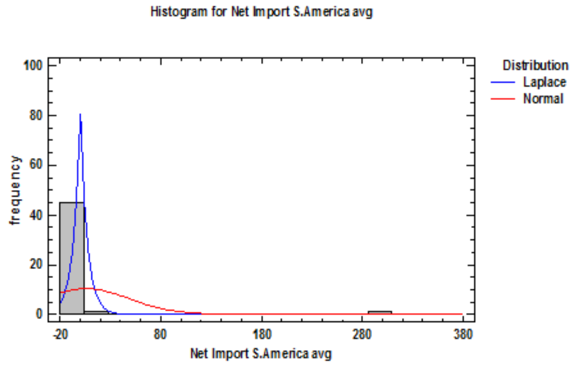

Histogram for LT GVNT Bond Yield Oceania avg
Distribution
Largest Extreme Value
Normal
frequency
LT GVNT Bond Yield Oceania avg

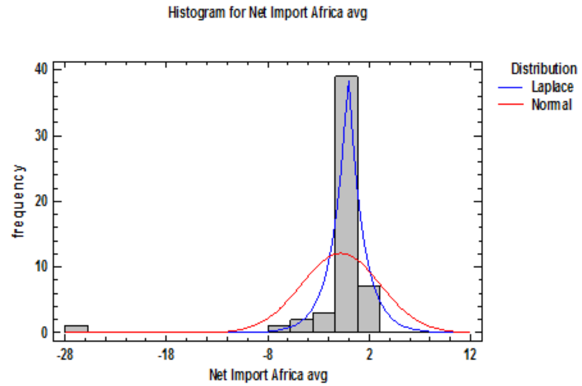

Histogram for Net Import Global avg
Distribution
Laplace
Normal
frequency
Net Import Global avg

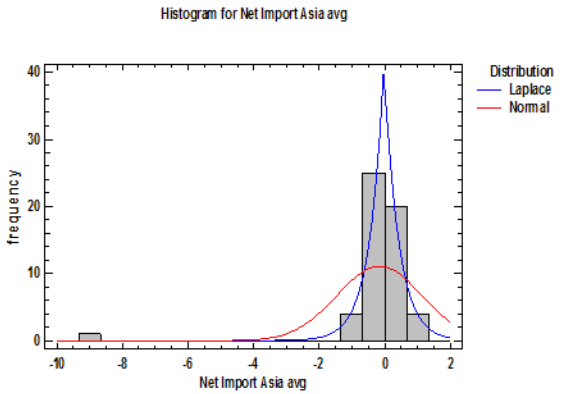

Histogram for Net Import OECD avg
Distribution
Laplace
Normal
frequency
Net Import OECD avg

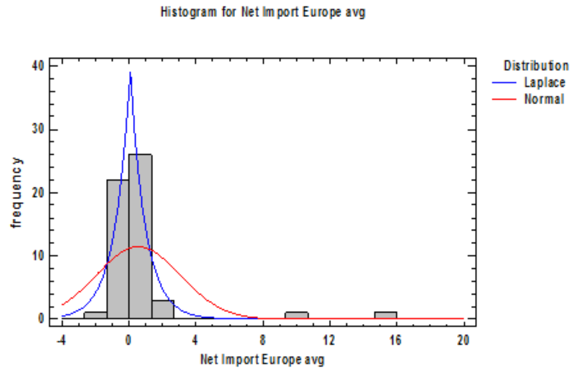

Histogram for Net Import non-OECD avg
Distribution
Laplace
Normal
frequency
Net Import non-OECD avg

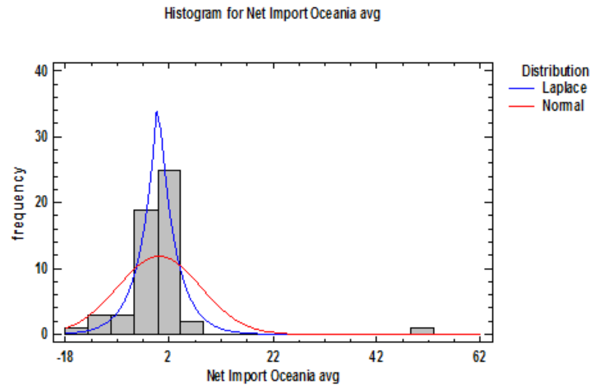

Histogram for Net Import N.America avg
Distribution
Laplace
Normal
frequency
Net Import N.America avg

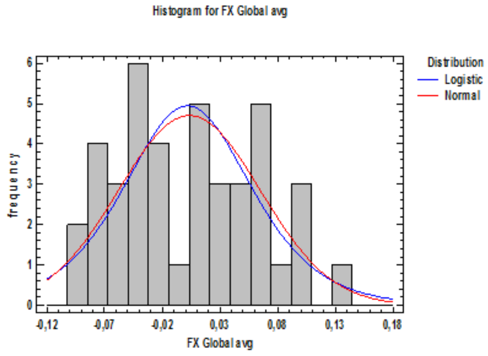

Histogram for Net Import S.America avg
Distribution
Laplace
Normal
frequency
Net Import S.America avg

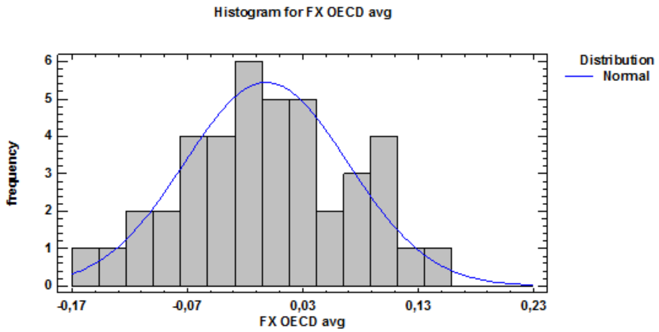

Histogram for Net Import Africa avg
Distribution
Laplace
Normal
frequency
Net Import Africa avg

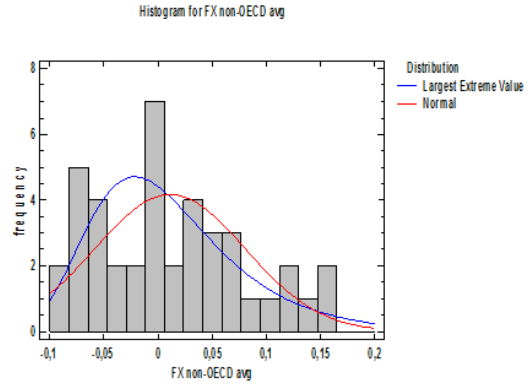

Histogram for Net Import Asia avg
Distribution
Laplace
Normal
frequency
Net Import Asia avg

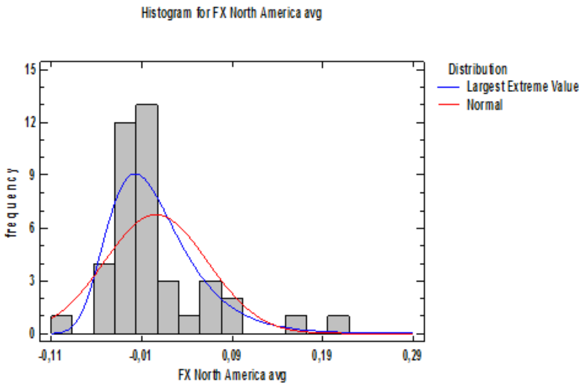

Histogram for Net Import Europe avg
Distribution
Laplace
Normal
frequency
Net Import Europe avg

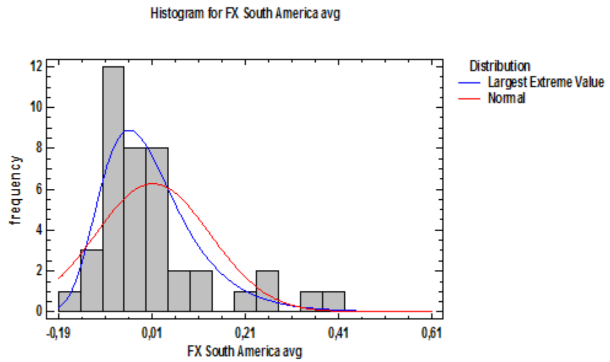

Histogram for Net Import Oceania avg
Distribution
Laplace
Normal
frequency
Net Import Oceania avg

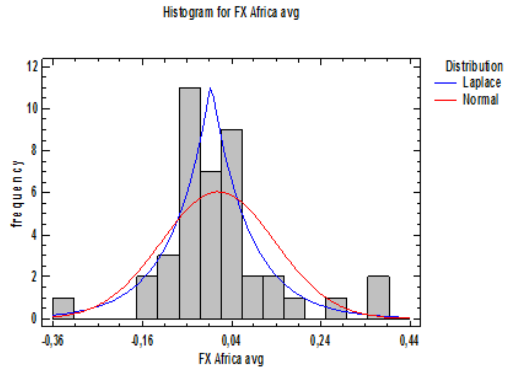

Histogram for FX Global avg
frequency
FX Global avg
Distribution
Logistic
Normal

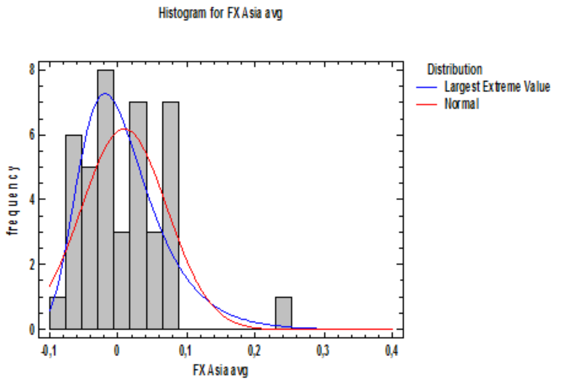

Histogram for FX OECD avg
frequency
FX OECD avg
Distribution
Normal

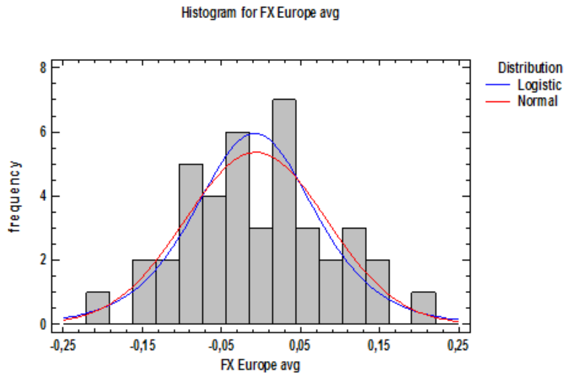

Histogram for FX non-OECD avg
frequency
FX non-OECD avg
Distribution
Largest Extreme Value
Normal

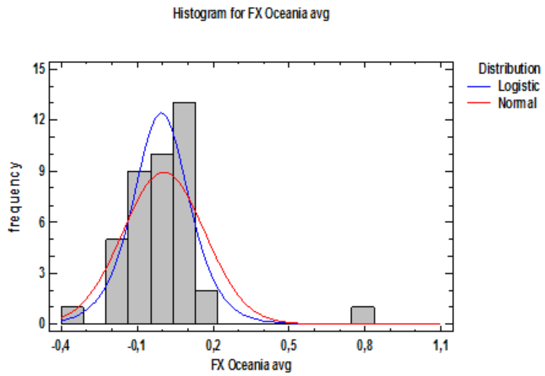

Histogram for FX North America avg
frequency
FX North America avg
Distribution
Largest Extreme Value
Normal

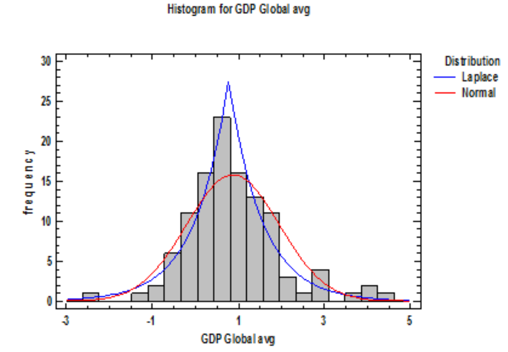

Histogram for FX South America avg
frequency
FX South America avg
Distribution
Largest Extreme Value
Normal

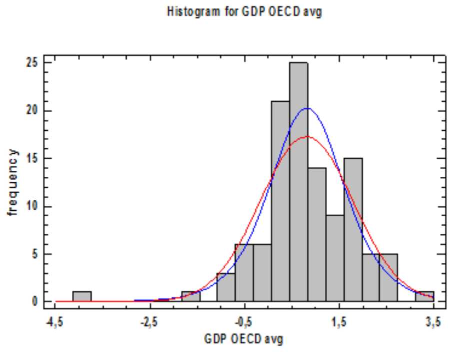

Histogram for FX Africa avg
frequency
FX Africa avg
Distribution
Laplace
Normal

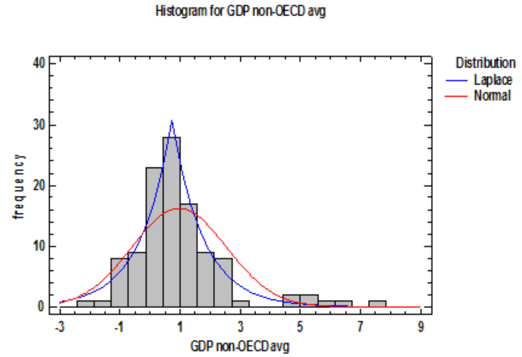

Histogram for FX Asia avg
frequency
FX Asia avg
Distribution
Largest Extreme Value
Normal

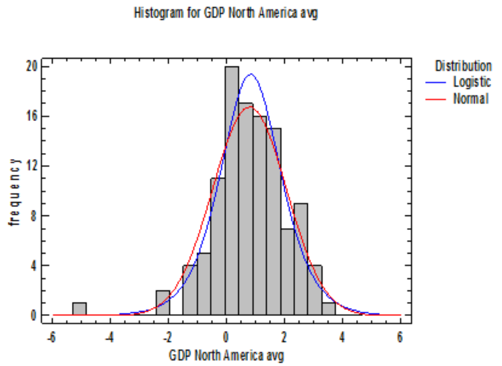

Histogram for FX Europe avg
frequency
FX Europe avg
Distribution
Logistic
Normal

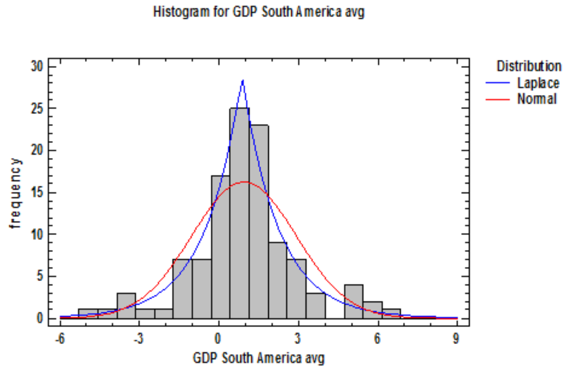

Histogram for FX Oceania avg
frequency
FX Oceania avg
Distribution
Logistic
Normal

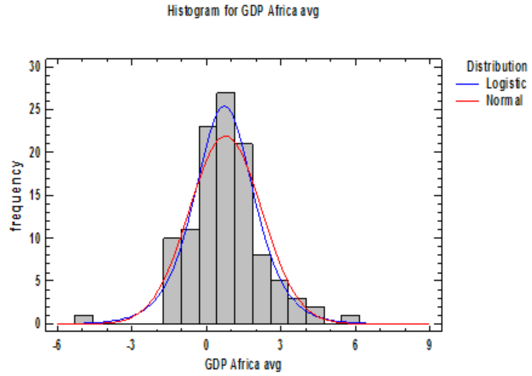

Histogram for GDP Global avg
frequency
GDP Global avg
Distribution
Laplace
Normal

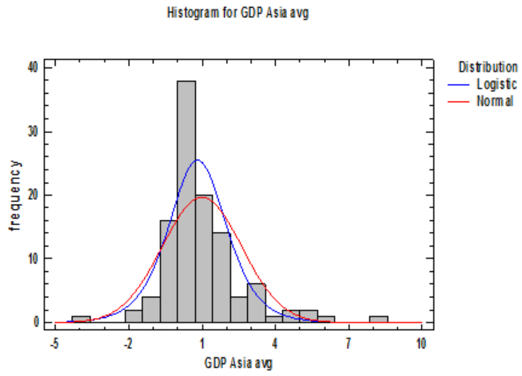

Histogram for GDP OECD avg
frequency
GDP OECD avg
Distribution
Logistic
Normal

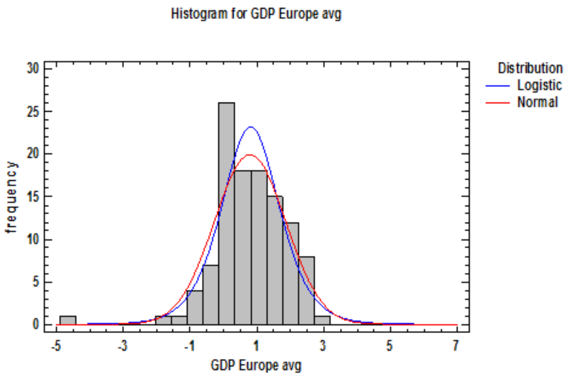

Histogram for GDP non-OECD avg
frequency
GDP non-OECD avg
Distribution
Laplace
Normal

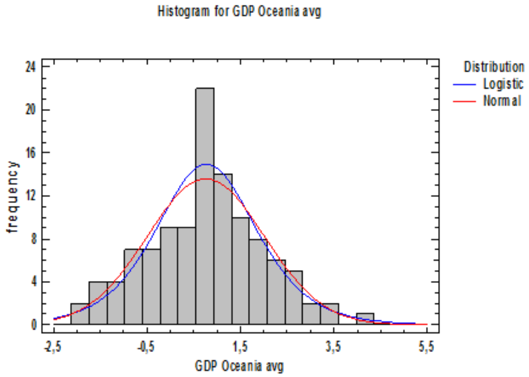

Histogram for GDP North America avg
frequency
GDP North America avg
Distribution
Logistic
Normal

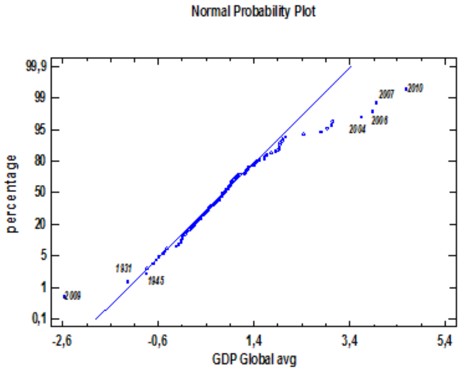

Histogram for GDP South America avg
frequency
GDP South America avg
Distribution
Laplace
Normal

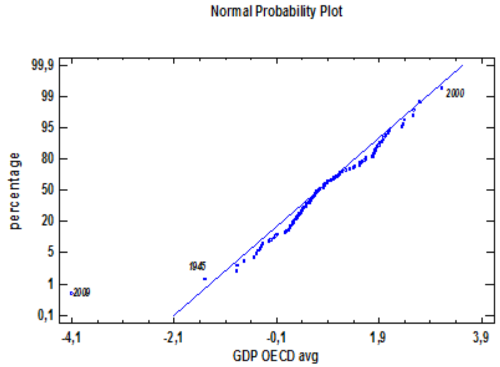

Histogram for GDP Africa avg
frequency
GDP Africa avg
Distribution
Logistic
Normal

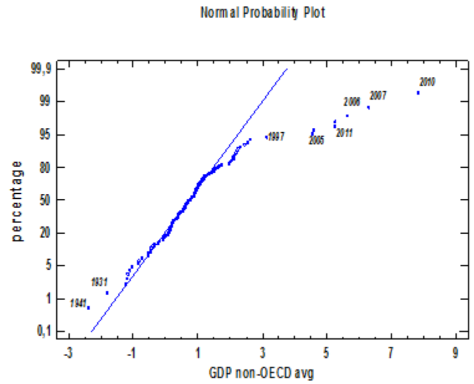

Histogram for GDP Asia avg
frequency
GDP Asia avg
Distribution
Logistic
Normal

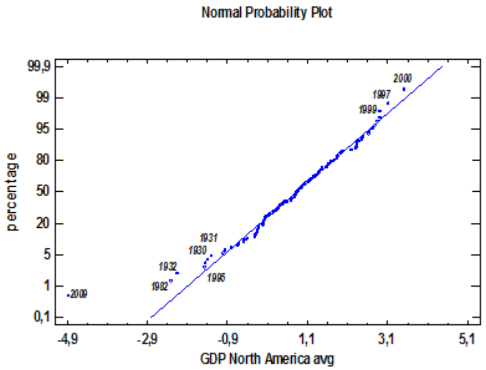

Histogram for GDP Europe avg
frequency
GDP Europe avg
Distribution
Logistic
Normal

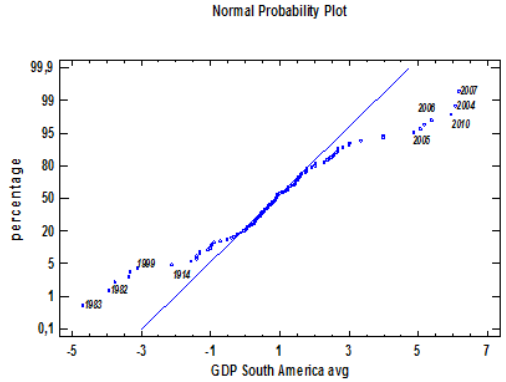

Histogram for GDP Oceania avg
frequency
GDP Oceania avg
Distribution
Logistic
Normal

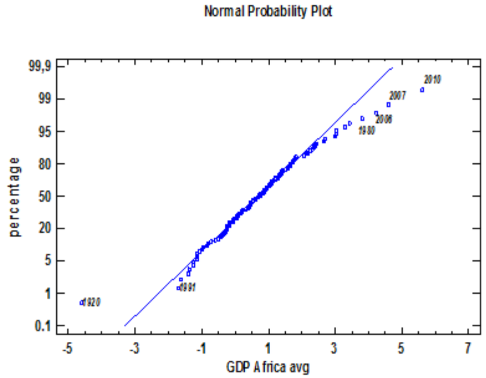

Normal Probability Plot
percentage
GDP Global avg

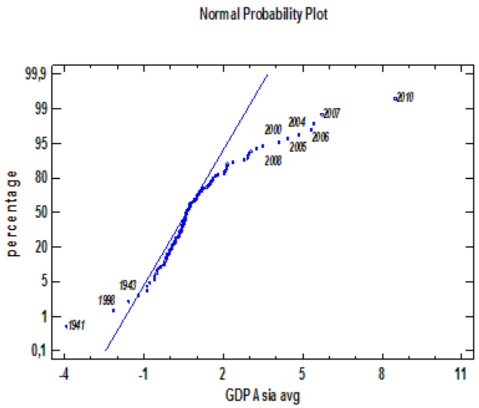

Normal Probability Plot
percentage
GDP OECD avg

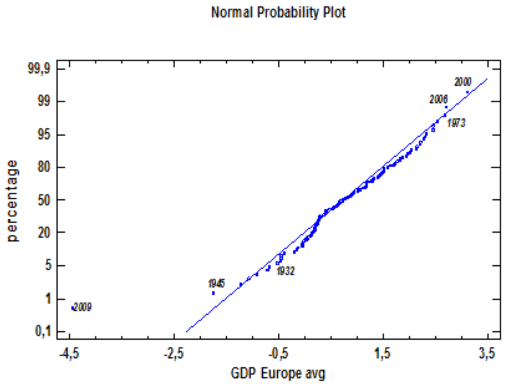

Normal Probability Plot
percentage
GDP non-OECD avg

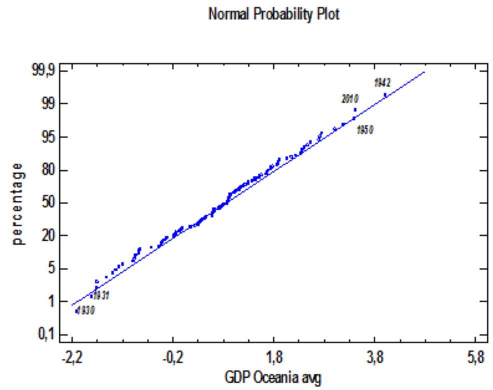

Normal Probability Plot
percentage
GDP North America avg

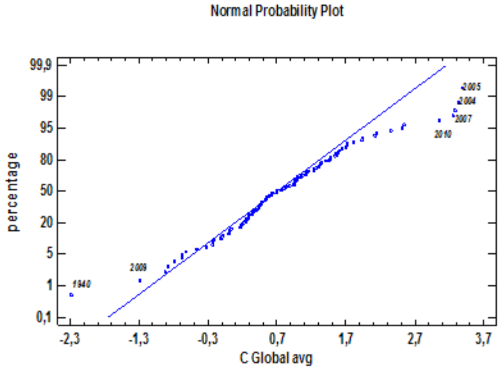

Normal Probability Plot
percentage
GDP South America avg

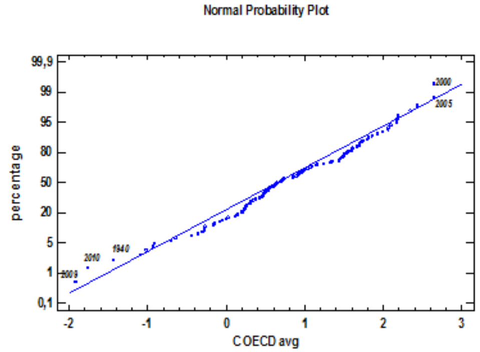

Normal Probability Plot
percentage
GDP Africa avg

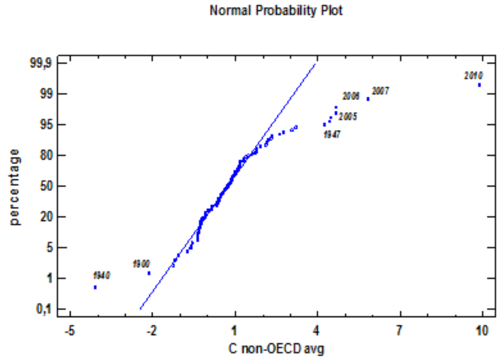

Normal Probability Plot
percentage
GDP Asia avg

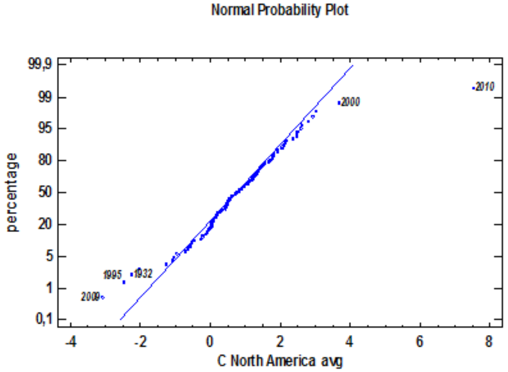

Normal Probability Plot
percentage
GDP Europe avg

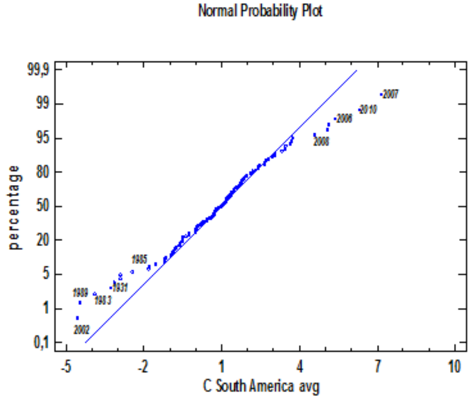

Normal Probability Plot
percentage
GDP Oceania avg

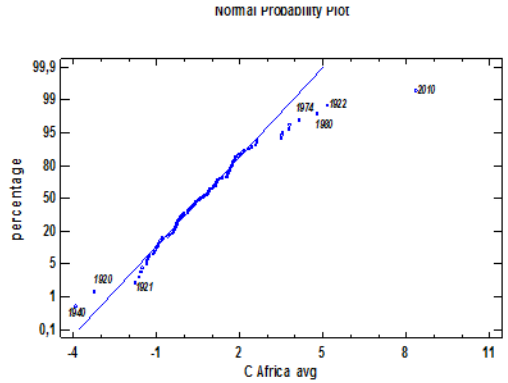

Normal Probability Plot
percentage
C Global avg

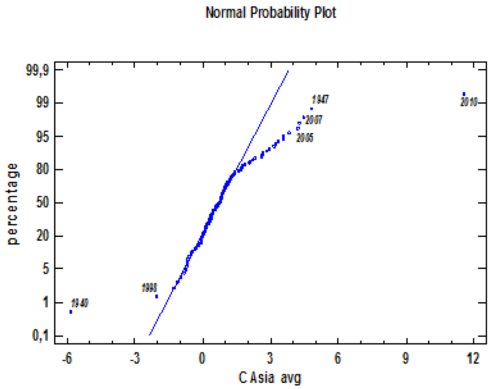

Normal Probability Plot
percentage
C OECD avg

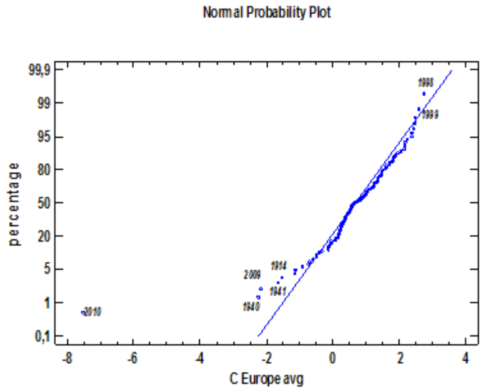

Normal Probability Plot
percentage
C non-OECD avg

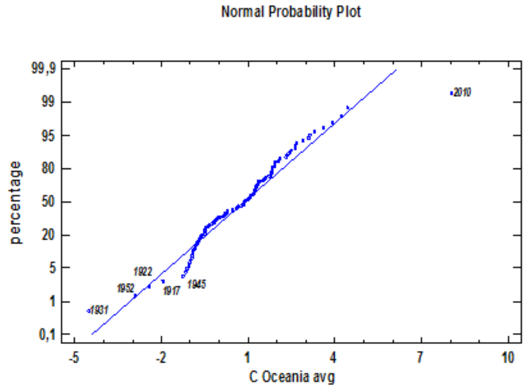

Normal Probability Plot
percentage
C North America avg

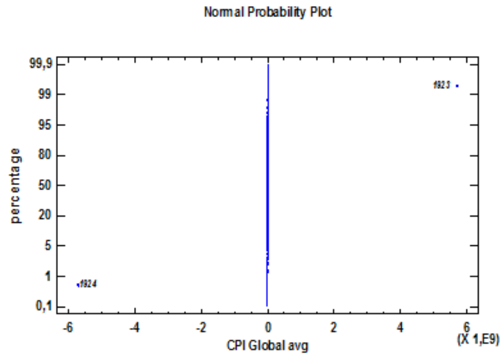

Normal Probability Plot
percentage
C South America avg

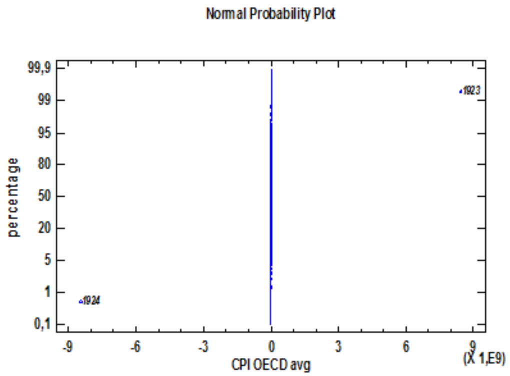

Normal Probability Plot
percentage
C Africa avg

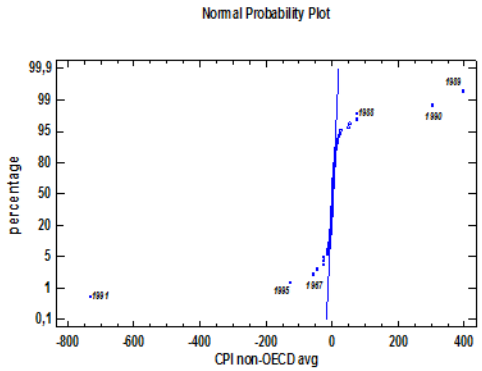

Normal Probability Plot
percentage
C Asia avg

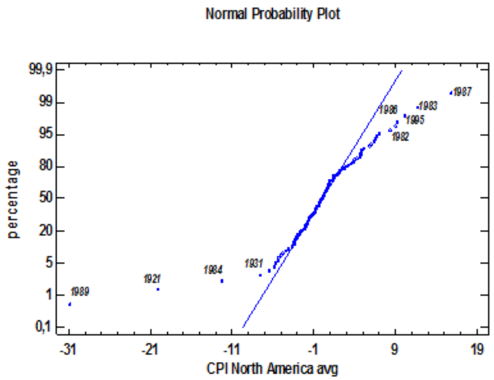

Normal Probability Plot
percentage
C Europe avg

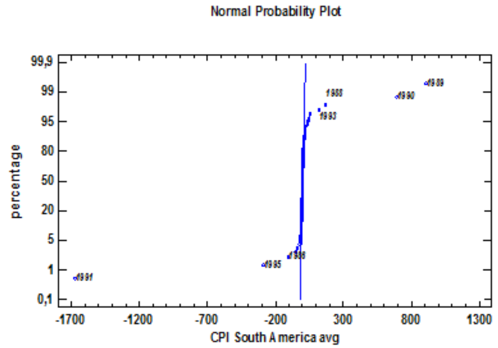

Normal Probability Plot
percentage
C Oceania avg

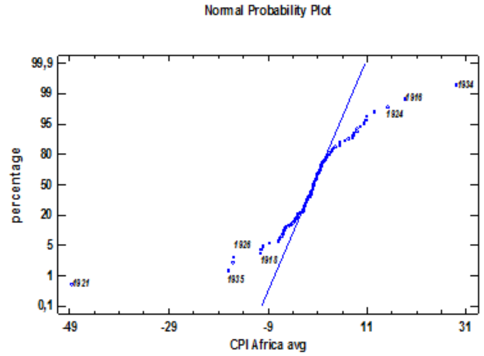

Normal Probability Plot
percentage
CPI Global avg
(X 1,E9)

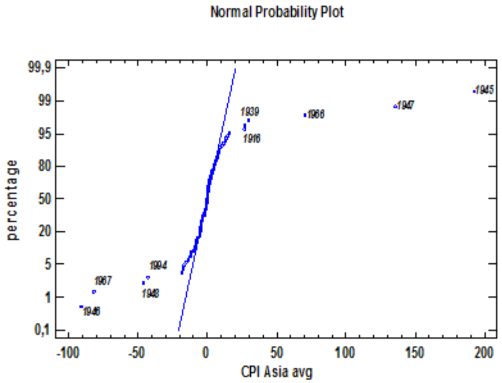

Normal Probability Plot
percentage
CPI OECD avg
(X 1,E9)

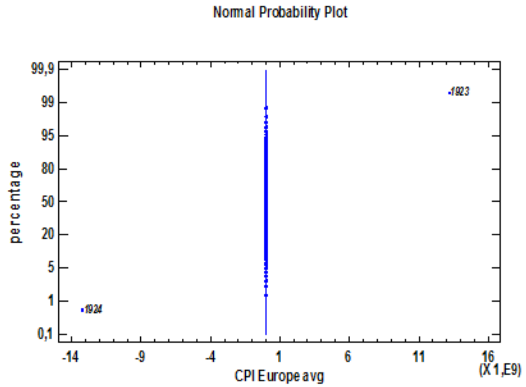

Normal Probability Plot
percentage
CPI non-OECD avg

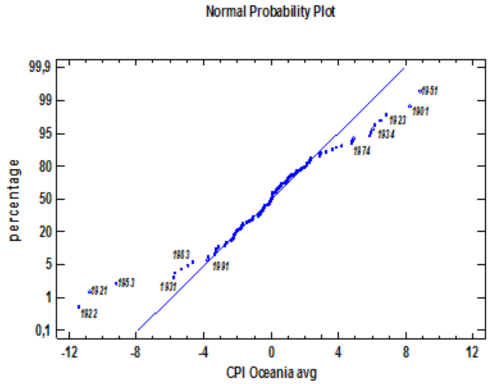

Normal Probability Plot
percentage
CPI North America avg

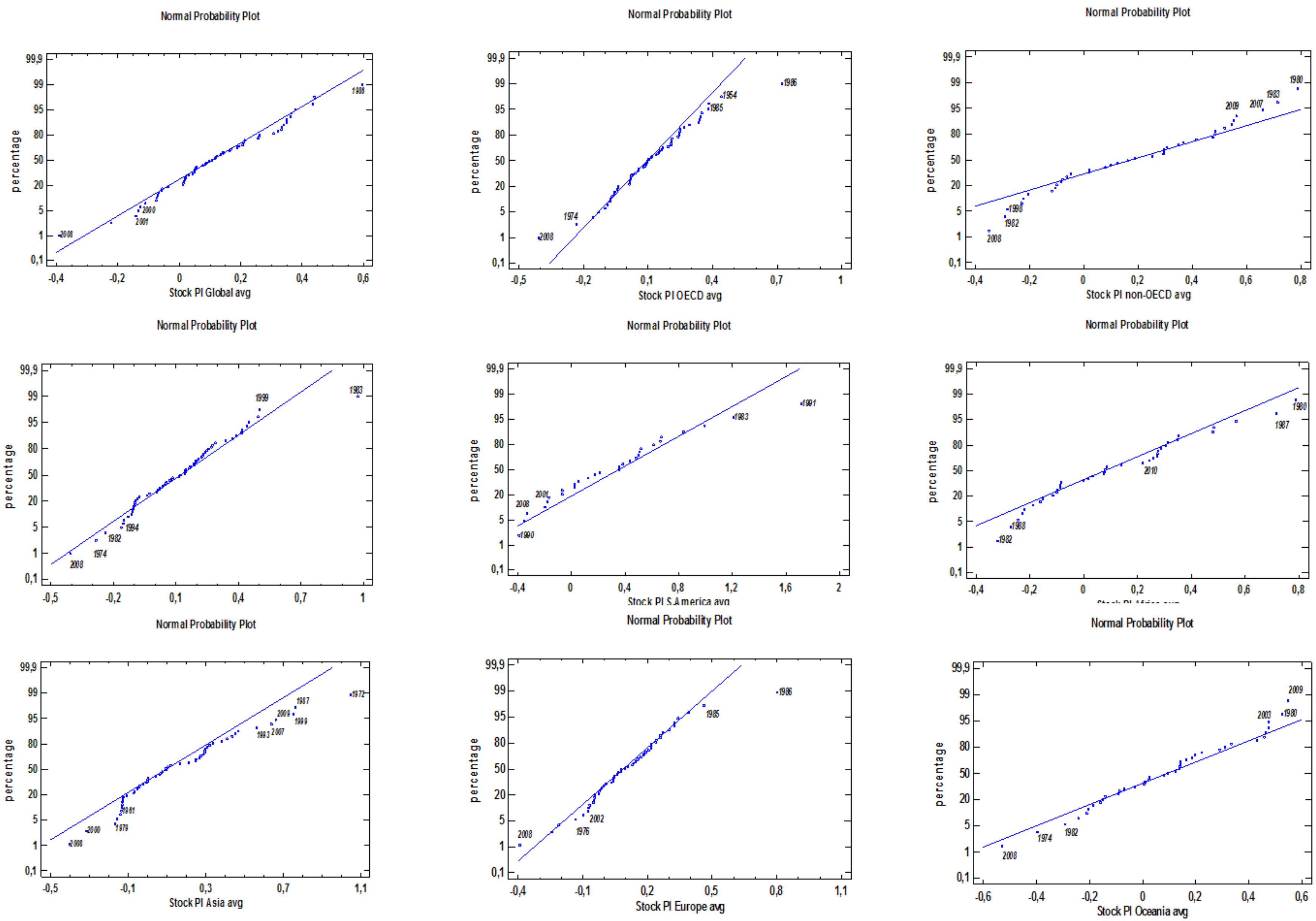

Normal Probability Plot
percentage
CPI South America avg


Normal Probability Plot
percentage
CPI Africa avg


Normal Probability Plot
percentage
CPI Asia avg


Normal Probability Plot
percentage
CPI Europe avg
(X 1,E9)


Normal Probability Plot
percentage
CPI Oceania avg


Normal Probability Plot
percentage
Stock PI Global avg
Normal Probability Plot
Stock PI OECD avg
Normal Probability Plot
Stock PI non-OECD avg
Normal Probability Plot
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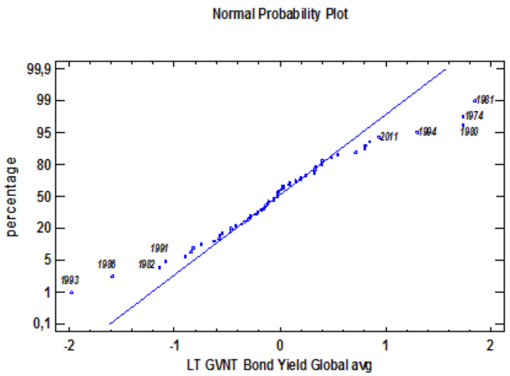
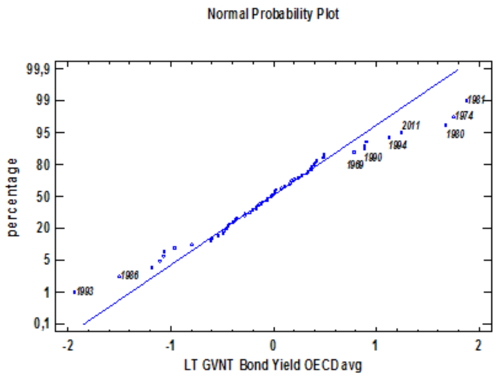
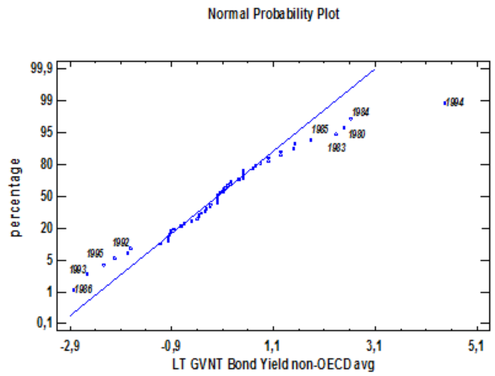
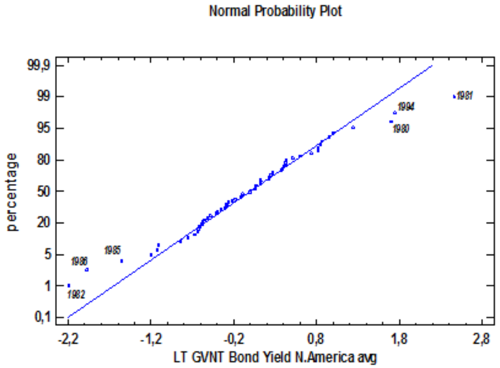
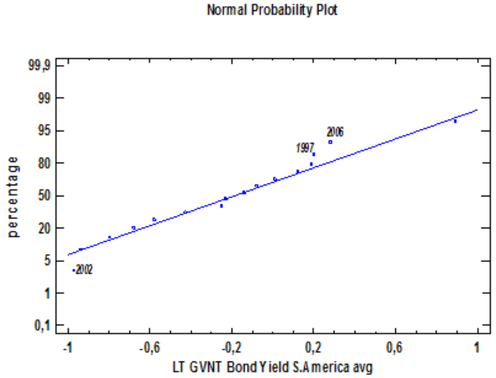
Normal Probability Plot
Stock PI Oceania avg

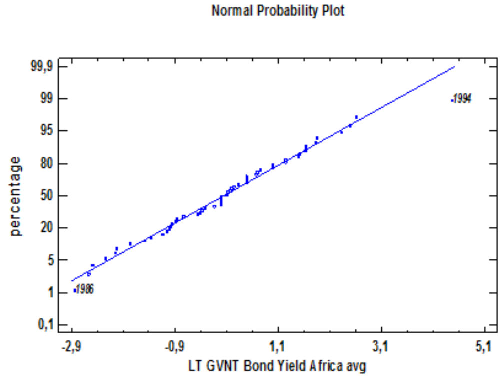

Normal Probability Plot
percentage
LT GVNT Bond Yield Global avg

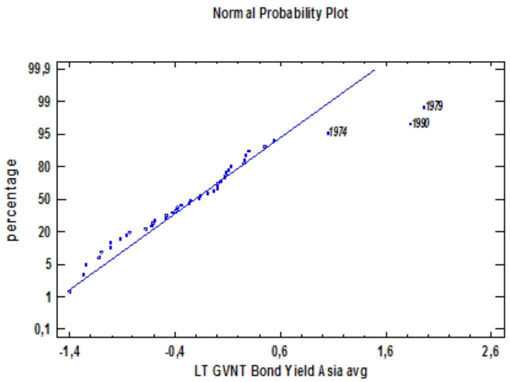

Normal Probability Plot
percentage
LT GVNT Bond Yield OECD avg

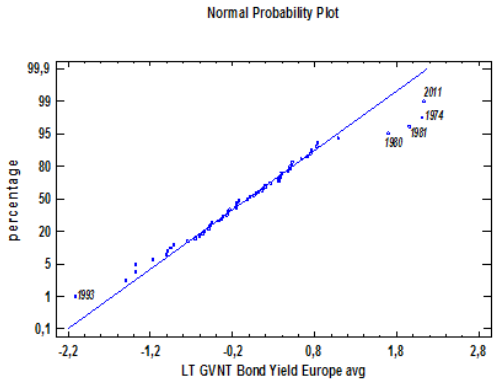

Normal Probability Plot
percentage
LT GVNT Bond Yield non-OECD avg

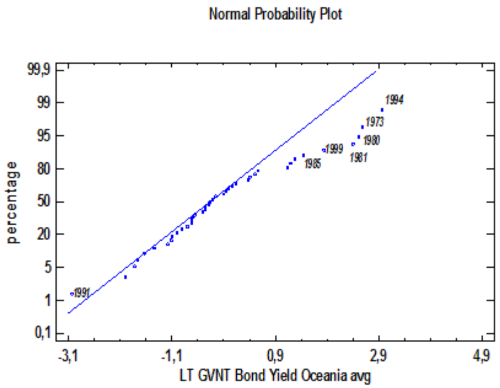

Normal Probability Plot
percentage
LT GVNT Bond Yield N.America avg

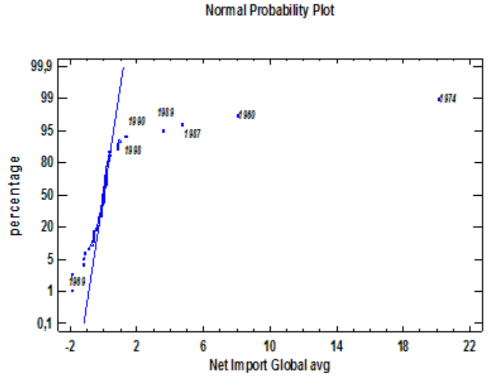

Normal Probability Plot
percentage
LT GVNT Bond Yield S.America avg

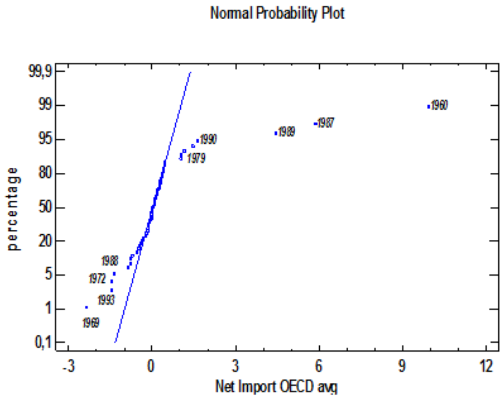

Normal Probability Plot
percentage
LT GVNT Bond Yield Africa avg

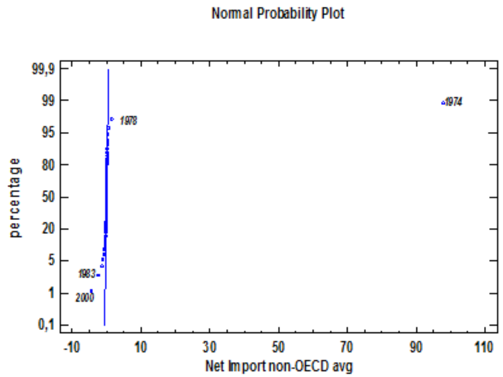

Normal Probability Plot
percentage
LT GVNT Bond Yield Asia avg

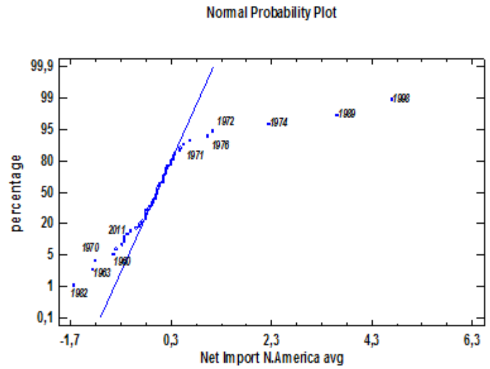

Normal Probability Plot
percentage
LT GVNT Bond Yield Europe avg

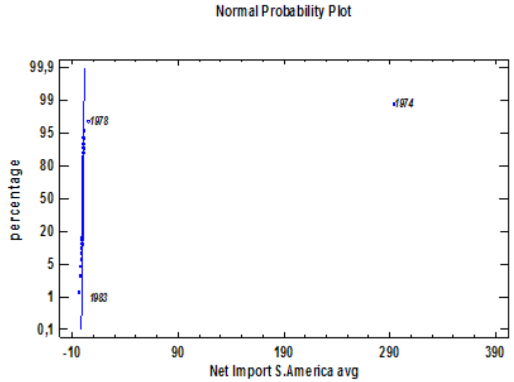

Normal Probability Plot
percentage
LT GVNT Bond Yield Oceania avg

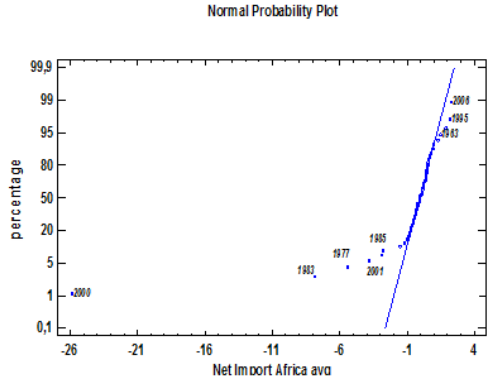

Normal Probability Plot
percentage
Net Import Global avg

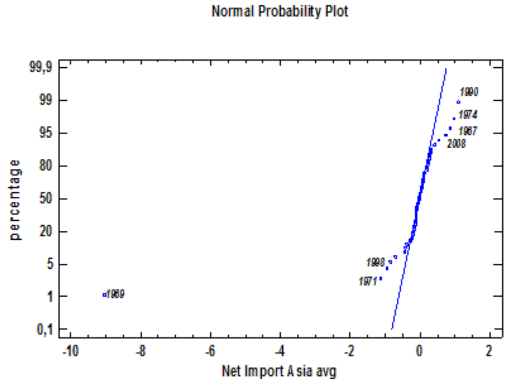

Normal Probability Plot
percentage
Net Import OECD avg


Normal Probability Plot
percentage
Net Import non-OECD avg


Normal Probability Plot
percentage
Net Import N.America avg


Normal Probability Plot
percentage
Net Import S.America avg


Normal Probability Plot
percentage
Net Import Africa avg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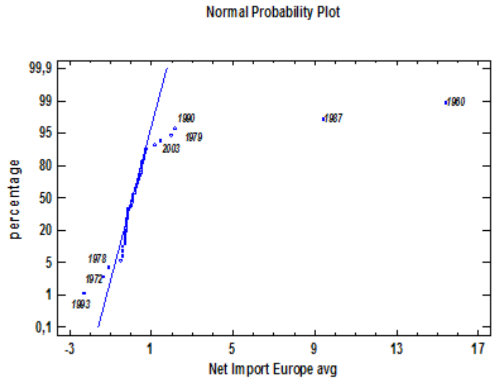
percentage
Net Import Asia avg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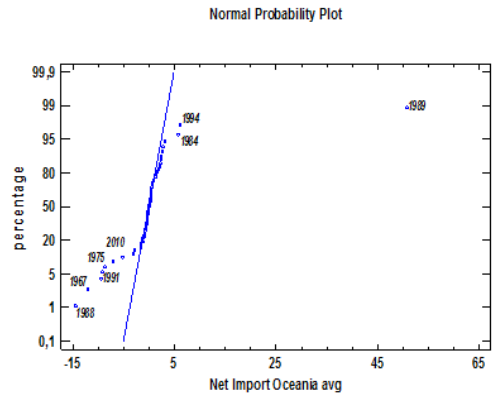
percentage
Net Import Europe avg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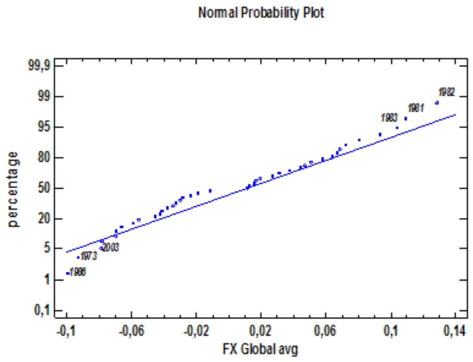
percentage
Net Import Oceania avg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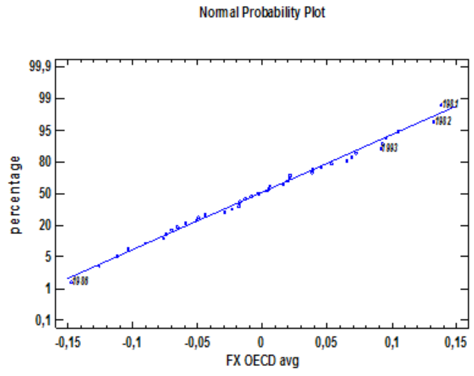
percentage
FX Global avg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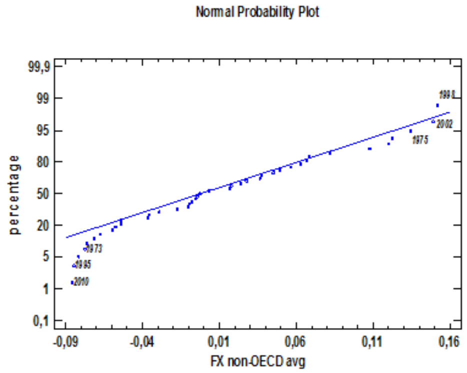
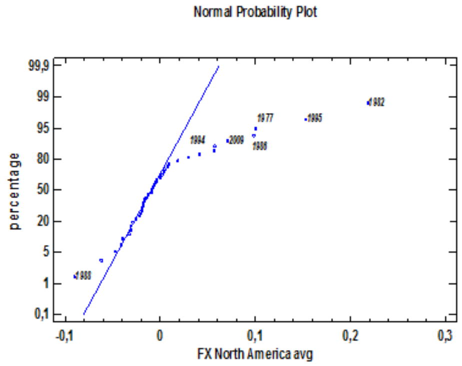
percentage
FX OECD avg


Normal Probability Plot
percentage
FX non-OECD avg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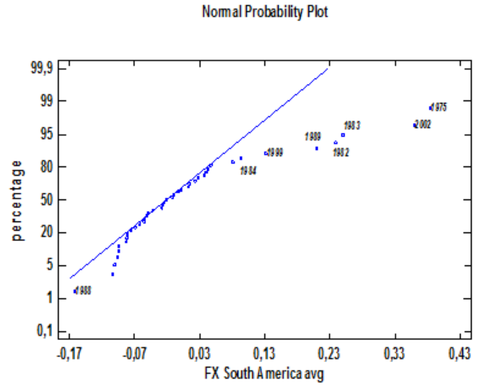
percentage
FX North America avg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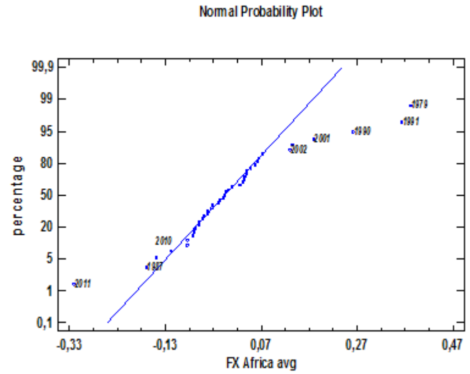
percentage
FX South America avg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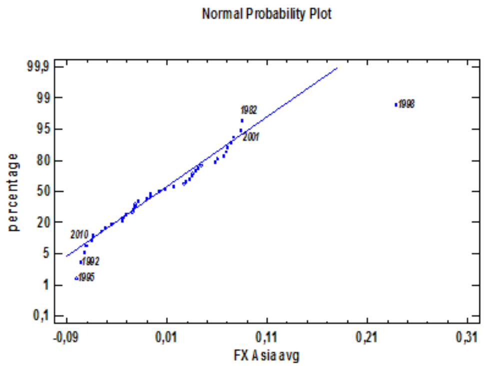
percentage
FX Africa avg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percentage
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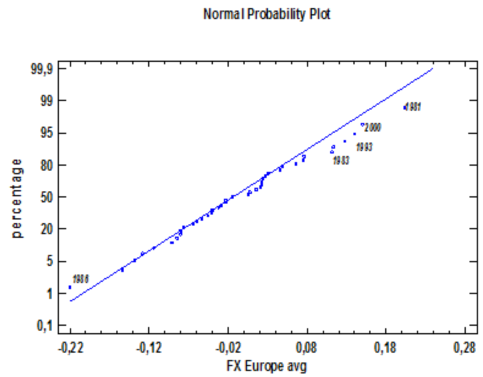
Normal Probability Plot
percentage
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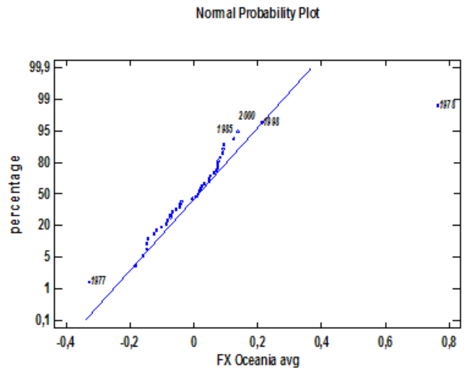
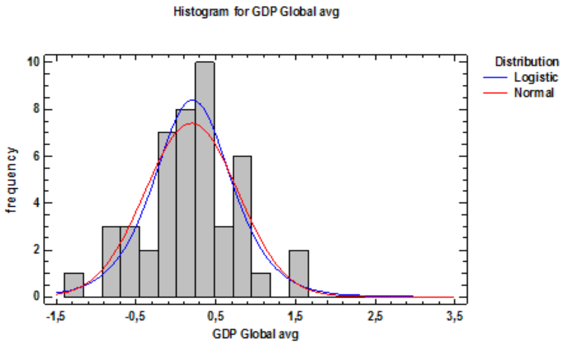
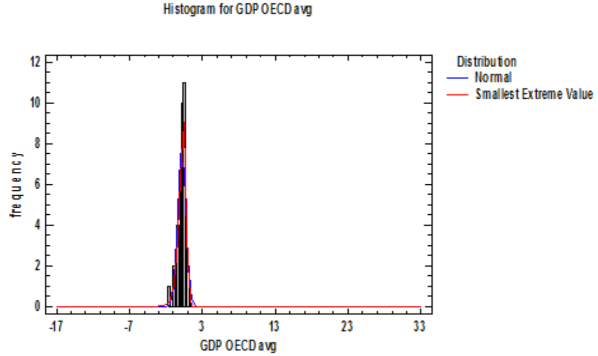
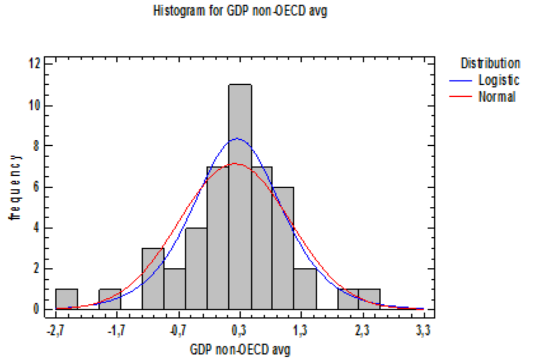
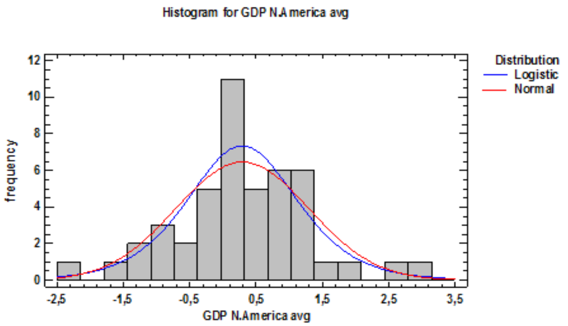

Normal Probability Plot
percentage
FX Oceania avg

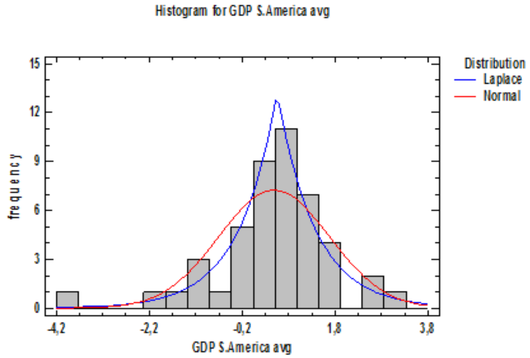
APPENDIX 8 HISTOGRAMS AND NORMAL PROBABILITY PLOTS 1900-1947 YEARS

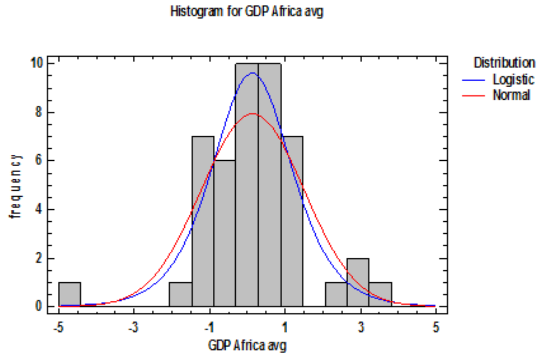


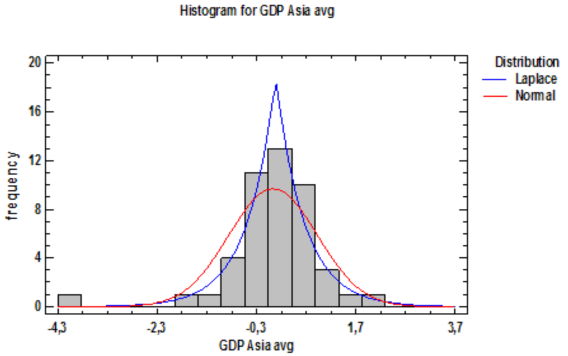


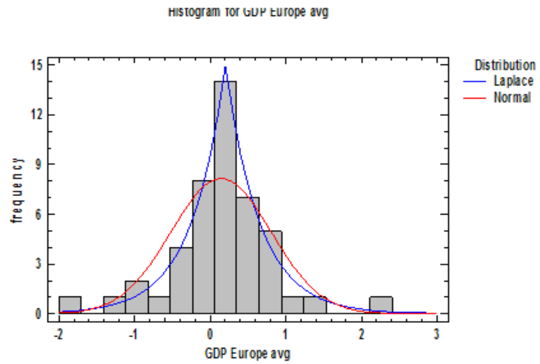


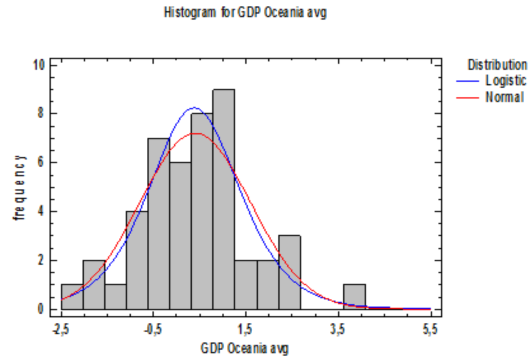


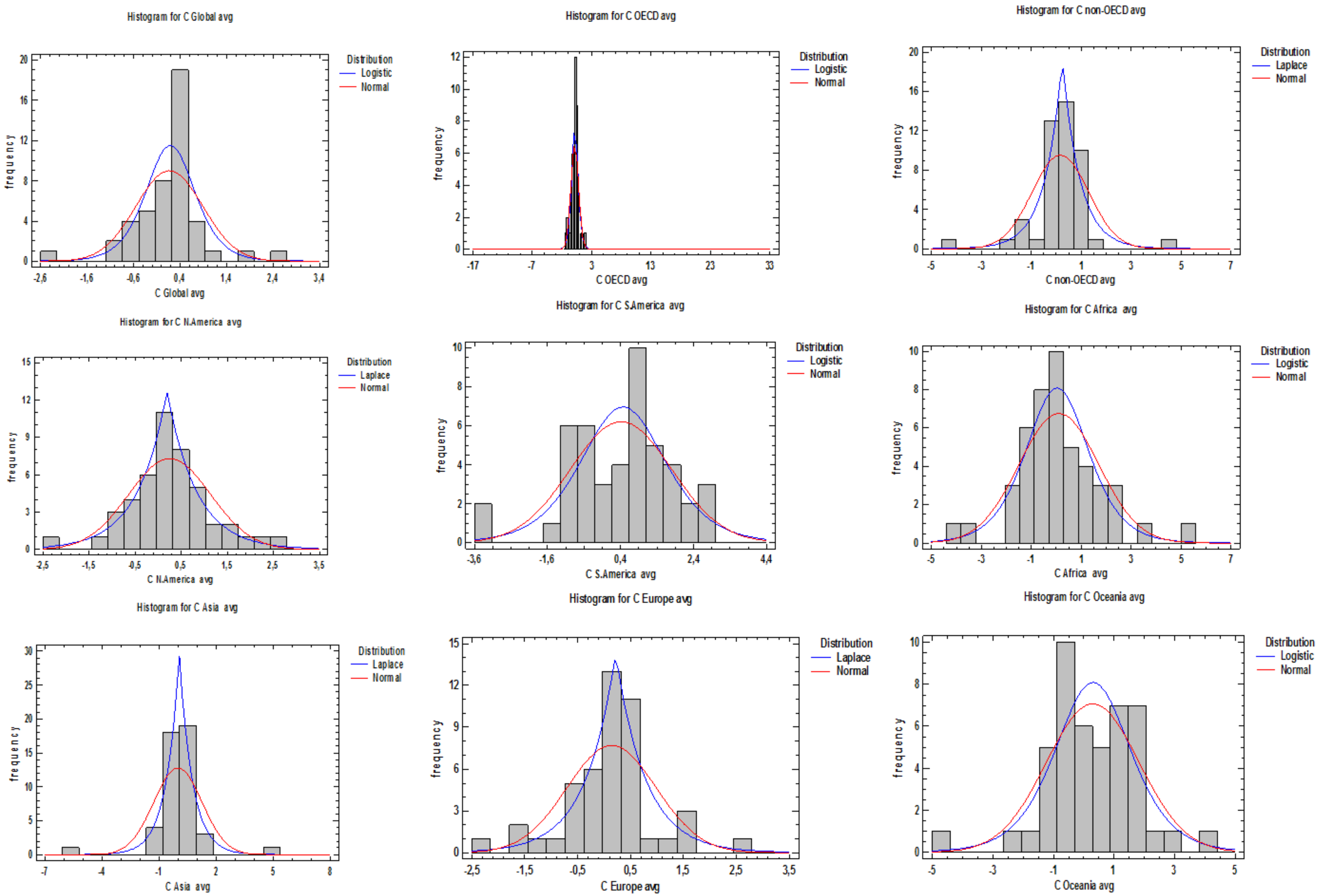











Histogram for C Global avg
Distribution
Logistic
Normal
frequency
C Global avg
Histogram for C OECD avg
Distribution
Logistic
Normal
frequency
C OECD avg
Histogram for C non-OECD avg
Distribution
Laplace
Normal
frequency
C non-OECD avg
Histogram for C N.America avg
Distribution
Laplace
Normal
frequency
C N.America avg
Histogram for C S.America avg
Distribution
Logistic
Normal
frequency
C S.America avg
Histogram for C Africa avg
Distribution
Logistic
Normal
frequency
C Africa avg
Histogram for C Asia avg
Distribution
Laplace
Normal
frequency
C Asia avg
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Distribution
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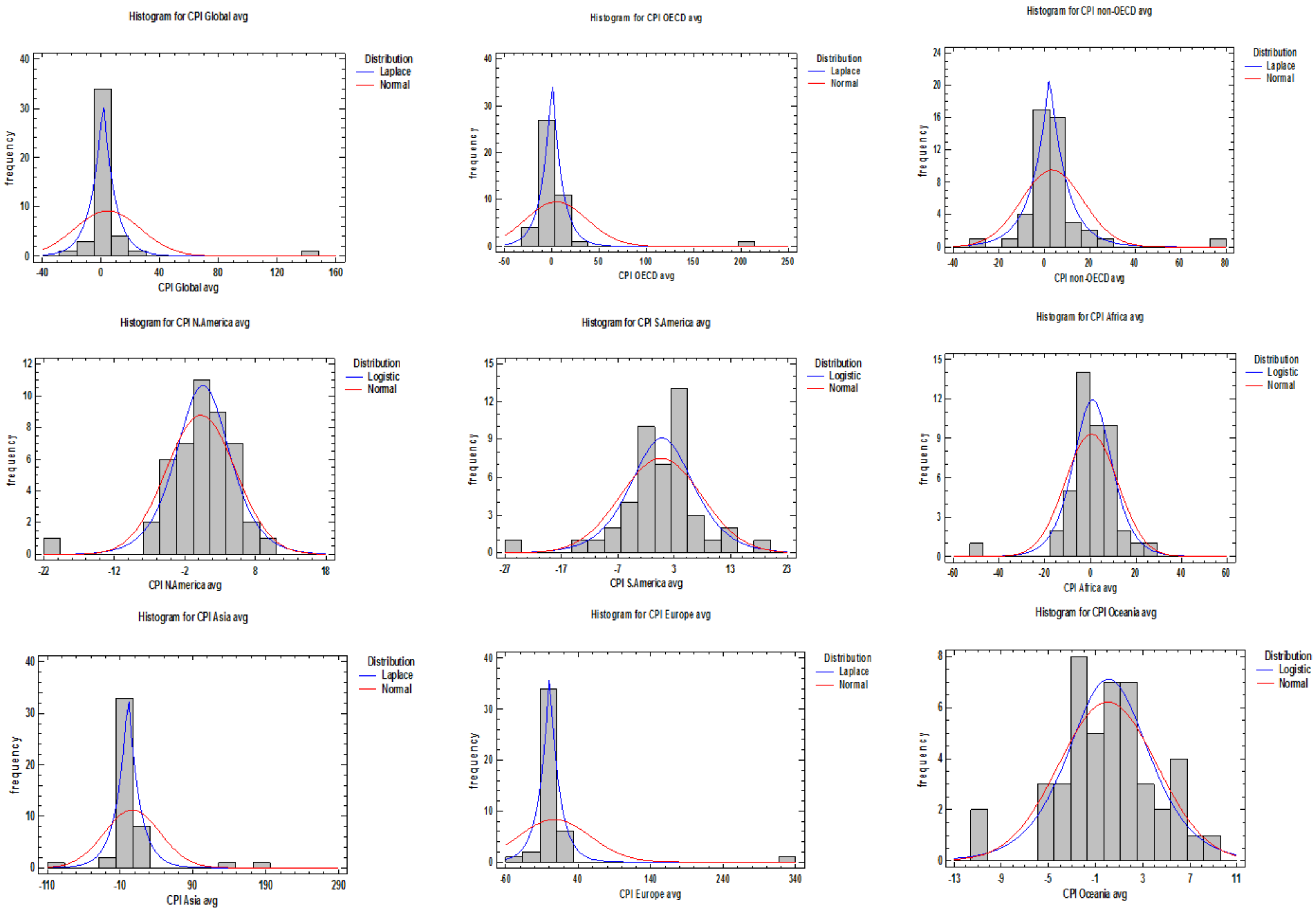
Normal
frequency
C Europe avg
Histogram for C Oceania avg
Distribution
Logistic
Normal
frequency
C Oceania avg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Distribution
Laplace
Normal
frequency
CPI Global avg
Histogram for CPI OECD avg
Distribution
Laplace
Normal
frequency
CPI OECD avg
Histogram for CPI non-OECD avg
Distribution
Laplace
Normal
frequency
CPI non-OECD avg
Histogram for CPI N.America avg
Distribution
Logistic
Normal
frequency
CPI N.America avg
Histogram for CPI S.America avg
Distribution
Logistic
Normal
frequency
CPI S.America avg
Histogram for CPI Africa avg
Distribution
Logistic
Normal
frequency
CPI Africa avg
Histogram for CPI Asia avg
Distribution
Laplace
Normal
frequency
CPI Asia avg
Histogram for CPI Europe avg
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Normal
frequency
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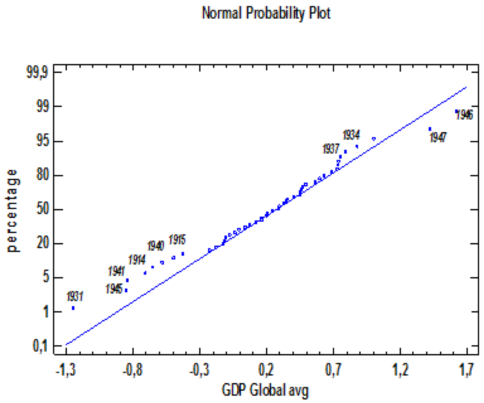
Histogram for CPI Oceania avg
Distribution
Logistic
Normal
frequency
CPI Oceania avg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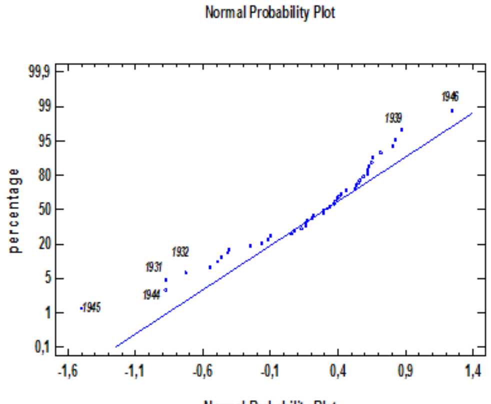
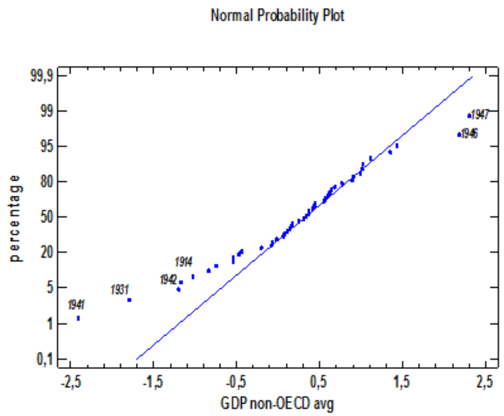
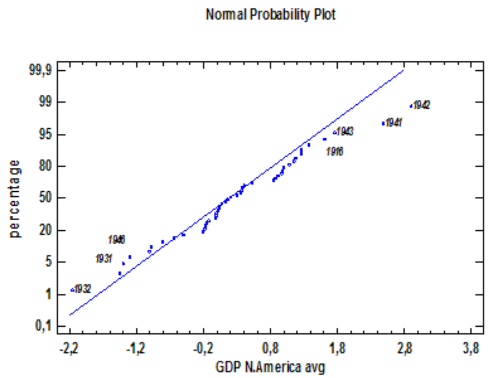
percentage
GDP Global avg


Normal Probability Plot
percentage
GDP S.America avg


Normal Probability Plot
percentage
GDP non-OECD avg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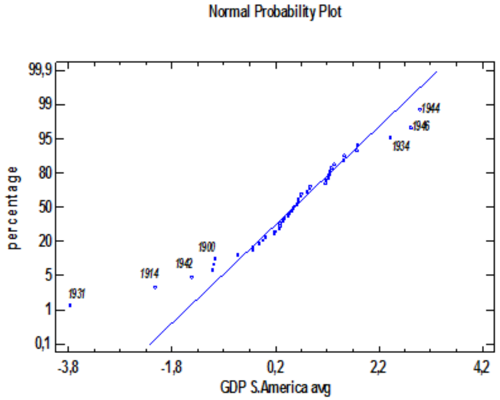
percentage
GDP N.America avg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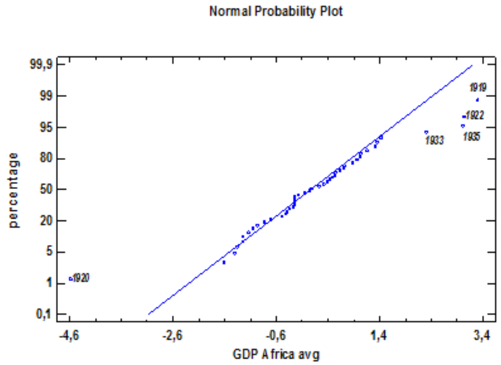
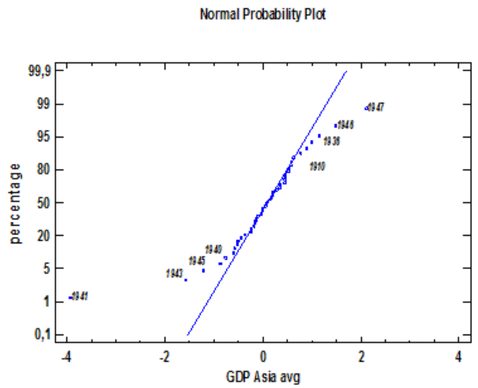
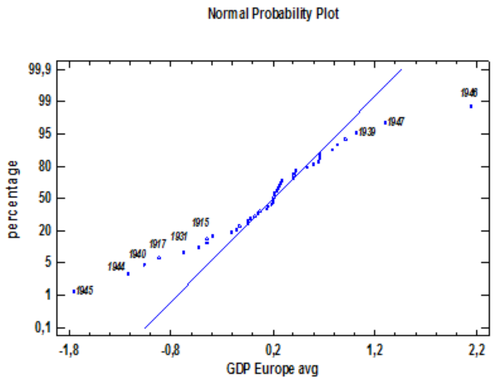
percentage
GDP S.America avg


Normal Probability Plot
percentage
GDP Africa avg


Normal Probability Plot
percentage
GDP Asia avg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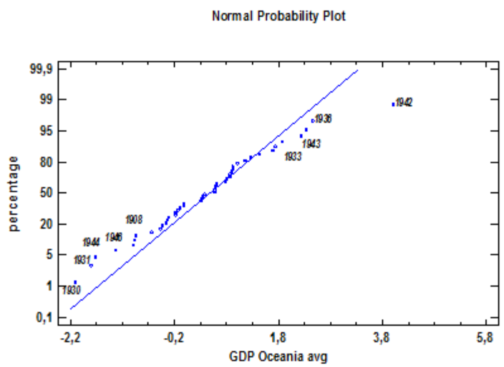
percentage
GDP Europe avg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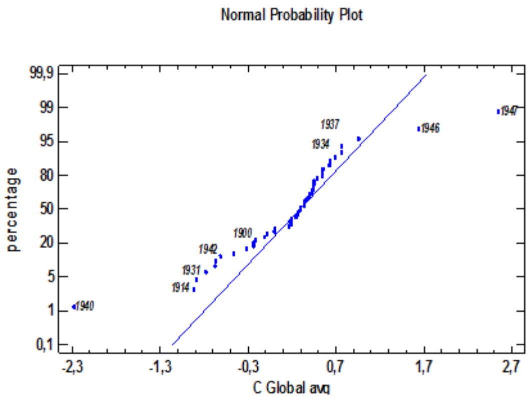
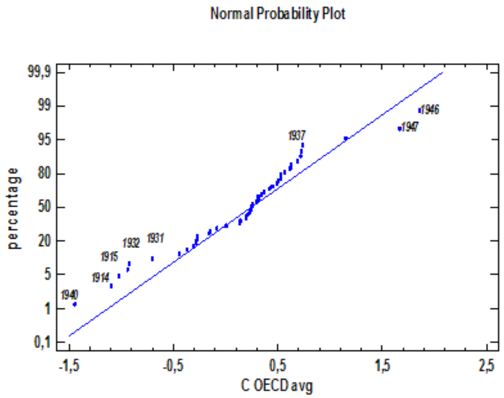
percentage
GDP Oceania avg


Normal Probability Plot
percentage
C Global avg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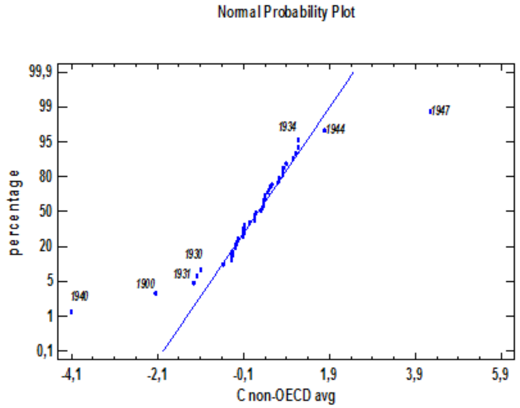
C OECD avg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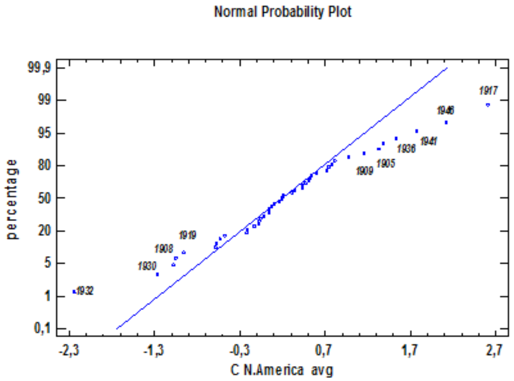
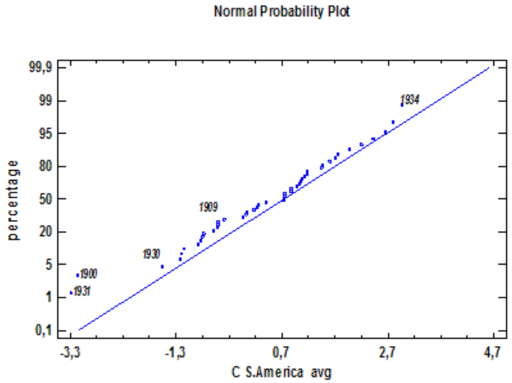
percentage
C non-OECD avg


Normal Probability Plot
percentage
C N.America avg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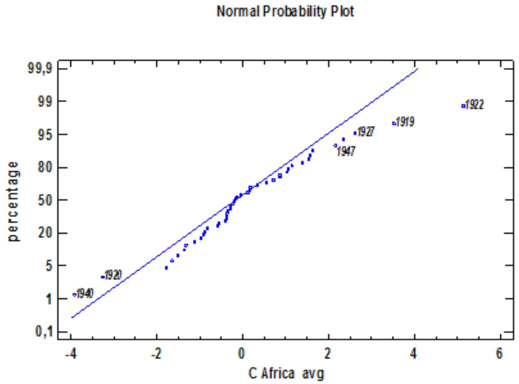
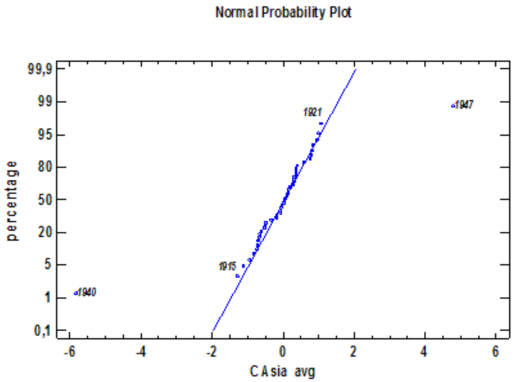
percentage
C S.America avg


Normal Probability Plot
percentage
C Africa avg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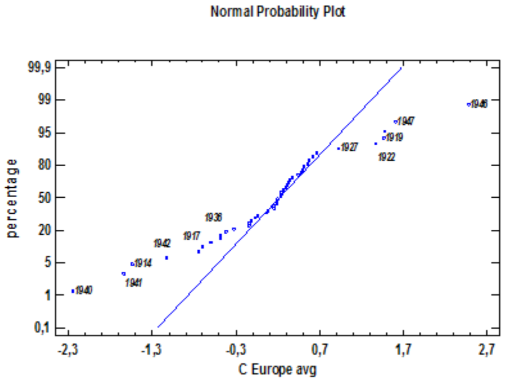
percentage
C Asia avg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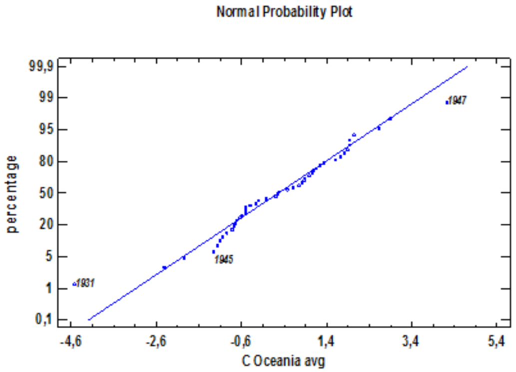
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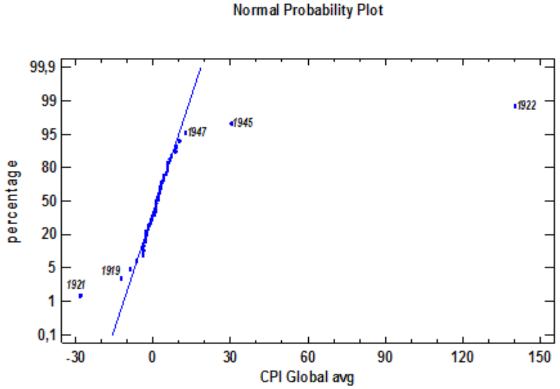
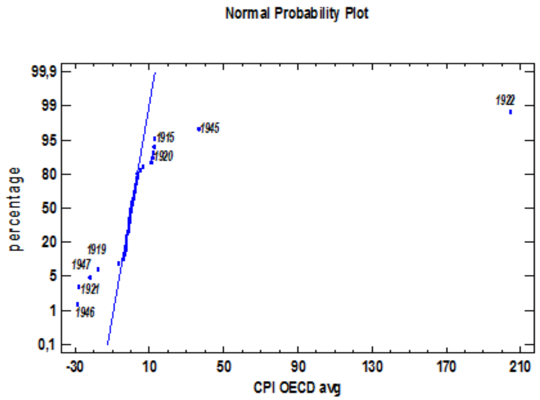
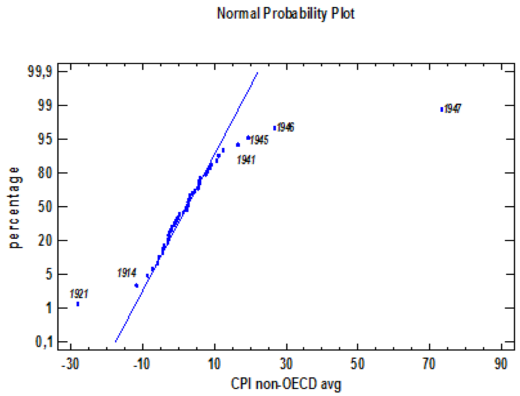
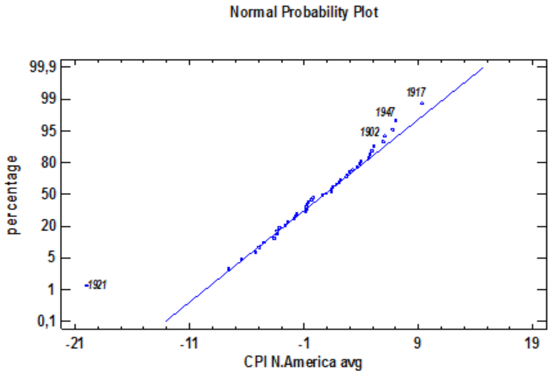
percentage
C Oceania avg


Normal Probability Plot
percentage
CPI Global avg
1921
1919
1947
1945
1922


Normal Probability Plot
percentage
CPI OECD avg
1922
1945
1915
1920
1919
1947
1921
1946


Normal Probability Plot
percentage
CPI non-OECD avg
1947
1946
1945
1941
1914
1921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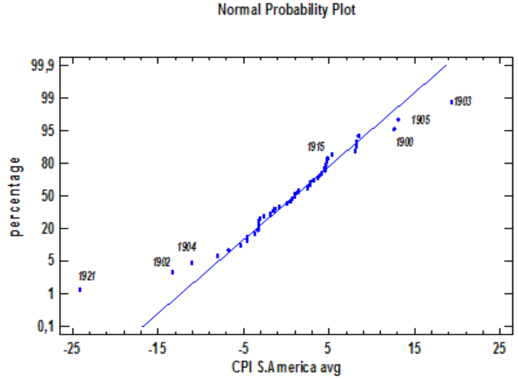
percentage
CPI N.America avg
1917
1947
1902
1921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percentage
CPI S.America avg
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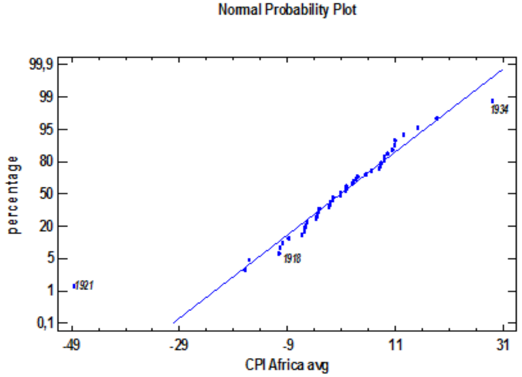
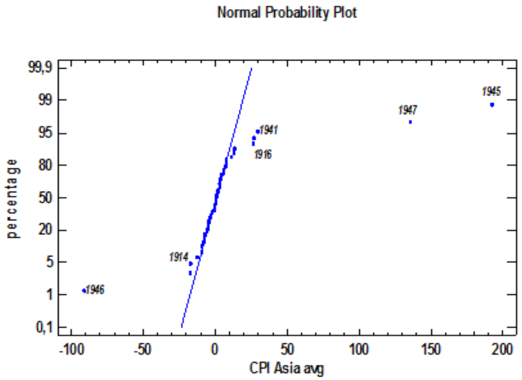
1905
1915
1900
1904
1902
1921


Normal Probability Plot
percentage
CPI Africa avg
1934
1918
1921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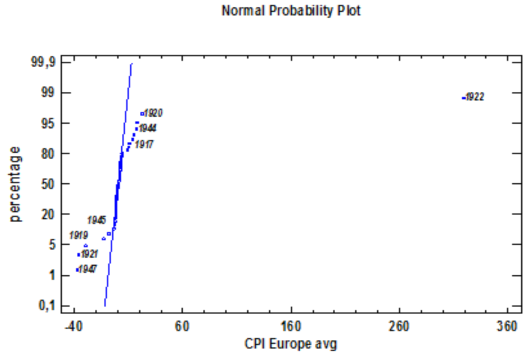
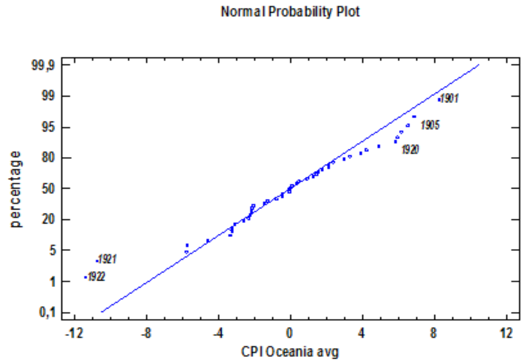
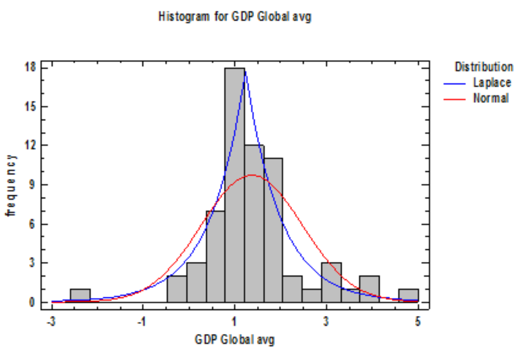
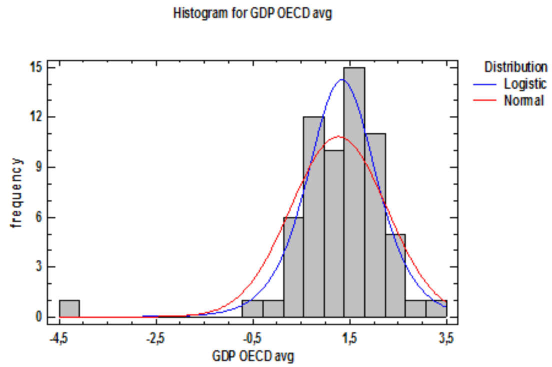
percentage
CPI Asia avg
1945
1947
1941
1916
1914
1946

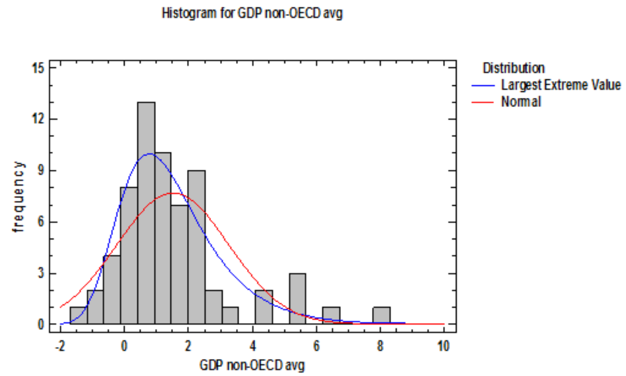

Normal Probability Plot
percentage
CPI Europe avg
1922
1920
1944
1917
1945
1919
1921
1947

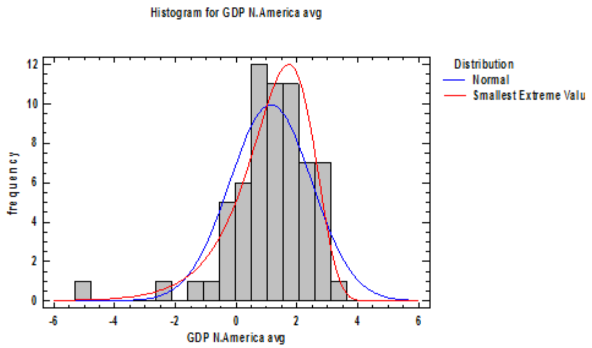

Normal Probability Plot
percentage
CPI Oceania avg
1901
1905
1920
1921
1922

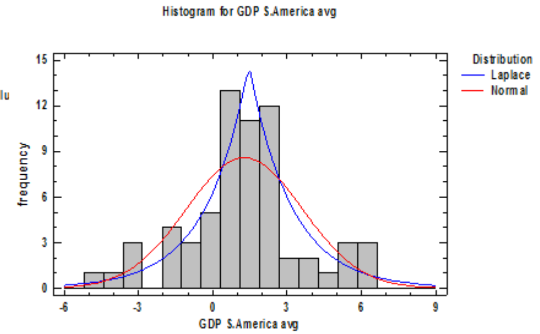
APPENDIX 9 HISTOGRAMS AND NORMAL PROBABILITY PLOTS 1948-2011 YEARS

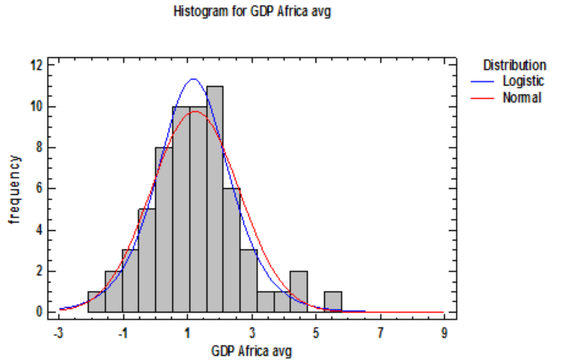


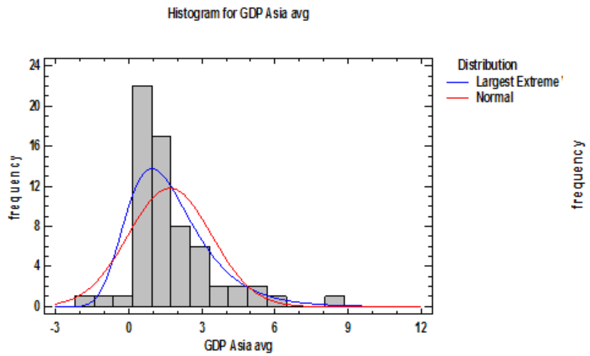


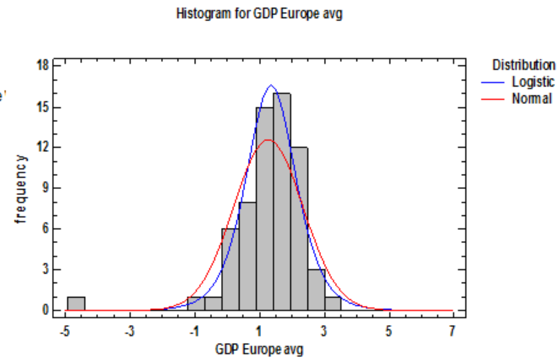


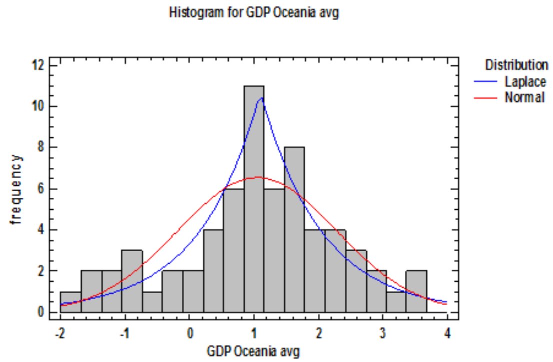




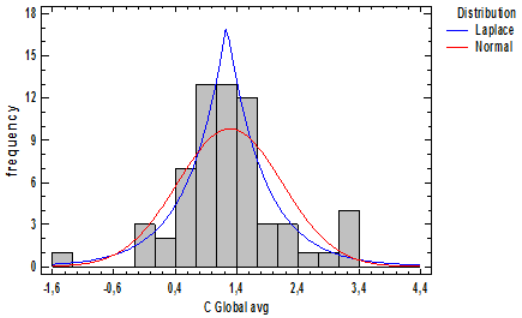




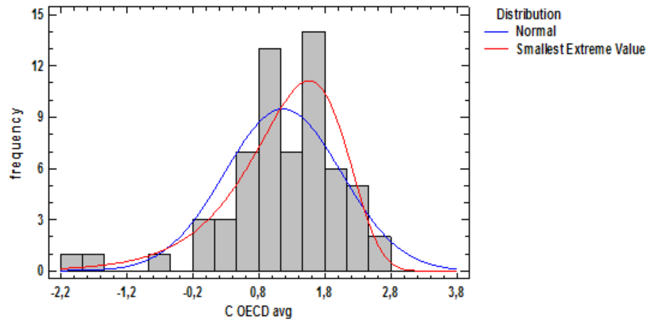




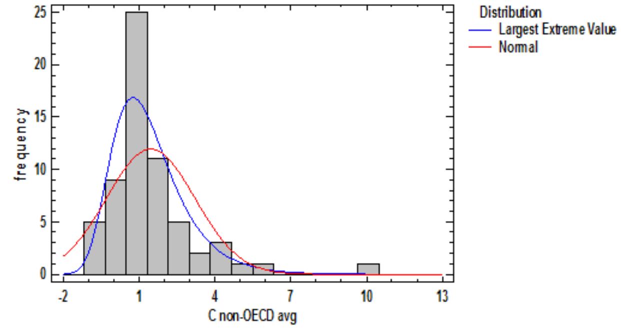
Histogram for C Global avg



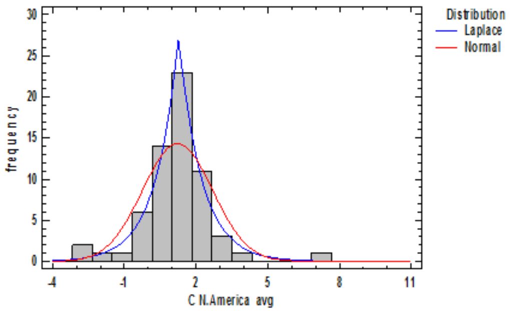
Histogram for C OECD avg



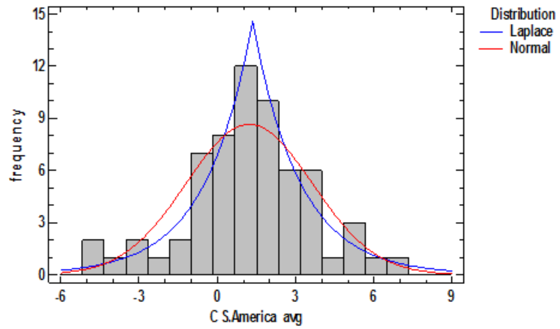
Histogram for C non-OECD avg



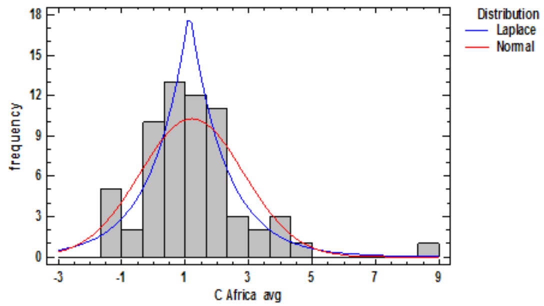
Histogram for C N.America avg



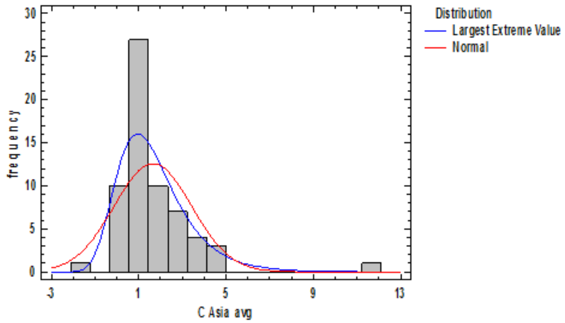
Histogram for C S.America avg



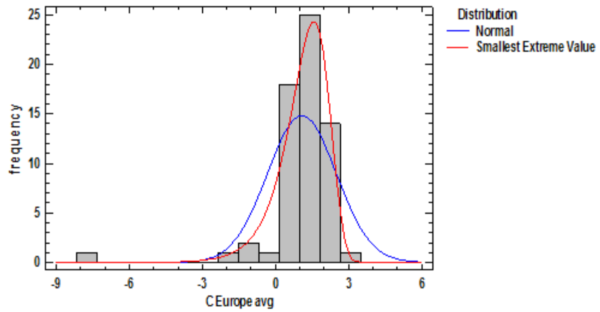
Histogram for C Africa avg



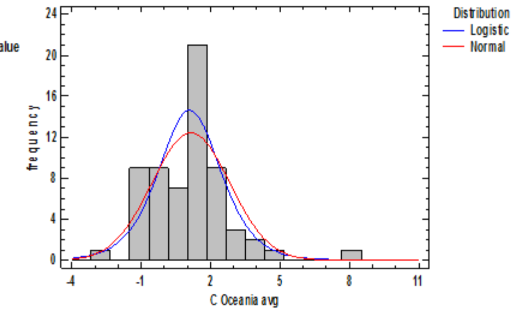
Histogram for C Asia avg



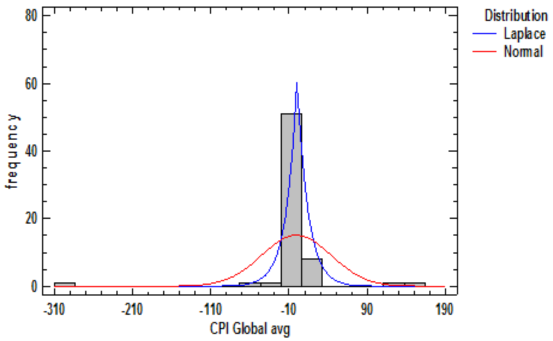
Histogram for C Europe avg



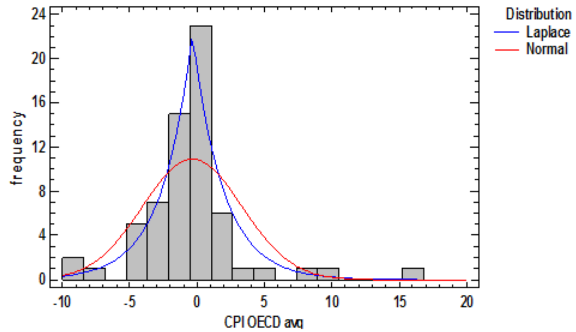
Histogram for C Oceania avg



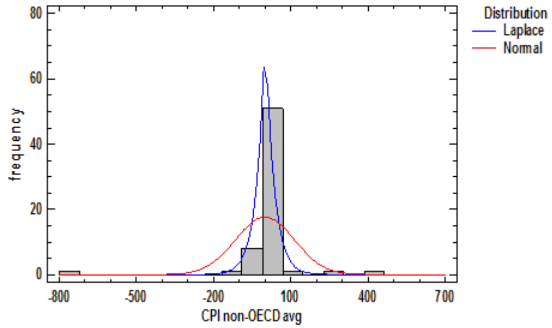
Histogram for CPI Global avg



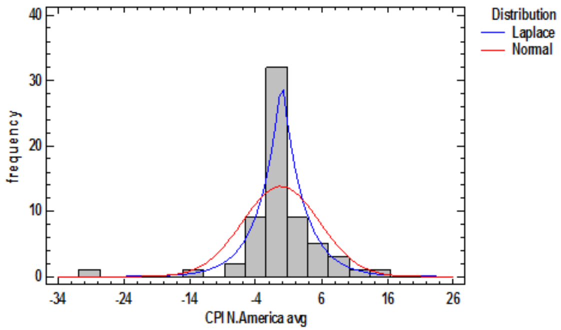
Histogram for CPI OECD avg



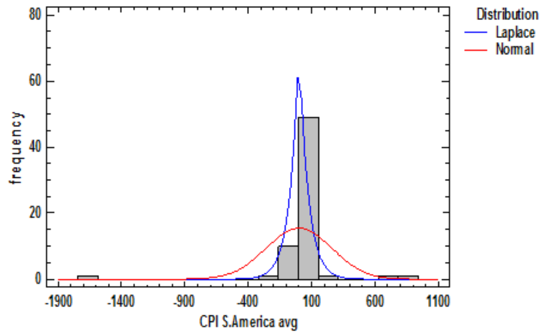
Histogram for CPI non-OECD avg



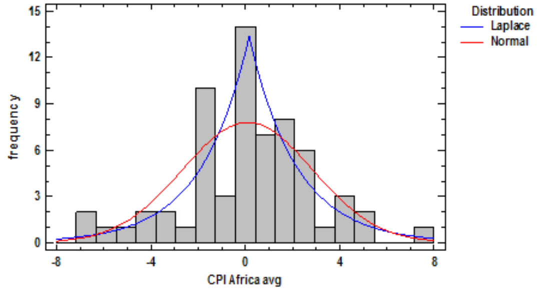
Histogram for CPI N.America avg



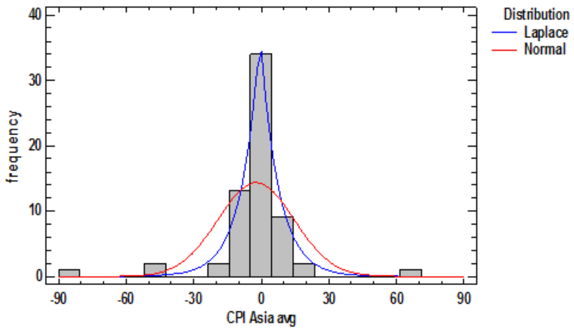
Histogram for CPI S.America avg



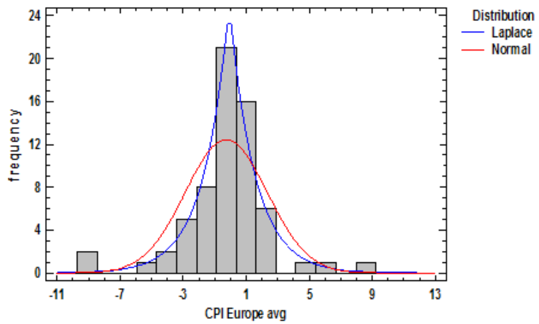
Histogram for CPI Africa avg



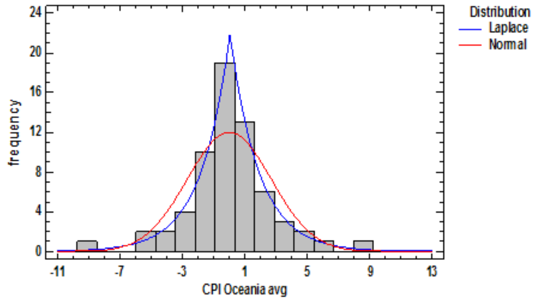
Histogram for CPI Asia avg

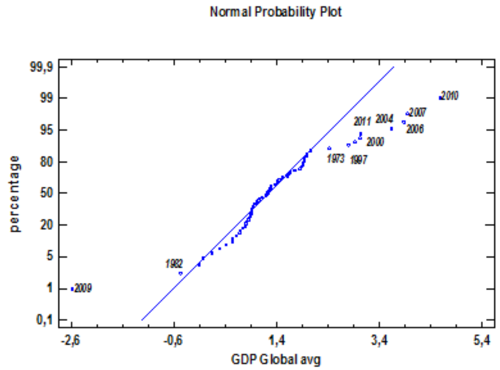


Histogram for CPI Europe avg



Histogram for CPI Oceania avg




Normal Probability Plot
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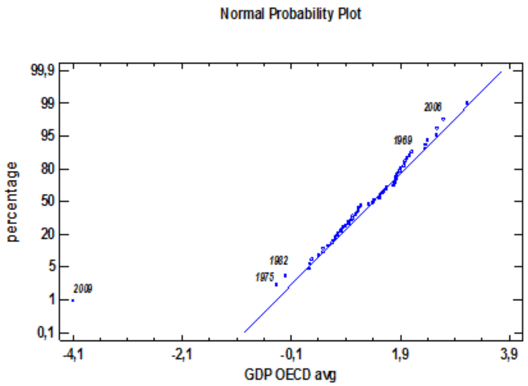
99,9 99 95 80 50 20 5 1 0,1
-2,6 -0,6 1,4 3,4 5,4
GDP Global avg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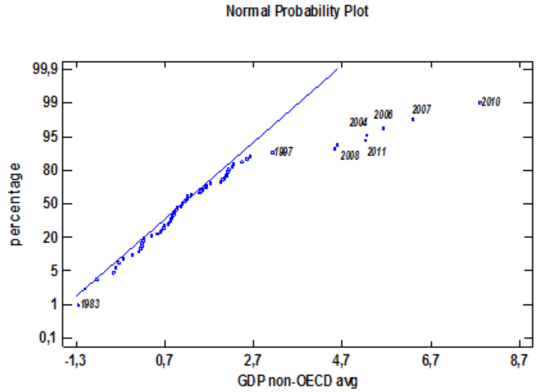
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percentage
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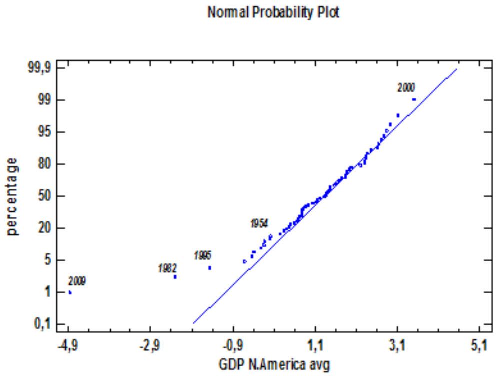
GDP non-OECD avg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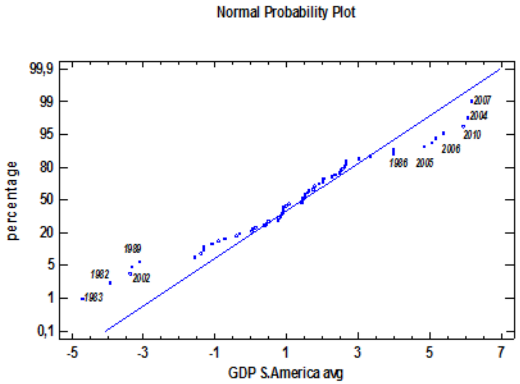
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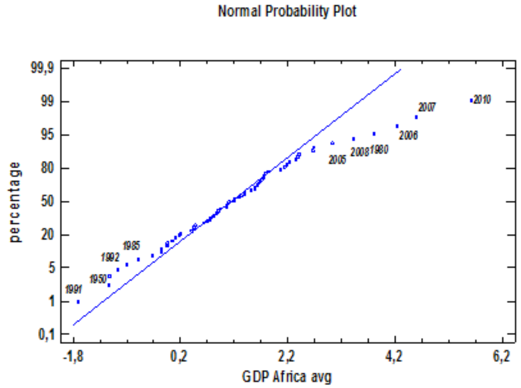
GDP S.America avg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percentage
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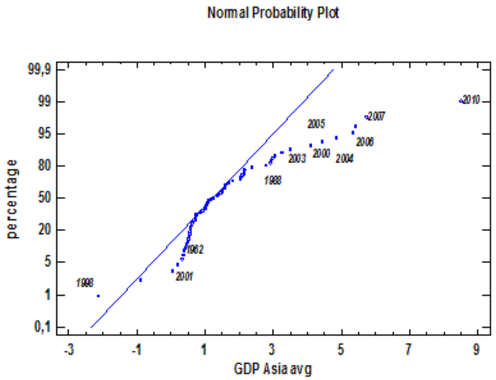
-1,8 0,2 2,2 4,2 6,2
GDP Africa avg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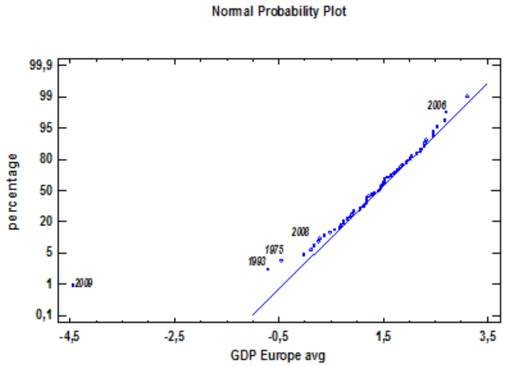
GDP Asia avg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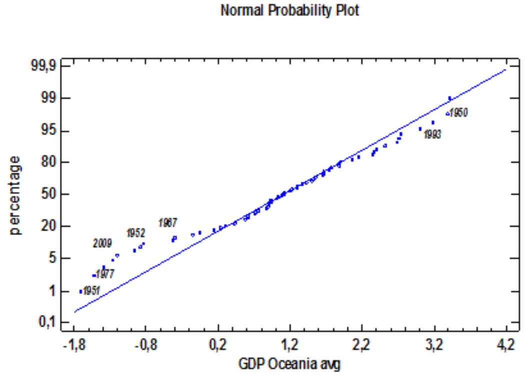
GDP Europe avg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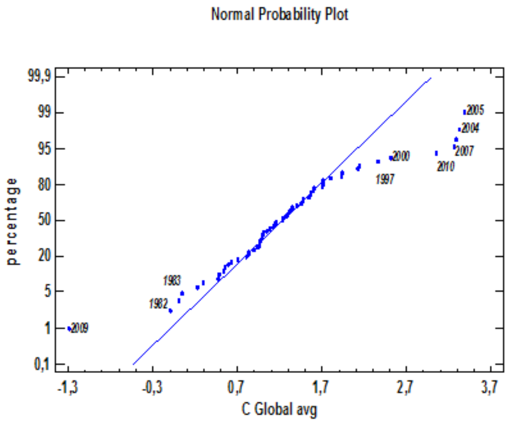
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95
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50
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0,1
-1,3
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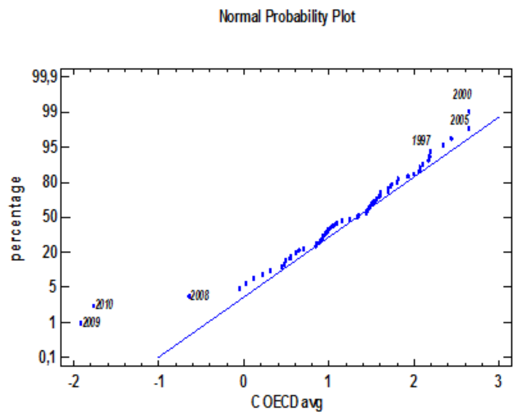
1,7
2,7
3,7
C Global avg
2009
1982
1983
1997
2000
2010
2007
2004
2005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percentage
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99
95
80
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0
1
2
3
C OECD avg
2009
2010
2008
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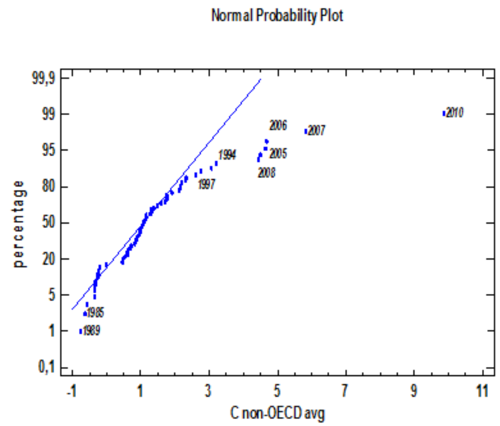
2005
2000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5
7
9
11
C non-OECD avg
1989
1985
1997
1994
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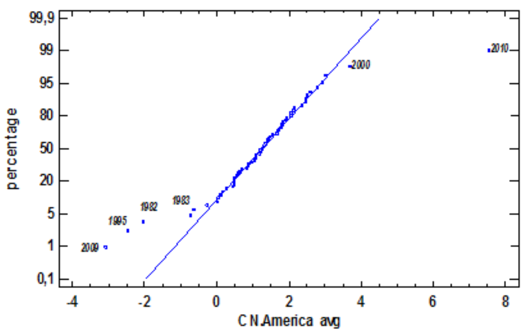
2006
2007
2010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95
80
50
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-4
-2
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4
6
8
C N.America avg
2009
1995
1982
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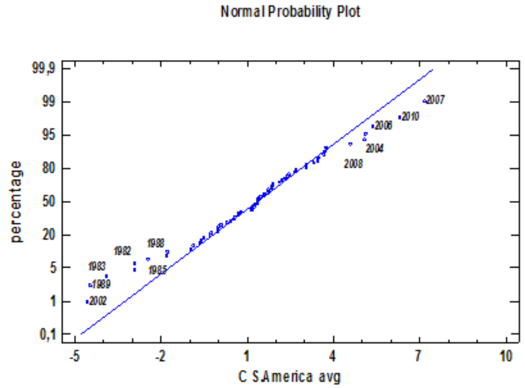
2000
2010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0,1
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7
10
C S.America avg
2002
1989
1983
1982
1988
1985
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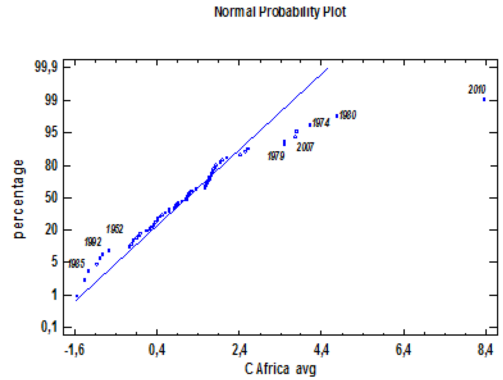
2004
2006
2010
2007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95
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50
20
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0,1
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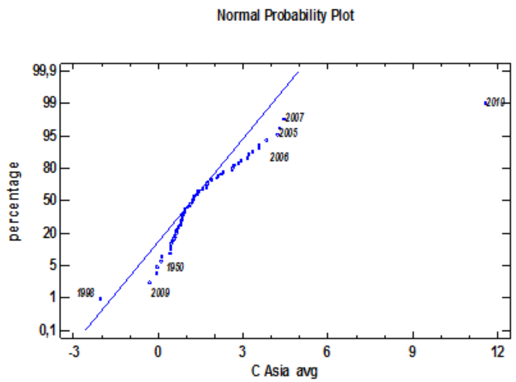
2,4
4,4
6,4
8,4
C Africa avg
1985
1992
1952
1979
2007
1974
1980
2010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9
12
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2006
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2007
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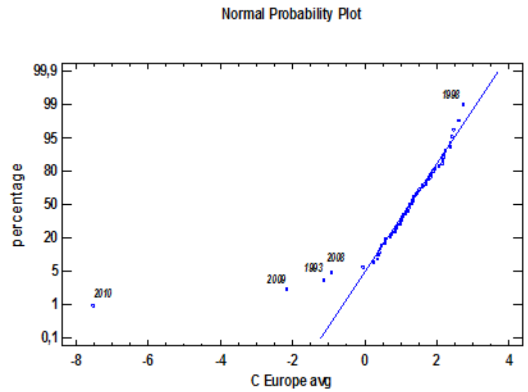
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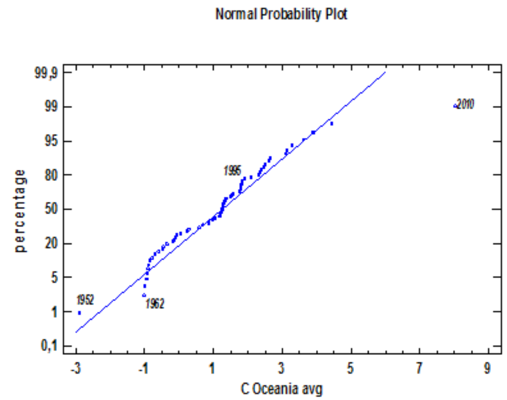
C Europe avg
2010
2009
1993
2008
1998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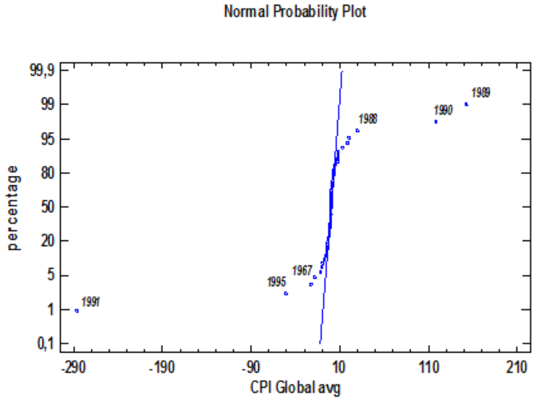
7
9
C Oceania avg
1952
1962
1995
2010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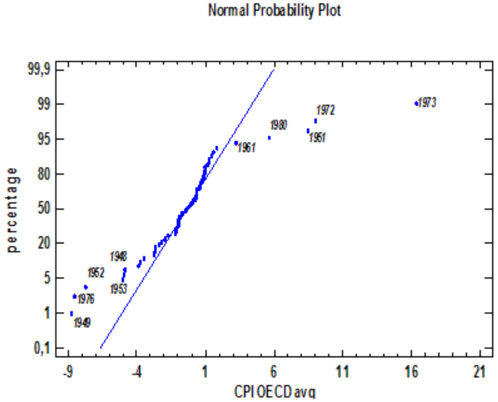
210
CPI Global avg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21
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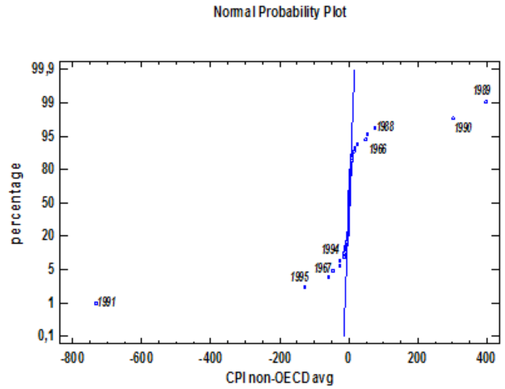
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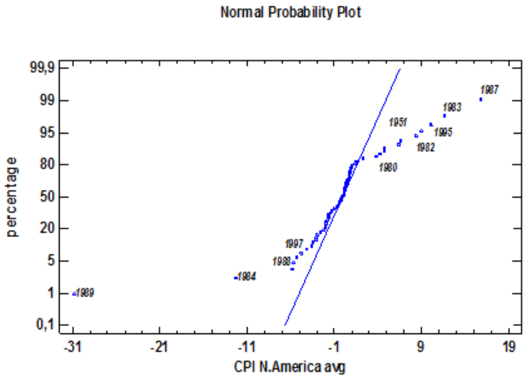
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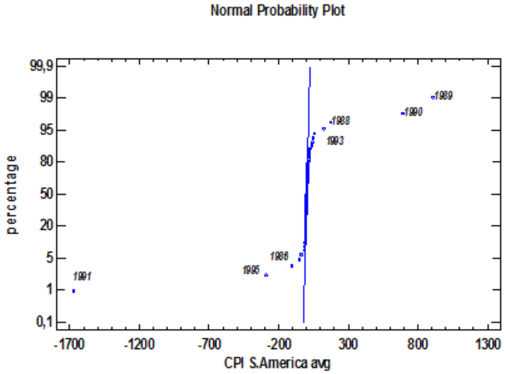
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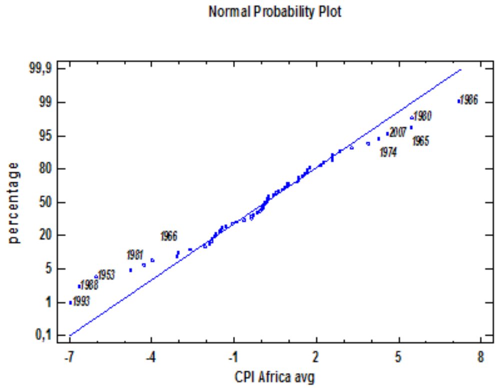
Normal Probability Plot
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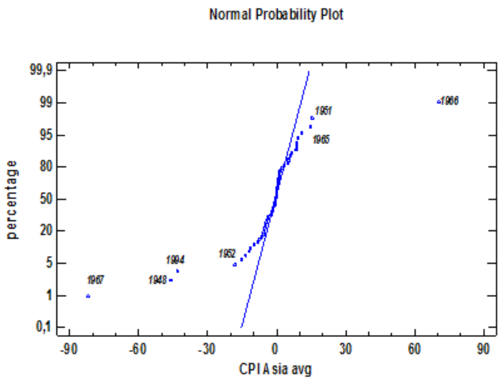
8
CPI Africa avg


Normal Probability Plot
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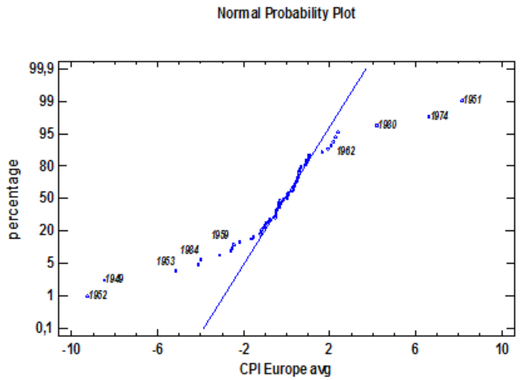
CPI Asia avg


Normal Probability Plot
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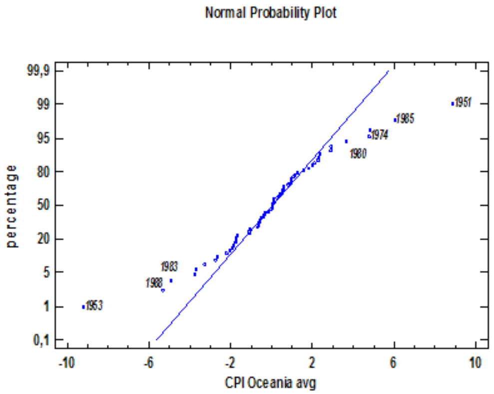
CPI Europe avg


Normal Probability Plot
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10
CPI Oceania avg