Cointegration in Equity Markets: A comparison between South African and major developed and emerging markets

by

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DECLARATION

Except for references specifically indicated in the text, this study is my own work and has not been submitted elsewhere for degree purposes.

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ABSTRACT

Cointegration has important implications for portfolio diversification. One of these is that in order to spread risk it is advisable to invest in markets that are not cointegrated. Over the last several decades communication technology has made the world a smaller place and hence cointegration in equity markets has become more prevalent. The bulk of research into cointegration focuses on developed and Asian markets, with little research been done on African markets.

This study compares the Engle-Granger and Johansen tests for cointegration and uses them to calculate the level of cointegration between South African and other global equity markets. Each market is compared pair-wise with South Africa and the results have been that in general South Africa is cointegrated with other emerging markets but not really with African nor developed markets. Short-run analysis with the error correction was carried out and showed that in general markets respond slowly to any disequilibrium. Innovation accounting methods showed that the country placed first in Cholesky ordering dominates the other one.

Multivariate cointegration was carried out using three selections of 4, 6 and 8 market portfolios. One of the markets was SA and the others were all chosen based on the criteria that they are not pair-wise cointegrated with SA. The level of cointegration varied depending on the portfolios, as did the error correction rates, impulse responses and variance decomposition. The one constant was that the USA dominated any portfolio where it was introduced. Recommendations were finally made about which market portfolio an investor should consider as most favourable.

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Chapter 1

Introduction

1.1 Context of Research

The global integration of financial markets as well as decreasing marginal returns obtained in developed countries have made investment in emerging markets a topical issue. However, the emerging markets are generally more volatile as defined by the reward-to-volatility ratio and any economic recession in developed markets will affect the developing markets strongly because investor confidence in these markets drops, sometimes without any serious justification but more because of a "herd instinct" (Harford, 2006: 12; Duasa and Kassim, 2009: 3). Over the last decades there has also been a relaxation of capital controls which has increased investors' interest in international diversification. This allows a larger basket of financial foreign goods to choose from as part of their portfolios. Despite these problems investors realise the importance of emerging markets and these have been the subject of many scientific studies in recent years.

Studies on emerging markets have also increased since the equity market crises in 1987 when the stock markets globally crashed and in 1997 when the Asian financial crisis hit the markets. These studies also looked at the level of integration that African markets have with the rest of the world. Before the 1980s, there was little research done on African markets mainly because of the difficulty in finding credible data. In addition, as most African markets were not of interest to foreign investors, researchers ignored them. The improvement in communication technology allowed the world access to investments in Africa and other developing parts of the world. Most of these studies have tried to show how a group of selected developed markets affected African markets; these developed markets are in most cases the USA, Western Europe and Japan. These studies also revealed that in general the African markets are independent of the developed markets, the exceptions being South Africa and Egypt, which are coincidentally the most developed of African equity markets (Lamba and Otchere, 2001: 20; Biekpe and Collins, 2003: 190).

One area of interest in these studies is how emerging markets are linked with developed markets and whether or not movements between them are somehow cointegrated.

Cointegration of these markets means looking to see if there is long-term equilibrium between them. A more technical definition of cointegration is that, if two or more variables are non-stationary but their linear combination is stationary, it can be said that those variables are cointegrated (Enders, 2004: 319). The financial markets of developing countries are examined to see how these markets may follow a random walk but if combined with the markets of developed countries, these markets may be cointegrated.

The main use of testing for cointegration is its effect on portfolio diversification. If cointegration exists then the benefits of portfolio diversification are limited. For example, if the markets of the USA and Ghana are found to be cointegrated then an investor who tries to hedge his risk from the USA equity market by investing in Ghana will not be protected from shocks. This is because the markets of Ghana and the USA move together and any movement in one market will be copied in the other one as well. Hence, in this case, there is no gain to be made by splitting an investment between these two markets. In order for portfolio diversification to be an effective hedging strategy it is necessary that the markets in which it is done are not cointegrated (Phengpis and Swanson, 2006: 316). With our current available technology, information travels very rapidly between interested parties, hence the same information is available in all markets worldwide; they usually have the same effect regardless of the location or the level of development of the country. For example, the USA invasion of Afghanistan in 2003 had the same negative effect on all markets (Wadhams and Korb, 2007: 8). As expected, early tests for cointegration conducted in the 1970s when it was first defined as a topic found some evidence of cointegration between certain markets (Ripley, 1973; Solnik, 1974; Panton *et al.*, 1976; Hillard, 1979). Tests conducted more recently have obtained more convincing results as the improvements in communication technology effectively make the world a smaller place (Kasa, 1992: 95; Arbelàez *et al.*, 2001: 237; Chen *et al.,* 2002: 1113; Voronkova, 2004: 633).

1.2 Objectives of the Study

The main goals of this study are:

- To introduce the concepts of cointegration, heteroscedasticity, autocorrelation and outline the more important theory pertaining to these concepts.

- Test for cointegration between South African equity markets and other emerging markets and developed markets.
- Compare different methods of cointegration, mainly the Engle-Granger procedure and the Johansen test.
- Describe what implications the presence or lack of cointegration will have on the markets.
- Explain the terms “short-run equilibrium” and “long-run equilibrium”.
- Use the error correction mechanism, impulse response functions and variance decompositions to analyze the short-run dynamics of the model.

1.3 Methodology

Using *E-Views* and *Statistica*, the following statistical analyses were done:

- Data were differenced of the same order and individual variables were tested for stationarity.
- The linear combinations of the differenced variables were tested for stationarity.
- Cointegration was tested using the Engle-Granger and Johansen methods.
- Assumptions necessary for OLS were checked.
- Multi-time series tests were carried out to test for the presence of cointegrated vector autoregression.

1.4 Data

The data used were equity market indices from various developed and emerging markets. The data are accessible from the Thomson Datastream**.** Data were actual price indices as well as the Morgan Stanley Capital International (MSCI) World index. This is a well respected global equity index and is often used for research. Financial information is available on all major indices. The procedure used to decide on the markets chosen was as follows: data on every available African market were considered. For the developed and other emerging markets, the largest equity markets were selected. In addition, some of the more populous countries whose equity markets are not on the list of biggest markets in the world were used.

When deciding what time period to use, weekly data were selected because it is less susceptible to shocks than daily data and are generally smoother. Using monthly data may not provide an adequate amount of observations. In addition, the natural logarithm of the data are taken as well so as to make the scale more even when comparing different series. The data are available from December 1995 to April 2010, a total of 747 observations. Data are available for earlier periods for the more developed and well known stock markets. However, data for emerging markets, especially from Africa, are not available for earlier periods and when they are, only monthly data are used. As a result it was not possible to split the data into three periods, namely: before the stock market crash of 1987, between the crashes of 1987 and 1997, and after the 1997 crash. A visual inspection of the time series plots of the data showed that there could be potentially increased cointegration after 2003; hence, markets were also tested for cointegration using data from 2003 onwards.

Using information from the International Monetary fund, the markets were split into developed and emerging ones. The emerging markets used were as follows:

Africa: Egypt, Morocco, Nigeria, South Africa

Europe: Poland, Russia, Turkey

Asia: Bangladesh, China, India, Indonesia, Pakistan, Philippines, Thailand

South and *Central America*: Argentina, Brazil, Colombia, Mexico.

The developed markets used were:

Europe: France, Germany, Netherlands, Spain, Switzerland, UK

North America: Canada, USA

Asia and *Australasia*: Australia, Hong Kong, Japan, South Korea.

1.5 Organization of the Study

The next chapter examines previous research in cointegration and summarizes key findings. It also includes a summary of the history of cointegration and portfolio diversification. Chapter 3 examines the methods to be used in more detail; it includes derivation of key results as well as outlines of proofs of some of the theorems. In Chapter 4 the results of the data analyses are presented and discussed. Finally, there is the conclusion where a summary of the study is presented along with a discussion about possible areas for further research.

Chapter 2

Literature Review

2.1 History of Cointegration

The history of cointegration had a rather interesting beginning. Towards the end of the 19th century, there was interest in investigating peculiar correlations, one of the more famous examples being the high correlation between the number of storks nesting in chimneys and the number of babies born in those households. In 1901 Hooker created the first steps with a look at the correlation between marriage rate and trade and found that there was a significant correlation. However, the first analytical results were provided by Yule in 1926 who looked at the dangers of looking at correlation between non-stationary variables and how this provided us with spurious regression. Yule based his work on Brownian motion which had been used to model equity price movements. In his paper, Yule showed that any two integrated series could be significantly correlated, even though their initial shocks and positions were unrelated, this is one of the first instances of cointegration.

Research into this area was left untouched until the 1970s when increased computer processing power became available and made analysis of long-term time series data possible. Granger and Newbold drew renewed attention to the problem of nonsense correlation in 1977. In this paper they showed that taking the difference between the variables solved the problem. However, despite all the improvements the prevailing econometric models still performed less effectively than time-series devices not based on any theory, so in effect they were not much better than a guess. This led to a search for the resolution to this problem, which was eventually solved by Granger.

Ironically, Clive Granger, who co-authored with Robert Engle one of the more popular tests for cointegration, at first denied its existence at a conference in 1975, despite it being rather obvious to other researchers. Granger was critical of a class of economic models introduced by Sargan known as equilibrium correction, where it is assumed that trends generally converge to equilibrium (Sargan, 1964). Granger's problem with these series was that the stationarity of combinations of variables was assumed, and not proven. Integrated data properties were also taken as given rather than verified empirically from the models. If econometric models for the other variables were also postulated, such that the system had a long-run equilibrium, then that contradicted the fact that the data were integrated. To avoid this problem, the same feedback had to occur in several equations. Granger set out to prove that linear combinations of integrated variables would remain integrated. In the process, he developed the conditions under which cointegration could occur. The main result of this was the Granger representation theorem. Engle and Granger proposed a way of estimating equations containing potentially cointegrated relationships and their two-step method led to new theory and applications.

The condition that there are fewer levels of feedback than variables generates a reduced-rank in the long-run matrix of the dynamics and leads to the multivariate cointegration approach developed by Johansen in 1988. The main benefit of this test over the Engle-Granger (EG) procedure is that it does not require all variables to be in the same order of integration.

2.2 Portfolio Diversification

Portfolio diversification can take on several forms. However, since in this study only equity markets are dealt with, portfolio diversification will be defined as holding equities in different markets, for example having equity in South African, British and American markets.

The benefits of portfolio diversification were advocated before statistical methods became available. Shakespeare wrote in *The Merchant of Venice* "… I thank my fortune for it, My ventures are not in one bottom trusted, Nor to one place; nor is my whole estate Upon the fortune of this present year…". Using variance to measure risk was first suggested by Fisher in 1906. He suggested that the more variance an asset had, the riskier it would become. However, in his book *The Theory of Investment Value*, Williams (1938) believed that all risk could be removed by holding a portfolio with a wide variety of financial assets, which proved to be a false statement.

Markowitz (1952) had the idea that while diversification would reduce risk it would not remove it completely. He suggested that an investor should maximize returns and at the same time minimize risk. His 1952 paper was the first to apply mathematical methods to the problem of portfolio selection. When looking at the variance of assets, the important point to consider is how a particular asset will affect the total variance of the portfolio and not its individual variance. Interestingly enough, Roy (1952) published a paper with almost identical conclusions as Markowitz, virtually at the same time. Markowitz and other authors have subsequently extended his initial ideas to incorporate other areas (Tobin, 1958; Sharpe, 1964). Rubinstein in a 2002 paper analysed Markowitz's seminal work and found that his ideas were responsible for transforming portfolio diversification from what was in effect guesswork into a topic with valid mathematical principles.

One of the areas which Markowitz missed was that he focused on diversification within borders; he did not consider international diversification. Grubel, in a 1968 paper, attempted to fill in these gaps and came to the conclusion that international portfolio diversification boosts overall trade. He also found that when international equity markets move together, the benefits of portfolio diversification across borders are limited.

Theories regarding portfolio diversification have changed over time and the current school of thought is that in order to minimize the risk, assets in a portfolio should be weakly correlated and that the equities should be negatively correlated. These conditions are in place ensuring that any equity losses will be compensated for by others gaining in value and, hence, the losses in one equity will be balanced by gains in others (Glezakos *et al.*, 2007: 25). Morana and Beltratti, in a 2006 paper, found that in order for international equity markets to be weakly correlated, it is necessary that the economies have different macro-economic policies. Hence, *a priori* assumptions would be that markets in countries of similar levels of economic development, each following similar economic policies, would have high levels of cointegration. So, for example, markets in the USA and the UK are expected to be cointegrated. The reverse assumption is also true, developed and developing countries will not have levels of cointegration as high as those between countries at similar stages of economic development. Despite some inconsistencies, studies conducted under these assumptions have generally supported this conclusion (Wong *et al.*, 2004: 201; Worthington and Higgs, 2004: 90; Alagidede, 2008: 3).

After Grubel promoted the use of international portfolio diversification, yet at the same time to be wary of markets which are cointegrated, several researchers soon looked to see what comovements, if any, occurred between markets. The bulk of the research conducted in the 1970s found that there was little cointegration between markets (Ripley, 1973; Solnik, 1974; Panton *et al.*, 1976; Hillard, 1979). However, a few researchers found that equity prices in markets of developed countries move together (Agmon, 1972). Since the 1970s, there have been numerous improvements in communication technology, financial innovations, financial liberalization and other areas. These developments have led to a freer exchange of information and as a result, since the 1980s, the levels of cointegration have greatly increased. As a result studies into cointegration have found that the levels of cointegration have increased considerably since the 1970s (Kasa, 1992: 95; Arbelàez *et al*., 2001: 237; Chen *et al*., 2002: 1113; Voronkova, 2004: 633).

2.3 Empirical Findings of Cointegration

The findings of some of the researchers are as follows: Paul Alagidede, analyzing markets in Africa, found that the markets in Africa are not well integrated with each other and have a weak relationship with the developed countries. External shocks do not have as big an effect on African markets as local shocks (Alagidede, 2008: 29). Alagidede also found that South Africa suffered during the 1997/1998 Asian financial crisis, a sign of cointegration. Another group of four researchers (Wong *et al*., 2004) compared markets in the Asia-Pacific region with developed markets and found that the levels of cointegration between the markets varied with different countries being influenced differently by external shocks. What was interesting was that the level of cointegration intensified strongly after the 1987 stock market crash and again after the 1997 crash. They found that this increased cointegration limited the usefulness of asset diversification across international borders, which was assumed (Wong *et al.*, 2004: 214). Worthington and Higgs found that cointegration between markets varied depending on geographical location with markets in North Asia, Australasia and South America; these were more influenced by domestic conditions whereas markets in South Asia were more strongly influenced by markets outside of their geographical region (Worthington and Higgs, 2004: 90).

Linne (1998) reported evidence of cointegration between emerging Central and Eastern European markets but they are not individually cointegrated with any of the major world equity markets. MacDonald (2001) analyzed the stock market indices of Central and Eastern European indices as a group against each of three developed markets and found significant long-run relationships. However, Gilmor and McManus (2002) found that the Central and Eastern European markets were not linked with the USA markets. They only tested against the USA market and not other developed markets.

Subsequent research was done comparing African markets and the main conclusion was that African markets were not well cointegrated with each other, with the exception of a few cases where Namibia was found to be cointegrated with South Africa. The African markets were also found to be poorly cointegrated with global markets when compared pair-wise, but certain combinations of portfolios from various markets revealed the presence of cointegration (Appiah-Kusi and Pescetto, 1998; Piesse and Hearn, 2002; Wang *et al*., 2003; Collins and Abrahamson, 2004). As Piesse and Hearn note, since the late 1980s, the IMF and World Bank have sponsored structural adjustment programs in the equity markets of most African countries. This, along with more easily available stock price information, has increased foreign participation in African markets. African markets have traditionally not been regarded as safe by foreign investors due to concerns about political stability, corruption, lack of proper legal and commercial structure amongst other things. However, the structural adjustment of the financial sector and the increased political integration in the form of trade unions have increased the chances of cointegration amongst African markets and African markets with the rest of the world (Piesse and Hearn, 2005: 38). Bekaert and Harvey (2002) also conducted research and summarized key findings that have been made over the last few decades and found that traditional models do not fit the data as well as with developed markets. In addition, the data that are available for emerging markets are not as detailed and extensive as that available for developed markets.

2.4 Efficiency

There is a direct correlation between the levels of cointegration and the improvement in transferring information. This idea was first formulated by Fama in 1970. In this paper he introduces an idea known as the Efficient Market Hypothesis (EMH). This hypothesis basically states that equity markets are informationally efficient, which means that any available information is transferred to the market so that the equity price is a true reflection. The EMH can take on three forms: weak, semi-strong and strong. In weak efficiency, future prices cannot be predicted by analyzing previous prices. In the long run, excess returns cannot be earned by using strategies based on historical equity prices. There are no patterns in asset prices which imply that future prices are determined by information not contained in the price series and prices follow a random walk. For semi-strong efficiency, prices adjust rapidly to publicly available information and in strong efficiency prices reflect all information, public and private, as soon as it becomes available.

The EMH is concerned with detailing how quickly information is transferred through the market; useful information for an investor. It can be hypothesized that before the 1980s, there was poor transfer of information between equity markets, hence the same information would not be available in all markets and as a result there were no comovements in markets because they all had conflicting information. This was generally an era of weak efficiency. Since the 1980s the world has moved into an era of semi-strong efficiency, where information can be transferred momentarily from one person to another. With the advent of the Internet it has become much harder to keep information private. The same information is now available to all markets and hence, increased levels of cointegration have been seen as markets respond in similar manner to the same news. Strong efficiency will probably never be achieved as long as activities such as insider trading are practiced.

2.5 Comparison of Tests of Cointegration

There are a number of problems associated with the Engle-Granger (EG) test of cointegration. The first of these is that the test is biased towards finding regression. The stationarity of the estimated residuals is tested with a unit root test in the second step. However, these residuals are estimates of the true residuals. They are calculated using OLS regression which minimizes the sum of squared residuals. Since the residual variance is made as small as possible, this process is biased towards finding stationarity of the error process. Regular Dickey-Fuller tables cannot be used for this reason to estimate the cointegrating vector. New critical values have to be calculated bearing this shortcoming in mind (MacKinnon, 2010: 11).

Another problem is that in tests with three or more variables there may be more than one cointegrating vector and this method has no procedure for the separate estimation of the multiple cointegrating vectors. The EG procedure can only produce one cointegrating vector as output. Hence, this procedure is effective only when comparing two time series at a time. The Johansen maximum likelihood estimators circumvent the use of two-step estimators and can test for the presence of multiple cointegrating vectors. In addition, the EG procedure is a two-stage process and as a result any mistakes that are made in the first step will be carried over to the second step (Karagianni *et al*., 2002: 107).

Another problem is that very different results may be obtained depending on which variable is taken as the dependent one and which as the independent one in the initial regression. Because of this inconsistency it is common to try two regressions, with them swopping the independent and dependent variables. The Johansen test is robust to various departures from normality in that it allows any of the variables to be used as the dependent variable while maintaining the same cointegration results (Johansen and Juselius, 1990: 171).

The Johansen test can also place restrictions on the cointegrating vector(s) and the speed of adjustment coefficients (Juselius, 2006: 173).

All the problems mentioned above are the reason why the Johansen procedure has become the more popular test between the two. A drawback of the Johansen procedure is that it can be more difficult to interpret, especially when there is more than one cointegrating vector. If this is the case then it is necessary to decide which cointegrating vector is appropriate.

As mentioned by Cheung and Lai (1993), another disadvantage that the Johansen test has is that it is susceptible to a small sample bias. However, since in this study the sample sizes are 747, this should not be an issue.

Chapter 3

Theoretical Considerations

3.1 Stationarity

Before introducing the concept of cointegration, it is first necessary to describe what it means if a series is stationary. Simply put, a stochastic process is said to be stationary if its mean and variance are constant over time and the value of the covariance between the two time periods depends only on the distance between the two time periods and not the time at which the covariance is calculated. Such a stochastic process is known as covariance stationary or weakly stationary (Gujarati, 2003: 797). Formally, such a process has the following properties, if at all times *t* and *t-s*,

$$E(y_t) = E(y_{t-s}) = \mu \qquad [1]$$

$$E[(y_t - \mu)^2] = E[(y_{t-s} - \mu)^2] = \sigma_y^2 \qquad [var(y_t) = var(y_{t-s}) = \sigma_y^2] \qquad [2]$$

$$E[(y_t - \mu)(y_{t-s} - \mu)] = E\big[(y_{t-j} - \mu)(y_{t-j-s} - \mu)\big] = \gamma_s \qquad [3]$$

$$[cov(y_t, y_{t-s}) = cov(y_{t-j}, y_{t-j-s}) = \gamma_s]$$

where $\mu, \sigma_y^2, \gamma_s$ are all constants.

Unlike covariance stationary time series, a strongly stationary time series need not have a finite mean or variance. This study only considers weakly or covariance stationary processes and these will henceforth, be simply called stationary. The benefit of stationary series in time series analysis is that one can predict the mean of a series by looking at its present values (Gujarati, 2003: 798).

Conversely if a time series is not stationary, it is called non-stationary. The classic example is a random walk. Random walks can be of two types: with drift or without drift. As an example, for a first-order autoregressive (AR(1)) random walk model without drift, we have

$y_t = y_{t-1} + u_t$ and, in general,

$y_t = y_0 + \sum_{t=1}^{t-1} u_t$ from this:

$$E(y_t) = E(y_0 + \sum_{t=1}^{t-1} u_t) = y_0 \qquad [4]$$

where u_t is a white noise error term with mean 0 and variance ζ^2. From this it can be seen that the mean remains unchanged. Similarly the variance of y_t is

$$Var(y_t) = t\sigma^2. \qquad [5]$$

Hence, while the mean is constant, the variance is not, violating an assumption of stationarity.

For random walks with drift, we have

$$y_t = \delta + y_{t-1} + u_t \qquad [6]$$

where δ is the drift parameter.

It can be shown that

$$E(y_t) = y_0 + t\delta$$

$$Var(y_t) = t\sigma^2. \qquad [7]$$

So in this case the mean as well as the variance are time dependent.

Figure 3.1 shows examples of stationary and non-stationary series.

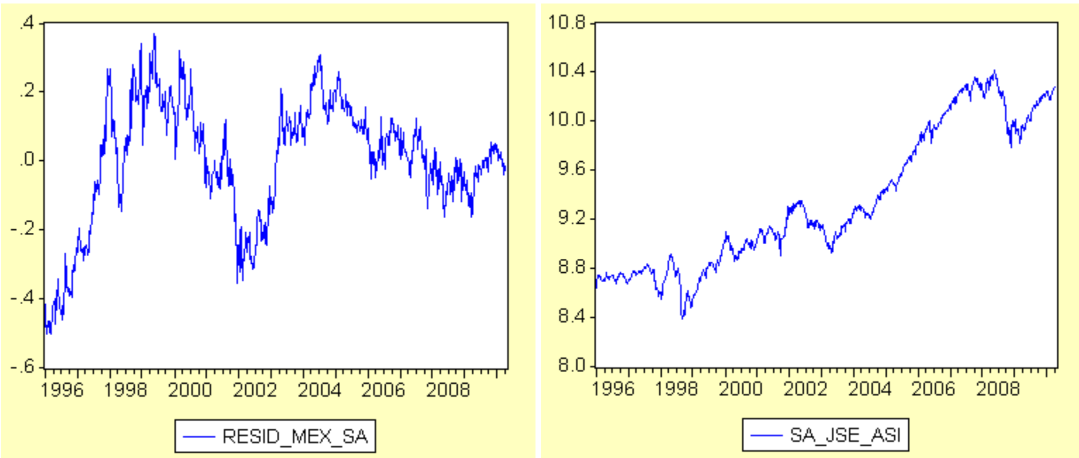

Fig. 3.1 Time series plots of the residuals from the regression of Mexican market data on South African market data (left-hand side) and the natural logarithm of the JSE All Share Index (right-hand side).

On the right is the plot of the natural logarithm of the JSE All Share Index. As can be seen there is an upward trend and the mean does not remain the same over time and hence, the series is non-stationary. On the left is a plot of the residuals from the OLS regression of Mexican market data on South African market data. As can be seen the mean is roughly centred at zero and the variance does not vary much and hence, the residual series is stationary.

3.1.1 Testing for Stationarity

In order for series to be cointegrated it is necessary to test that they are all non-stationary and integrated of the same order. The order of integration refers to how many times a series should be differenced to make it stationary. Unit root tests are carried out to test whether or not the series are stationary.

3.1.2 Dickey-Fuller Test

One of the more popular tests is the Dickey-Fuller (DF) test (Dickey and Fuller, 1981; Gujarati, 2003: 814). The starting point is as follows, consider an AR(1) process,

$$y_t = \rho y_{t-1} + u_t \qquad \text{where } -1 \leq \rho \leq 1 \quad \text{and } u_t \text{ is a white noise error term.} \qquad [8]$$

If $\rho = 1$, that is, if we have a unit root then the process follows a random walk without drift and is non-stationary. To test this, regress y_t on its lagged value y_{t-1} and determine if the estimated ρ is statistically significant to 1. If it is, then y_t is non-stationary. Subtracting y_{t-1} from both sides of equation [8], we have

$$y_t - y_{t-1} = \rho y_{t-1} - y_{t-1} + u_t$$

$$\Delta y_t \ = (\rho - 1) y_{t-1} + u_t$$

$$\Delta y_t \ = \delta y_{t-1} + u_t \qquad [9]$$

where $\Delta y_t = y_t - y_{t-1}$ and $\delta = \rho - 1$. From this we formulate the regression equation and test the null hypothesis that $\delta = 0$. If $\delta = 0$, it follows that $\rho = 1$, that is we have a unit root and the time series is hence non-stationary. If $\delta = 0$, then $\Delta y_t \ = \ u_t$ and the first difference of a random walk series is stationary. After carrying out the regression (equation [9]), if the estimate of δ, $\hat{\delta} = 0$, then the series is said to be non-stationary. If on the other hand, it is negative, the conclusion is that the series is non-stationary. $\hat{\delta}$ will be negative because $\delta = \rho - 1$ and for stationarity $|\rho|$ must be less than one, and therefore, δ must be negative. When testing for the significance of $\widehat{\delta}$, t-tests cannot be used because the t-value of the estimated coefficient of y_{t-1} does not follow a normal distribution even for large samples. Dickey and Fuller have shown that under the null hypothesis of $\delta = 0$, the estimated *t*-value of the coefficient of y_{t-1} follows the *tau* (η) statistic (Dickey and Fuller, 1981: 1070). Critical values of the *tau* statistic have been calculated using Monte Carlo simulations.

There are three different forms of the DF test:

$\Delta y_t = \delta y_{t-1} + u_t$ (y_t is a random walk without drift)

$\Delta y_t = \beta_1 + \delta y_{t-1} + u_t$ (y_t is a random walk with drift)

$\Delta y_t = \beta_1 + \beta_2 t + \delta y_{t-1} + u_t$ (y_t is a random walk with drift around a stochastic trend); where t is the time variable. In each case the critical values of the *tau* statistic are different. If the computed value of the *tau* statistic exceeds the DF critical *tau* values, we reject the null hypothesis of $\delta = 0$.

Before moving on to the Augmented Dickey-Fuller test, it is necessary to define autocorrelation.

3.1.3 Autocorrelation

This term is defined as "correlation between members of series of observations ordered in time or space" (Kendall and Buckland, 1971: 8). In the context of regression, the classical linear regression model assumes that such autocorrelation does not exist in the disturbances u_t, so we have

$$E(u_i u_j) = 0 \quad \text{for all } i \neq j.$$

If this assumption is violated then autocorrelation is present in the series.

3.1.4 Durbin-Watson Test

One of the more popular tests for autocorrelation is the Durbin-Watson (DW) test (Durbin and Watson, 1950; Gujarati, 2003: 467). This statistic was proposed by Durbin and Watson in 1950 and since then has become one of the established statistics when testing for autocorrelation. They proposed the *d*-statistic which is defined as:

$$d = \sum_{t=2}^{n} (\hat{u}_t - \hat{u}_{t-1})^2 \,/\, \sum_{t=2}^{n} \hat{u}_t^2 \qquad [10]$$

where $\hat{u}_t$ are the estimated errors. This statistic is simply the sum of squared differences in successive residuals to the residual sum of squares (RSS). It is important to note the following assumptions of the DW test (Gujarati, 2003: 467):

- The regression model includes an intercept term.
- The explanatory variables are non-stochastic.
- The error terms, u_t, are generated by the first-order autoregressive process

  $u_t = \rho u_{t-1} + u_t.$

- The regression model does not include lagged values of the dependent variable (i.e. not higher order autoregressive models).

There are no unique critical values for the d-statistic and these depend on the number of variables and the sample sizes. Expanding [10] we have:

$$d = (\sum \hat{u}_t^2 + \sum \hat{u}_{t-1}^2 - 2\sum \hat{u}_t \hat{u}_{t-1}) / \sum \hat{u}_t^2 \quad [11]$$

Since $\sum \hat{u}_t^2$ and $\sum \hat{u}_{t-1}^2$ differ in only one observation, they are approximately equal, hence:

$$d \approx 2(1 - (\sum \hat{u}_t \hat{u}_{t-1} / \sum \hat{u}_t^2)). \quad [12]$$

From this we obtain

$$d = 2(1 - \hat{p}) \quad [13]$$

where $\hat{\rho} = \sum \hat{u}_t \hat{u}_{t-1} / \sum \hat{u}_t^2$.

Since $-1 \leq p \leq 1$, it implies that $0 \leq d \leq 4$.

From this relationship it is clear that if $\hat{\rho} = 0$ then $d = 2$. Hence the rule of thumb is that if d is close to 2, then there is no first-order autocorrelation either positive or negative. In this study, all the d-statistics were 2 when measured to two decimal places, hence there was no autocorrelation.

There are some limitations of the DW test. Firstly, the distribution of the DW statistic depends on the data. Secondly, it is not valid if there are lagged dependent variables on the explanatory side of the regression. Lastly, only the null hypothesis of no serial correlation can be tested against the alternative of the presence of first order serial correlation.

If the explanatory variables include a lagged dependent variable, Durbin's h-statistic has been proposed to measure autocorrelation:

$$h = \left(1 - \tfrac{1}{2}d\right)\sqrt{T/[1 - T\,\widehat{Var}(\widehat{b_1})]} \qquad [14]$$

where T is the total number of time periods that are being lagged and $\widehat{b_1}$ is the estimated trend parameter of the regression. This statistic is biased for autoregressive moving average models.

3.1.5 Breusch-Godfrey Test of Autocorrelation

One method that overcomes the shortcomings of the *d* and *h*-statistics is the Breusch-Godfrey (BG) test (Gujarati, 2003: 472). Suppose the disturbance term u_t is generated from the following m^{th}-order autoregressive process

$$u_t = \rho_1 u_{t-1} + \rho_2 u_{t-2} + \cdots + \rho_m u_{t-m} + \varepsilon_t \qquad [15]$$

where ε_t is a white noise disturbance term with zero mean and constant variance. The null hypothesis is that: $\rho_1 = \ldots = \rho_m = 0$. That is, all autoregressive coefficients are equal to zero, which means there is no autocorrelation of any order. Breusch (1978) and Godfrey (1978) have shown that the null hypothesis can be tested as follows:

- Estimate the OLS regression model, $y_t = \beta_1 + \beta_2 X_{t-1} + u_t$, and obtain the residuals $\hat{u}_t$.
- Regress $\hat{u}_t$ against all the regressors in the model plus the additional regressors $\hat{u}_{t-1}, \hat{u}_{t-2}, \ldots, \hat{u}_{t-m}$ where the latter are the lagged values of the estimated residuals in the previous step. Obtain the R^2 value from this regression.
- For a large sample size, Breusch and Godfrey have shown that

$$(n - m)R^2 \sim \chi^2_m. \qquad [16]$$

If the null hypothesis is rejected then at least one ρ in equation [15] is significantly different from zero. Unlike with the DW test, the regressors included in the original equation model may contain lagged values of the dependent variable. The BG test is also applicable even if the disturbance term follows an m^{th}-order moving average process. However, there is a drawback in that the length of the lag cannot be specified *a priori* and it is necessary to experiment with the number of lag lengths.

3.1.6 Augmented Dickey-Fuller Test

For the DF test, it was assumed that the error term u_t was uncorrelated. However, if u_t are correlated, there is a test developed called the Augmented Dickey-Fuller (ADF) test. In this case, the preceding three equations are augmented by adding the lagged values of the dependent variable Δy_t. Using the model with drift and stochastic trend the ADF test will consist of estimating the following regression:

$$\Delta y_t = \beta_1 + \beta_2 t + \delta y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta y_{t-i} + \varepsilon_t \quad [17]$$

where ε_t is a white noise error term and

$$\Delta y_{t-1} = (y_{t-1} - y_{t-2}),\ \Delta y_{t-2} = (y_{t-2} - y_{t-3}), \ldots, \Delta y_{t-m} = (y_{t-m} - y_{t-m-1}).$$

The equation can be adjusted similarly for cases where it is a random walk without drift. The number of lagged differenced terms to include is often determined empirically by looking at correlograms, for example. The idea is to include enough terms so that the error term is serially uncorrelated. For an ADF test the null hypothesis is $\delta = 0$ and the test has the same asymptotic distribution as the DF statistic, meaning that the same critical values can be used.

3.1.7 Integrated Stochastic Processes

As mentioned earlier cointegration can only be carried out on series that are non-stationary. However, not only do series have to be non-stationary but they all have to be integrated of the same order, $I(d)$. Integrated of the same order means that all the series, that are tested for cointegration, become level after being differenced the same number of times. So, for example, if one series is $I(1)$ and another is $I(2)$ we cannot test them for cointegration because they are not of the same order of integration. In this study, all the series are $I(1)$ and hence can be tested for cointegration.

3.2 Cointegration

Now that stationarity has been defined and its importance clarified, we are in a position to define cointegration. If two or more series are non-stationary but a linear combination of them is stationary, then the series are said to be cointegrated. From Enders (2004: 321-323), a more formal definition is as follows:

Consider a set of variables in long-run equilibrium when

$$\beta_1 x_{1t} + \beta_2 x_{2t} + \cdots + \beta_n x_{nt} = 0. \qquad [18]$$

Letting β and x_t denote the vectors $(\beta_1, \beta_2, \dots, \beta_n)$ and $(x_{1t}, x_{2t}, \dots, x_{nt})$, the system is said to be in long-run equilibrium when $\beta x_t = 0$. The deviation from long-run equilibrium, called the equilibrium error, is $e_t = \beta x_t$. If the equilibrium is valid, then the equilibrium process is stationary. The components of the vector $x_t = (x_{1t}, x_{2t}, \dots, x_{nt})$ are said to be cointegrated of order *d, b*, denoted by $x_t \sim CI(d, b)$ if

- All components of x_t are cointegrated of order *d.*
- There exists a vector $\beta = (\beta_1, \beta_2, \dots, \beta_n)$ such that the linear combination $\beta x_t = \beta_1 x_{1t} + \beta_2 x_{2t} + \cdots + \beta_n x_{nt}$ is integrated of order $(d - b)$ where $b > 0$.

The vector β is called the cointegrating vector and is not unique, since it can be multiplied by any non-zero scalar without affecting equality.

There are some important points to note about cointegration:

- Cointegration refers to linear combinations of non-stationary variables. While it is possible to have non-linear long-run combinations of variables, methods to do this are currently under research.
- For variables to be cointegrated they need to be cointegrated of the same order. In our case all the variables are $I(1)$.
- If x_t has *n* non-stationary components there may be at most *n*-1 linearly independent cointegrating vectors. If multiple cointegrating vectors are found, it may not be possible to identify the behavioural relationships from what may be reduced-form relationships (Granger and Lee, 1990: 84).
- Most cointegration literature focuses on the case in which each variable contains a single unit root.

Two test methods for cointegration will be examined and compared, the Engle-Granger test and the Johansen test.

3.2.1 Engle-Granger Test

Suppose there are two variables, x_t and y_t that are both $I(1)$ and it is necessary to determine whether or not there exists an equilibrium relationship between the two. Engle and Granger

(1987) proposed the following method to determine if two $I(1)$ variables are cointegrated of order $CI(1, 1)$:

- Once it has been established that the variable are indeed integrated of the same order, estimate the following long-run equilibrium relationship:

$$x_t = \beta_0 + \beta_1 y_t + e_t. \qquad [19]$$

If the variables are cointegrated, an OLS regression yields a "super-consistent" estimator of the cointegrating parameters β_0 and β_1. Stock (1987) showed that OLS estimates of β_0 and β_1 converge faster than in OLS models with stationary variables.

To test for cointegration, determine the estimated residuals using equation [19] and denote them by $\{\hat{e}_t\}$. If these residuals are stationary then the series $\{x_t\}$ and $\{y_t\}$ are $CI(1, 1)$. The stationarity of the residuals can be checked using a Dickey-Fuller test on the residuals to determine their order of integration. Consider the following autoregression of the residuals:

$$\Delta\hat{e}_t = a_1\hat{e}_{t-1} + \varepsilon_t. \qquad [20]$$

There is no need to include an intercept term since the estimated residual series is from a regression equation. The important parameter to test is a_1. If we fail to reject the null hypothesis $a_1 = 0$, we can conclude that the residual series contains a unit root. Hence, the conclusion is that the $\{x_t\}$ and $\{y_t\}$ are not cointegrated. If the null hypothesis is rejected then the series does not have a unit root and $\{x_t\}$ and $\{y_t\}$ are $CI(1, 1)$. Tables giving the critical values for the EG test are used.

Dickey-Fuller tables cannot be used for this method because the $\{\hat{e}_t\}$ sequence is generated from a regression equation and the actual value of e_t is not known, only its estimate, $\hat{e}_t$. OLS regression selects values of β_0 and β_1 that minimize the sum of squared residuals. Since the residual variance is made as small as possible, the procedure is biased towards finding stationarity. Hence, the test statistic used to test the magnitude of a_1 must reflect this fact. Only if β_0 and β_1 are known in advance and used to construct the true values of the residuals will the DF tables be appropriate.

Since serial correlation of ε_t in equation [20] is very often a problem, it is more common to use an augmented Engle-Granger (AEG) test. AEG test is related to the EG test in the same way as the ADF test is related to the DF test. Lagged values of the residuals are added to equation [20]. Enough lags should be added such that evidence of serial correlation is removed. In this case the following autoregression is estimated:

$$\Delta\hat{e}_t = a_1\hat{e}_{t-1} + \sum_{i=1}^{n} a_{i+1}\Delta\hat{e}_{t-1} + \varepsilon_t. \qquad [21]$$

The conclusions from rejection or failure to reject of the null hypothesis remain the same.

- If the variables are cointegrated then the residuals from the equilibrium regression (equation [19]) are used to estimate the error correction model. If x_t and y_t are $CI(1, 1)$, the variables have the error-correction form:

$$\Delta x_t = \alpha_1 + \alpha_x[x_{t-1} - \beta_1 y_{t-1}] + \sum_{i=1}\alpha_{11}(i)\Delta x_{t-i} + \sum_{i=1}\alpha_{12}(i)\Delta y_{t-i} + \varepsilon_{xt} \qquad [22]$$

$$\Delta y_t = \alpha_2 + \alpha_y[x_{t-1} - \beta_1 y_{t-1}] + \sum_{i=1}\alpha_{21}(i)\Delta x_{t-i} + \sum_{i=1}\alpha_{22}(i)\Delta y_{t-i} + \varepsilon_{yt} \qquad [23]$$

where β_i are the parameters of the cointegrating vector given by the original regression of x_t on y_t. ε_{xt} and ε_{yt} are white-noise disturbances, and $\alpha_1, \alpha_2, \alpha_x, \alpha_y, \alpha_{11}(i), \alpha_{12}(i), \alpha_{21}(i), \alpha_{22}(i)$ are all parameters.

Since $\hat{e}_{t-1} = x_{t-1} - \beta_1 y_{t-1}$, it is possible to rewrite equations [22] and [23] as:

$$\Delta x_t = \alpha_1 + \alpha_x\hat{e}_{t-1} + \sum_{i=1}\alpha_{11}(i)\,\Delta x_{t-i} + \sum_{i=1}\alpha_{12}(i)\,\Delta y_{t-i} + \varepsilon_{xt} \qquad [24]$$

$$\Delta y_t = \alpha_2 + \alpha_y\hat{e}_{t-1} + \sum_{i=1}\alpha_{21}(i)\,\Delta x_{t-i} + \sum_{i=1}\alpha_{22}(i)\,\Delta y_{t-i} + \varepsilon_{yt}. \qquad [25]$$

Except for the error-correction term $\hat{e}_{t-1}$, equations [24] and [25] constitute a vector autoregression (VAR) in first differences and hence regular VAR procedures apply to the VECM (*cf* Section 3.3). OLS is an efficient strategy since the same set of regressors is used and since all the terms in equations [24] and [25] are stationary, the test statistics used in VAR analysis are appropriate. All these procedures show that the VECM is a VAR with restrictions placed on it.

- It is important to assess the adequacy of the model by performing diagnostic checks to determine whether the residuals of the error-correction equations approximate white noise. If the residuals are serially correlated, lag lengths may be too short. The model is re-estimated using lag lengths that yield serially uncorrelated errors. There may be cases where it is necessary to allow longer lag lengths of some variables than others.

The speed of adjustment coefficients α_x and α_y have important implications for the dynamics of the system. From equation [25], for any given values of $\hat{e}_{t-1}$, a large value of α_y is associated with a large value of Δy_t. If α_y is zero, the change in y_t does not respond to the deviation from long-run equilibrium in $(t - 1)$. If the variables are cointegrated, α_x and/or α_y should be significantly different from zero because if α_x and α_y are both zero, there is no error correction and equations [24] and [25] are simply a VAR in first differences. Also, the absolute values of the speed of adjustment coefficients should not be too large otherwise there is no great difference between the short-run and long-run equilibrium. The point estimates should imply that Δx_t and Δy_t converge to the long-run equilibrium relationship.

Impulse response and variance decomposition analysis collectively called innovation accounting can be used to obtain information regarding the interactions among the variables (Lütkepohl and Reimers, 1992: 75). These methods are then used to see if the responses of the variables conform to theory and *a priori* assumptions.

3.2.2 Johansen Test

Simply put, the Johansen (1988) procedure is a multivariate generalization of the Dickey-Fuller test for unit roots. In the univariate case of the DF test, we have

$$\Delta y_t = \delta y_{t-1} + \varepsilon_t.$$

If $\delta = 0$ then the y_t process has a unit root and if $\delta \neq 0$ the series is stationary. Generalizing this to n-variables, let

$$x_t = A_1 x_{t-1} + \varepsilon_t \qquad \text{from which it follows}$$

$$\Delta x_t = A_1 x_{t-1} - x_{t-1} + \varepsilon_t$$

$$\Delta x_t = (A_1 - I) x_{t-1} + \varepsilon_t$$

$$\Delta x_t = \pi x_{t-1} + \varepsilon_t \qquad [26]$$

where x_t and ε_t are $(n \cdot 1)$ vectors, A_1 is an $(n \cdot n)$ matrix of parameters, I an $(n \cdot n)$ identity matrix and π is $(A_1 - I)$. The number of cointegrating vectors is expressed by the rank of π. So if the rank of π is zero then there is no cointegration. A drift or trend term can be included in the specification of the model, and if this is the case write the equation as:

$$\Delta x_t = A_0 + \pi x_{t-1} + \varepsilon_t \qquad [27]$$

where $A_0 = (n \cdot 1)$ vector of constants. A_0 should be included if the variables show signs of increasing or decreasing or if *a priori* assumptions or economic theory suggest that it is acceptable to include a trend or an intercept term (Enders, 2004: 348-351).

It must be noted that by manipulating the elements of A_0 it is possible to include a constant in the cointegrating vector(s) without creating a trend in the series. A way to include a constant in the cointegrating relationships is to restrict the values of the a_{i0} elements. So, for example, if rank(π) = 1, the rows can be expressed as multiples of the first row.

$$\Delta x_{1t} = \pi_{11}x_{1t-1} + \pi_{12}x_{2t-1} + \cdots + \pi_{1n}x_{nt-1} + a_{10} + \varepsilon_{1t}$$

$$\Delta x_{2t} = s_2(\pi_{11}x_{1t-1} + \pi_{12}x_{2t-1} + \cdots + \pi_{1n}x_{nt-1}) + a_{20} + \varepsilon_{2t}$$

...

$$\Delta x_{nt} = s_n(\pi_{11}x_{1t-1} + \pi_{12}x_{2t-1} + \cdots + \pi_{1n}x_{nt-1}) + a_{n0} + \varepsilon_{nt} \qquad [28]$$

where s_i are scalars such that $s_i\pi_{1j} = \pi_{ij}$. If the a_{i0} can be restricted such that $a_{i0} = s_i a_{10}$, all the Δx_{it} sequences can be written with the constant included in the cointegrating vector:

$$\Delta x_{1t} = (\pi_{11}x_{1t-1} + \pi_{12}x_{2t-1} + \cdots + \pi_{1n}x_{nt-1} + a_{10}) + \varepsilon_{1t}$$

$$\Delta x_{2t} = s_2(\pi_{11}x_{1t-1} + \pi_{12}x_{2t-1} + \cdots + \pi_{1n}x_{nt-1} + a_{10}) + \varepsilon_{2t}$$

...

$$\Delta x_{nt} = s_n(\pi_{11}x_{1t-1} + \pi_{12}x_{2t-1} + \cdots + \pi_{1n}x_{nt-1} + a_{10}) + \varepsilon_{nt} \quad \text{or} \qquad [29]$$

$$\Delta x_t = \pi^* x^*_{t-1} + \varepsilon_t \qquad [30]$$

where $x_t = (x_{1t}, x_{2t}, \ldots, x_{nt})$

$x^*_{t-1} = (x_{1t-1}, x_{2t-1}, \ldots, x_{nt-1}, 1)$ and

$$\pi^* = \begin{bmatrix} \pi_{11} & \pi_{12} \cdots & \pi_{1n} & a_{10} \\ \pi_{21} & \pi_{22} \cdots & \pi_{2n} & a_{20} \\ . & . & . & . \\ \pi_{n1} & \pi_{n2} \cdots & \pi_{nn} & a_{n0} \end{bmatrix}.$$

In equation [30] the linear trend has been removed from the equation by altering the components of the A_0 matrix. This shows that trend can be removed by selecting appropriate values for the intercept terms.

In some cases economic theory suggests the presence of an intercept term and in these cases it is logical to include an intercept term in the cointegrating vector. Using a drift term and an intercept the system of equations above can be written as:

$$\Delta x_{1t} = (\pi_{11}x_{1t-1} + \pi_{12}x_{2t-1} + \cdots + \pi_{1n}x_{nt-1} + b_{10}) + b_{11} + \varepsilon_{1t}$$

$$\Delta x_{2t} = s_2(\pi_{11}x_{1t-1} + \pi_{12}x_{2t-1} + \cdots + \pi_{1n}x_{nt-1} + b_{10}) + b_{21} + \varepsilon_{2t}$$

...

$$\Delta x_{nt} = s_n(\pi_{11}x_{1t-1} + \pi_{12}x_{2t-1} + \cdots + \pi_{1n}x_{nt-1} + b_{10}) + b_{n1} + \varepsilon_{nt} \qquad [31]$$

where b_{i1} is defined to the value that satisfies $s_ib_{i0} + b_{i1} = a_{10}$. a_{10} was divided into two parts and one part was placed inside the cointegrating relationship. A potential hurdle is to decide what proportion of the intercept to include in the cointegrating vector. The general practice is to include a trend term if the series has an obvious upward or downward movement over time. Otherwise they include intercept terms in the cointegrating vector or exclude the deterministic regressors altogether. Johansen (1988) advises not using a trend unless economic theory suggests otherwise.

For higher order autoregressive processes the multivariate model can be generalized as follows (Enders, 2004: 352):

$$x_t = A_1x_{t-1} + A_2x_{t-2} + \cdots + A_{p-2}x_{t-p+2} + A_{p-1}x_{t-p+1} + A_px_{t-p} + \varepsilon_t \qquad [32]$$

where $x_t = (n \cdot 1)$ vector $(x_{1t}, x_{2t}, \dots, x_{nt})$ and ε_t = an independent identically distributed n-dimensional vector with zero mean and variance matrix $\sum_{\varepsilon}$. Equation [32] can be modified by adding and subtracting A_px_{t-p+1} to the right hand side of the equation

$$x_t = A_1x_{t-1} + A_2x_{t-2} + \cdots + A_{p-2}x_{t-p+2} + A_{p-1}x_{t-p+1} + A_px_{t-p} + A_px_{t-p+1} - A_px_{t-p+1} + \varepsilon_t$$

$$x_t = A_1x_{t-1} + A_2x_{t-2} + \cdots + A_{p-2}x_{t-p+2} + (A_{p-1} - A_p)x_{t-p+1} + A_p\left(x_{t-p} - x_{t-p+1}\right) + \varepsilon_t$$

$$x_t = A_1x_{t-1} + A_2x_{t-2} + \cdots + A_{p-2}x_{t-p+2} + (A_{p-1} - A_p)x_{t-p+1} - A_p\Delta x_{t-p+1} + \varepsilon_t.$$

Then add and subtract $(A_{p-1} + A_p)x_{t-p+2}$ to the right hand side:

$$x_t = A_1 x_{t-1} + A_2 x_{t-2} + \cdots - (A_{p-1}+A_p)\Delta x_{t-p+2} - A_p \Delta x_{t-p+1} + \varepsilon_t.$$

Continuing in such a fashion the following is obtained:

$$x_t = \sum_{i=1}^{p} A_i \, x_{t-1} - \sum_{i=1}^{p-1} \sum_{j=1+i}^{p} A_j \, \Delta x_{t-i} + \varepsilon_t.$$

This can be expressed as a difference term by subtracting x_{t-1} from both sides

$$\Delta x_t = \sum_{i=1}^{p} A_i \, x_{t-1} - x_{t-1} - \sum_{i=1}^{p-1} \sum_{j=1+i}^{p} A_j \, \Delta x_{t-i} + \varepsilon_t$$

$$\Delta x_t = \pi x_{t-1} + \sum_{i=1}^{p-1} \pi_i \Delta x_{t-i} + \varepsilon_t \qquad [33]$$

where $\pi = -(I - \sum_{i=1}^{p} A_i)$ and $\pi_i = -\sum_{j=i+1}^{p} A_j$.

The eigenvalues of the π matrix are used to determine the number of cointegrating relations. Consider equation [33] with a drift or intercept term. There are three possible cases, where rank(π) = n, rank(π) = 0 and rank(π) = r, where $1 \le r \le n - 1$. In the first case, the variables are all stationary, meaning that all its unit roots are outside the unit circle and the π matrix has full rank. In the second case, π matrix is null and there are n stochastic trends. As a result equation [33] is simply a regular VAR model. Finally, where the rank(π) = r, there are $n - r$ unit roots and assuming that the other roots all lie outside the unit circle, the n variables have $(n - r)$ common stochastic trends and there are r cointegrating equations.

3.2.3 Test Statistics

The eigenvalues, $\hat{\lambda}_i$, of π have implications to cointegration. The series are cointegrated if there exists linear combinations of variables that are stationary. In equation [33], this is expressed by the condition that $\pi \neq 0$, which implies a non-zero partial correlation of x_{t-i} with Δx_t. The number of cointegrating equations is equal to the number of non-zero correlations between linear combinations of x_{t-i} and Δx_t. Eigenvalues measure these correlations and are known as canonical correlations. The number of stochastic trends is equal to the number of zero canonical correlations. Hence the number of cointegrating equations, r, and the number of common stochastic trends can be determined by checking how many of the canonical correlations differ significantly from zero.

From this it is the case that r = (number of significant $\hat{\lambda}_i$) and $(n - r)$ = (number of $\hat{\lambda}_i \approx 0$). The eigenvalues of the π matrix are ordered from largest to smallest. The expression that are compared are ln(1 - $\hat{\lambda}_i$). This expression will be almost zero if $\hat{\lambda}_i \approx 0$ since ln(1) = 0 and this shows that there is no cointegration. The number of expressions ln(1 - $\hat{\lambda}_i$) that are not equal to zero will be the number of cointegrating equations.

In practical applications, only estimates of π and its eigenvalues can be obtained. The Johansen methodology is referred to as a maximum likelihood approach because the underlying estimation method that provides the two statistics is based on maximum likelihood. The test for the number of roots that are insignificantly different from unity can be done with the following two test statistics:

As shown by Johansen (1988), the trace statistic is:

$$\lambda_{trace}(r) = -T\sum_{i=r+1}^{n}\ln(1-\hat{\lambda}_i) \qquad [34]$$

where $\hat{\lambda}_i$ are the estimated values of the eigenvalues, obtained from the estimated π matrix and T = the number of usable observations. The null hypothesis would be rejected for large values of the test statistic, meaning that the eigenvalues are jointly significantly different from zero. The null and alternative hypotheses expressed in terms of cointegrating rank are:

H_0: $r_0 \leq r$

H_1: $r_0 > r$

where r_0 is the number of distinct cointegrating vectors.

In the unrestricted case for the trace statistic, the cointegrating rank is at most n. The restricted or null case is that the rank is $r - 1$. From looking at equation [34], in the case of alternative hypothesis being true at least one of the set of eigenvalues being tested is non-zero. It is possible that only the largest remaining, the r^{th} is non-zero and all others are zero, hence the cointegrating rank is r. On the other extreme all the eigenvalues are non-zero and here there is full rank.

The hypothesis tests are carried out iteratively, first test the null hypothesis that $r_0 \leq 0$. If this is rejected, then $r_0 > 0$. The next step is to test the null that $r_0 \leq 1$, but since $r_0 \leq 0$ has already been rejected the second null hypothesis becomes $r_0 = 1$. Rejection of this null hypothesis leads to the conclusion that $r_0 > 1$. This procedure is carried out until the null hypothesis is not rejected.

The second test statistic is called the maximum eigenvalue statistic:

$$\lambda_{max}(r, r+1) = -T\ln\left(1 - \hat{\lambda}_{r+1}\right). \qquad [35]$$

The null and alternative hypotheses are:

H$_0$: $r_0 = r$

H$_1$: $r_0 = r + 1$.

The maximum eigenvalue test has the same restricted model as in the trace test. However, the unrestricted model considers only a cointegrating rank of one higher. As a result the alternative hypothesis considers a cointegrating rank greater than the null by one.

Once again the hypothesis test is carried out iteratively, first test the null H$_0$: $r_0 = 0$. If this is rejected then conclude that $r_0 = 1$. However, since the case $r_0 > 1$ is not considered there may be more than 1 cointegrating vector hence it is necessary to test the null $r_0 = 1$ against the alternative $r_0 = 2$. This procedure is then carried on until the null is not rejected.

From the two test statistics, it is seen that the trace test is a joint test of all eigenvalues smaller than a particular value, while the maximum eigenvalue test considers one eigenvalue only. A problem that arises is which test to select if there are contradictions between the conclusions. The maximum eigenvalue test does not cover all possible cointegrating ranks except when testing the final null hypothesis, $r_0 = n - 1$. The trace test, on the other hand, considers all possible values. Hence from this criterion the trace test is recommended. However, the maximum eigenvalue test has the more precise alternative hypothesis and if the alternative of the maximum eigenvalue test is in fact the true rank, then it has more power than the trace test since the trace test considers that alternative along with a set of other irrelevant alternatives.

Monte Carlo simulation is used to obtain the critical values for the two tests and they are generally different, except when the number of non-stationary components, $n - r = 1$. They are also dependent on the number of cointegrating vectors being tested for and whether or not a trend and/or intercept term is included. Critical values tend to be smallest for both tests without trend or intercept and largest when intercept terms are included in the cointegrating vector. Rather than guess the structure of the model it is possible to test the various restricted forms of the vector.

3.2.4 Testing Restrictions

The main benefit of the Johansen procedure is that it allows for testing restricted forms of the cointegrating vector. The key factor in these hypothesis tests is that if there are *r* cointegrating vectors, only these *r* linear combinations of the variables are stationary, all other linear combinations are non-stationary. So if the model is re-estimated restricting the parameters of π and if the restrictions are not binding, then the number of cointegrating vectors should not be reduced (Enders, 2004: 355-356).

To test restrictions on the cointegrating vector, Johansen (1988: 233) defined two matrices α and β, both of dimensions $(n \cdot r)$ where r is the rank of π. α and β are defined such that $\pi = \alpha\beta$. β is the matrix of cointegrating parameters and α is the matrix of weights with which each cointegrating vector enters the *n* equations of the VAR. α may be viewed as the matrix of the speed of adjustment parameters. Since α and β cannot be estimated using OLS because of the cross-equation restrictions, Johansen proposed the following maximum likelihood estimation (MLE) procedure:

- Estimate $\Delta x_t = \pi x_{t-1} + \sum_{i=1}^{p-1} \pi_i \Delta x_{t-i} + \varepsilon_t$ as an ECM.
- Determine the rank of π.
- Use the *r* most significant cointegrating vectors to form β .
- Select α such that $\pi = \alpha\beta$.

This process can be easily explained in the case where rank(π) = 1 and there is a single cointegrating vector. In this case, the rows of π are all linear multiples of one another. Hence, from Enders (2004: 356) equation [33] has the following form (leaving out the matrices $\pi_i \Delta x_{t-i}$ for simplicity):

$$\Delta x_{1t} = \pi_{11} x_{1t-1} + \pi_{12} x_{2t-1} + \cdots + \pi_{1n} x_{nt-1} + \cdots + \varepsilon_{1t}$$

$$\Delta x_{2t} = s_2(\pi_{11} x_{1t-1} + \pi_{12} x_{2t-1} + \cdots + \pi_{1n} x_{nt-1}) + \cdots + \varepsilon_{2t}$$

...

$$\Delta x_{nt} = s_n(\pi_{11} x_{1t-1} + \pi_{12} x_{2t-1} + \cdots + \pi_{1n} x_{nt-1}) + \cdots + \varepsilon_{nt}$$

where s_i are scalars. Define $\alpha_i = s_i \pi_{1j}$ and $\beta_i = \pi_{1i}/\pi_{11}$. Therefore each equation can be written as:

$$\Delta x_{it} = \alpha_i(x_{1t-1} + \beta_2 x_{2t-1} + \cdots + \beta_n x_{nt-1}) + \cdots + \varepsilon_{it} \qquad \text{for } i = 1, \ldots, n.$$

In matrix form this can be written as (re-introducing $\pi_i \Delta x_{t-i}$):

$$\Delta x_t = \sum_{i=1}^{p-1} \pi_i \Delta x_{t-i} + \alpha\beta\ x_{t-1} + \varepsilon_t. \qquad [36]$$

Here the cointegrating vector is $\beta = (1,\ \beta_2,\ \beta_3,\ \ldots,\ \beta_n)$ and the speed of adjustment parameters are given by $\alpha = (\alpha_1,\ \alpha_2,\ \ldots,\ \alpha_n)$.

Once α and β are determined, testing various restrictions on α and β is possible. It is important to remember that if there are r cointegrating vectors, only these r linear combinations of the variables are stationary. Hence, the test statistics involve comparing the number of cointegrating vectors under the null and alternative hypotheses. Letting $\hat{\lambda}_1,\ \hat{\lambda}_2,\ \ldots,\ \hat{\lambda}_n$ and $\hat{\lambda}_1^*,\ \hat{\lambda}_2^*,\ \ldots,\ \hat{\lambda}_n^*$ denote the ordered eigenvalues of the unrestricted and restricted models, respectively, the restrictions on β can be tested with the following test statistic:

$$T \sum_{i=1}^{n} [\ln(1 - \hat{\lambda}_i^*) - \ln(1 - \hat{\lambda}_i)]. \qquad [37]$$

This statistic asymptotically has a χ^2 distributions with degrees of freedom equal to the number of restrictions placed on β. Small values of $\hat{\lambda}_i^*$ relative to $\hat{\lambda}_i$ (for $i \leq r$) imply a reduced number of cointegrating vectors.

If there is one cointegrating vector, the EG and Johansen methods have the same asymptotic distribution. If it can be concluded that only one cointegrating vector exists, it is usual to rely on the estimated error-correction model to test restrictions on α. If $r = 1$, and a single value of α is being tested, the usual t-statistic is asymptotically equivalent to the Johansen test.

3.2.5 Lag Length Tests

Since different choices of lag lengths can greatly affect the cointegration results, choosing the correct lag length is an important procedure. Popular methods to determine the lag length are the multivariate generalizations of the Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC) and many others. However, when using the recommended lag length selected by these criteria, quite often there is still some evidence of autocorrelation of the residuals. In this case it is recommended to use the first lag length at which autocorrelation is not present. In this study the lag length selected by the information criteria and the one at which residuals are not autocorrelated will be compared.

3.3 Introduction to Vector Autoregression (VAR) Analysis

When a variable depends not only on its past values but also on other variables' current and past values it is said to be endogenous. For example for a bivariate system, let $\{x_t\}$ be affected by its past values and current and past values of $\{y_t\}$, and let $\{y_t\}$ be affected by its past values and current and past values of $\{x_t\}$. This can be represented as follows (Enders, 2004: 264-279):

$$x_t = b_{10} - b_{12}y_t + \gamma_{11}x_{t-1} + \gamma_{12}y_{t-1} + \varepsilon_{xt} \quad [38]$$

$$y_t = b_{20} - b_{22}y_t + \gamma_{21}x_{t-1} + \gamma_{22}y_{t-1} + \varepsilon_{yt} \quad [39]$$

where x_t and y_t are both stationary, ε_{xt} and ε_{yt} are both white-noise disturbances with standard deviations of ζ_x and ζ_y respectively and $\{\varepsilon_{xt}\}$ and $\{\varepsilon_{yt}\}$ are uncorrelated.

Equations [38] and [39] are defined as a first-order VAR as the maximum lag is one. The bivariate system is known as a structural VAR. However, the structural form is not very useful because the equations are not in reduced-form since x_t has a contemporaneous effect on y_t, and y_t has a contemporaneous effect on x_t. The bivariate system can be rewritten as follows:

$$\begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix} \begin{bmatrix} x_t \\ y_t \end{bmatrix} = \begin{bmatrix} b_{10} \\ b_{20} \end{bmatrix} + \begin{bmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{22} \end{bmatrix} \begin{bmatrix} x_{t-1} \\ y_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{xt} \\ \varepsilon_{yt} \end{bmatrix} \text{ or}$$

$$Bz_t = \Gamma_0 + \Gamma_1 z_{t-1} + \varepsilon_t$$

where $B = \begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix}$, $z_t = \begin{bmatrix} x_t \\ y_t \end{bmatrix}$, $\Gamma_0 = \begin{bmatrix} b_{10} \\ b_{20} \end{bmatrix}$, $\Gamma_1 = \begin{bmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{22} \end{bmatrix}$, $\varepsilon_t = \begin{bmatrix} \varepsilon_{xt} \\ \varepsilon_{yt} \end{bmatrix}$.

Premultiplying by B^{-1} gives the VAR model in standard form.

$$z_t = A_0 + A_1 z_{t-1} + e_t \quad [40]$$

where $A_0 = B^{-1}\Gamma_0$, $A_1 = B^{-1}\Gamma_1$, $e_t = B^{-1}\varepsilon_t$.

To simplify notation it is possible to define a_{i0} as element i of the vector A_0, a_{ij} as the element in row i and column j of the matrix A_1 and e_{it} as the element i of the vector e_t. With the new notation, equation [40] can be written:

$$x_t = a_{10} + a_{11}x_{t-1} + a_{12}y_{t-1} + e_{1t} \quad [41]$$

$$y_t = a_{20} + a_{21}x_{t-1} + a_{22}y_{t-1} + e_{2t}. \quad [42]$$

Equations [41] and [42] are known as a VAR in standard form. The error terms e_{1t} and e_{2t} are composites of the shocks ε_{xt} and ε_{yt}. Since $e_t = B^{-1}\varepsilon_t$, e_{1t} and e_{2t} can be determined from:

$$e_{1t} = (\varepsilon_{xt} - b_{12}\varepsilon_{yt})/(1 - b_{12}b_{21}) \quad [43]$$

$$e_{2t} = (\varepsilon_{yt} - b_{21}\varepsilon_{xt})/(1 - b_{12}b_{21}). \quad [44]$$

By definition ε_{xt} and ε_{yt} are white noise processes, hence e_{1t} and e_{2t} have zero means, constant variances and are serially uncorrelated. Finding the expected value of e_{1t}:

$$E(e_{1t}) = E(\varepsilon_{xt} - b_{12}\varepsilon_{yt})/(1 - b_{12}b_{21}) = 0. \quad [45]$$

The variance is given by:

$$E(e_{1t})^2 = E((\varepsilon_{xt} - b_{12}\varepsilon_{yt})/(1 - b_{12}b_{21}))^2 = (\sigma_x^2 + b_{12}^2\sigma_y^2)/(1 - b_{12}b_{21})^2. \quad [46]$$

From this it can be seen that the variance is time-invariant. The autocorrelations of e_{1t} and $e_{1t\text{-i}}$ are:

$$E(e_{1t}e_{1t-i}) = E(\varepsilon_{xt} - b_{12}\varepsilon_{yt})(\varepsilon_{xt-i} - b_{12}\varepsilon_{yt-i})/(1 - b_{12}b_{21}))^2 = 0 \text{ for } i \neq 0. \quad [47]$$

Similar methods can be used for e_{2t}. The covariance of e_{1t} and e_{2t} is given by:

$$\begin{aligned} E(e_{1t}e_{2t}) &= E(\varepsilon_{xt} - b_{12}\varepsilon_{yt})(\varepsilon_{yt} - b_{21}\varepsilon_{xt})/(1 - b_{12}b_{21}))^2 \\ &= -(b_{21}\sigma_x^2 + b_{12}\sigma_y^2)/(1 - b_{12}b_{21})^2. \end{aligned} \quad [48]$$

This shows that e_{1t} and e_{2t} are correlated except for the case where $b_{12} = b_{21} = 0$. It is helpful to define the variance/covariance matrix of the e_{1t} and e_{2t} shocks as:

$$\Sigma = \begin{bmatrix} var(e_{1t}) & cov(e_{1t}, e_{2t}) \\ cov(e_{1t}, e_{2t}) & var(e_{2t}) \end{bmatrix} = \begin{bmatrix} \sigma_1^2 & \sigma_{12} \\ \sigma_{21} & \sigma_2^2 \end{bmatrix}. \quad [49]$$

This follows since the variances and covariances are time-invariant.

3.3.1 Stability of VAR Model and Alternative Representation

Using backward iteration the VAR model in standard form (equation [40]) can be written as:

$$z_t = A_0 + A_1(A_0 + A_1 z_{t-2} + e_{t-1}) + e_t = (I + A_1)A_0 + A_1^2 z_{t-2} + A_1 e_{t-1} + e_t.$$

For n iterations this is written as:

$$z_t = (I + A_1 + \cdots + A_1^n)A_0 + \sum_{i=0}^{n} A_1^i\, e_{t-i} + A_1^{n+1} z_{t-n-1}.$$

Since all the elements of A_1 are between -1 and 1, it is clear that A_1^n tends to zero as n approaches infinity. Assuming the stability condition, z_t can be written as:

$$z_t = \mu + \sum_{i=0} A_1^i e_{t-i} \qquad [50]$$

where $\mu = [\,\bar{x}\ \ \bar{y}\,]$, $\bar{x} = [a_{10}(1 - a_{22}) + a_{12}a_{20}]/\Psi$, $\bar{y} = [a_{20}(1 - a_{11}) + a_{21}a_{10}]/\Psi$,

$\Psi = (1 - a_{11})(1 - a_{22}) - a_{12}a_{21}$.

The unconditional means of x_t and y_t are $\bar{x}$ and $\bar{y}$, respectively. To determine the variance/covariance matrix of x_t and y_t first write the variance/covariance matrix as:

$$E(z_t - \mu)^2 = E\left[\sum_{i=0} A_1^i e_{t-i}\right]^2. \qquad [51]$$

Note that:

$$E(e_t)^2 = E\begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} [e_{1t} \quad e_{2t}] = \Sigma.$$

Therefore, since $E(e_t e_{t-1}) = 0$ for $i \neq 0$ it follows that:

$$E(z_t - \mu)^2 = (I + A_1^2 + A_1^4 + \cdots)\,\Sigma = (I - A_1^2)^{-1}\,\Sigma. \qquad [52]$$

Using an initial condition, the $\{x_t\}$ and $\{y_t\}$ sequences will be jointly covariance stationary if the stability condition holds. Each sequence has a finite mean and variance which are time-invariant.

3.4 Innovation Accounting

Two tools used to examine the relationships among economic variables are impulse analysis and variance decompositions. These tools together are called innovation accounting.

3.4.1 Impulse Response Functions

To further analyse the short-run dynamics of cointegrated systems one can look at impulse response functions (IRF). These track the impact of any variable on others in the system. That is, they look at how much shocks in the residuals affect the actual series values. So for example, what effect will a 1 unit shock in e_{xt} and e_{yt} have on values of x_t.

The IRF is derived as follows: A vector autoregression can be expressed as a vector moving average (VMA). VMA representation allows one to trace the time path of the various shocks on the variables contained in the VAR system.

The two variable VAR representation of equations [41] and [42] in matrix form is:

$$\begin{bmatrix} x_t \\ y_t \end{bmatrix} = \begin{bmatrix} a_{10} \\ a_{20} \end{bmatrix} + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} x_{t-1} \\ y_{t-1} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix}. \qquad [53]$$

This can then be expressed in VMA form as:

$$\begin{bmatrix} x_t \\ y_t \end{bmatrix} = \begin{bmatrix} \bar{x} \\ \bar{y} \end{bmatrix} + \sum_{i=0} \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}^i \begin{bmatrix} e_{1t-i} \\ e_{2t-i} \end{bmatrix}. \qquad [54]$$

Equation [54] expresses x_t and y_t in terms of $\{e_{1t}\}$ and $\{e_{2t}\}$ sequences. It is useful, however, to rewrite the equation in terms of $\{\varepsilon_{xt}\}$ and $\{\varepsilon_{yt}\}$ sequences. The vector of errors is written as:

$$\begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} = [1/(1 - b_{12}b_{21})] \begin{bmatrix} 1 & -b_{12} \\ -b_{21} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{xt} \\ \varepsilon_{yt} \end{bmatrix}. \qquad [55]$$

Combining equations [54] and [55]:

$$\begin{bmatrix} x_t \\ y_t \end{bmatrix} = \begin{bmatrix} \bar{x} \\ \bar{y} \end{bmatrix} + [1/(1 - b_{12}b_{21})] \sum_{i=0} \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}^i \begin{bmatrix} 1 & -b_{12} \\ -b_{21} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{xt-i} \\ \varepsilon_{yt-i} \end{bmatrix}.$$

To simplify the notation, define the following $(2 \cdot 2)$ matrix ϕ_i with elements $\phi_{jk}(i)$:

$$\phi_i = [A_1^i/(1 - b_{12}b_{21})] \begin{bmatrix} 1 & -b_{12} \\ -b_{21} & 1 \end{bmatrix}.$$

Then the VMA representation can be written as:

$$\begin{bmatrix} x_t \\ y_t \end{bmatrix} = \begin{bmatrix} \bar{x} \\ \bar{y} \end{bmatrix} + \sum_{i=0} \begin{bmatrix} \phi_{11}(i) & \phi_{12}(i) \\ \phi_{21}(i) & \phi_{22}(i) \end{bmatrix} \begin{bmatrix} \varepsilon_{xt-i} \\ \varepsilon_{yt-i} \end{bmatrix}.$$

Or more compactly:

$$z_t = \mu + \sum_{i=0} \phi_i \, \varepsilon_{t-i}. \qquad [56]$$

The coefficients of ϕ_i are used to generate the effects of ε_{xt} and ε_{yt} shocks on the time paths of $\{x_t\}$ and $\{y_t\}$. The four elements $\phi_{jk}(0)$ are impact multipliers. For example the coefficient $\phi_{12}(0)$ is the instantaneous impact of a one unit change in ε_{yt} on x_t. Similarly $\phi_{11}(1)$ and

$\phi_{12}(1)$ are the one-period responses of unit changes in ε_{xt-1} and ε_{yt-1} on x_t, respectively. $\phi_{11}(1)$ and $\phi_{12}(1)$ also represent effects of unit changes in ε_{xt} and ε_{yt} on x_{t+1}.

Cumulative effects of unit impulses in ε_{xt} and/or ε_{yt} can be obtained by the appropriate summation of the coefficients of the impulse response functions. For example, after n periods the effect of ε_{yt} on x_{t+n} is $\phi_{12}(n)$. Therefore, after n periods the cumulative sum of the effects of ε_{yt} on the $\{x_t\}$ sequence is $\sum_{i=0}^{n} \phi_{12}(i)$. Letting n approach infinity gives the long-run multiplier. Since the $\{x_t\}$ and $\{y_t\}$ sequences are assumed to be stationary, then for all j and k $\sum_{i=0} \phi_{jk}^2\,(i)$ is finite. The four coefficients $\phi_{11}(i), \phi_{12}(i), \phi_{21}(i)$ and $\phi_{22}(i)$ are called the impulse response functions (IRF). Plotting the impulse response functions against time is a practical way to visually represent the behaviour of the $\{x_t\}$ and $\{y_t\}$ series in response to the various shocks.

The structural VAR equations [38] and [39] cannot be estimated directly since an estimated VAR is under-indentified. The number of parameters of the structural VAR system is more than that of the standard VAR (equations [41] and [42]). Hence it is not possible to trace the time-path of the shocks ε_{xt} and ε_{yt} directly. It is therefore necessary to introduce a restriction on the structural system in order to identify the impulse responses.

3.4.2 Cholesky Ordering

One of the more popular restrictions is to use the Cholesky decomposition such that x_t does not have a contemporaneous effect on y_t. This restriction is applied by setting $b_{21} = 0$ in the structural system. In terms of equation [55] the error terms can be decomposed as follows:

$$e_{1t} = \varepsilon_{xt} - b_{12}\varepsilon_{yt} \qquad [57]$$

$$e_{2t} = \varepsilon_{yt}. \qquad [58]$$

From equation [58], all of the observed errors from $\{e_{2t}\}$ sequence are attributed to ε_{yt} shocks. Given the calculated $\{\varepsilon_{yt}\}$ sequence, knowledge of the values of the $\{e_{1t}\}$ sequence and the correlation coefficient e_{1t} and e_{2t} allows for the calculation of the $\{\varepsilon_{xt}\}$ sequence using equation [57]. In the Cholesky decomposition ε_{xt} shocks have no direct effect on y_t but there is an indirect effect since lagged values of x_t affect the contemporaneous value of y_t. These additional restrictions in the form of the Cholesky ordering create asymmetry on the system since a ε_{yt} shock has contemporaneous effects on both x_t and y_t. A ε_{yt} shock directly affects e_{1t}

and e_{2t} but a ε_{xt} shock does not affect e_{2t}. The terminology used here is that y_t is said to be "causally prior" to x_t.

Reversing the Cholesky decomposition such that b_{12} and not b_{21} is equal to zero has the following results. Since matrix A_1 is symmetric, the impulse responses of a ε_{xt} shock and ε_{yt} shock would be reversed. The correlation coefficient has implications for the Cholesky ordering. In the special case where the correlation coefficient between x_t and y_t is zero, b_{12} and b_{21} can both be set equal to zero and the Cholesky ordering will not make a difference.

Common practice is to test the significance of correlation coefficients. If they are close to zero then the procedure can go ahead in any order. If they are not close to zero then a specific ordering should be decided on. For the sake of experiment, it is advisable to compare the results when the ordering is reversed and if the conclusions are greatly different, it is recommended to investigate the short-run relationship between the variables further.

One of the methods to decide on the Cholesky ordering is to place markets according to the order in which they open for trading as carried out by Chinzara and Aziakpono (2008). However, this method does not have any scientific basis behind it and is more applicable to daily data.

3.4.3 Using Granger Causality for Cholesky Ordering

A method that can be used to determine the lead lag relationship in the Cholesky ordering is to use Granger causality. For example, a time series $\{x_t\}$ is said to Granger cause $\{y_t\}$ if previous and current values of $\{x_t\}$ provide statistically significant information about the future values of $\{y_t\}$ (Granger, 1969: 425). For $I(1)$ series, the test works by first doing a regression of $\{\Delta y_t\}$ on lagged values of $\{\Delta y_t\}$.

$$\Delta y_t = a_0 + a_1 \Delta y_{t-1} + \cdots + a_n \Delta y_{t-n} + \varepsilon_t, \qquad [59]$$

where ε_t are the residuals, Δy_{t-j} is kept in the regression model if it has a significant t-statistic and n is the greatest lag length for which the lagged dependent variable is significant. Lagged values of $\{\Delta x_t\}$ are then added to the regression model:

$$\Delta y_t = a_0 + a_1 \Delta y_{t-1} + \cdots + a_n \Delta y_{t-n} + b_p \Delta x_{t-p} + b_q \Delta x_{t-q} + u_t, \qquad [60]$$

where u_t are the residuals and p and q are the shortest and longest lag length respectively for which lagged values of $\{\Delta x_t\}$ are significant. Any particular lagged value of $\{\Delta x_t\}$ is retained in the regression if it is significant according to the individual t-statistics and if it and the other lagged values of $\{\Delta x_t\}$ jointly add explanatory power to the model which is tested with an F-test. The null hypothesis of no Granger causality is accepted if and only if no lagged values of $\{\Delta x_t\}$ have been retained. If the null hypothesis is rejected, then $\{\Delta x_t\}$ Granger causes $\{\Delta y_t\}$.

In practice, it is desirable to obtain results that one variable Granger causes another and not the other way round. However, often results are such that neither variable Granger causes the other or that they both cause each other (Lütkepohl, 2007: 50).

Granger causality is done pair-wise, so for a sample of more than two markets each market is compared pair-wise with the others. So, for example, with a sample of 4 markets there will be 4 combination 2 pairings which is 6. The market that Granger causes the most of the other markets is considered the most dominant and placed first in the Cholesky ordering, the market that Granger causes the second most markets is placed second in the ordering and so on.

3.4.4 Generalized Impulse Response Functions

Despite the usefulness of Granger causality to determine the ordering, the method of Cholesky ordering has one major disadvantage, which is that the results are greatly affected by the ordering of the variables. The results should be placed in a way such that the most dominant variable is placed first, the second most dominant variable placed second and so on in descending order. In cases where this lead-lag relationship is known the ordering is not an issue. However, in many applications there is no clear way of deciding which variables are dominant. An approach better than Granger causality would be one where the ordering of the variables does not matter. Pesaran and Shin (1998) introduced the generalized impulse response functions (GIRF). Instead of shocking all the elements of ε_t they considered a shock on only one element of ε_t, say the j^{th} element, and integrated out the effects of the other shocks using an assumed distribution of errors. Unlike traditional impulse response analysis, the generalized approach does not require the shocks to be orthogonal and is invariant to the ordering of the variables in the VAR.

3.4.5 Variance Decomposition

Unrestricted VARs are over-parameterized and hence are not very useful for short-term forecasts. However, understanding the properties of forecast errors is helpful in uncovering the interrelationships among the variables in the system. Suppose that A_0 and A_1 from the

VAR model in standard form (equation [40]) are known and the goal is to forecast various values of x_{t+i} conditional on the observed value of x_t. Updating the VAR model, equation [40], by one period we obtain:

$$z_{t+1} = A_0 + A_1 z_t + e_{t+1}.$$

Taking the conditional expectation of z_{t+1}:

$$E_t z_{t+1} = A_0 + A_1 z_t.$$

The one-step-ahead forecast error is given by:

$$z_{t+1} - E_t z_{t+1} = e_{t+1}.$$

Updating the VAR model for two periods:

$$z_{t+2} = A_0 + A_1 z_{t+1} + e_{t+2}$$

$$z_{t+2} = A_0 + A_1(A_0 + A_1 z_t + e_{t+1}) + e_{t+2}.$$

Taking conditional expectations, the two-step-ahead forecast of z_{t+2} is:

$$E_t z_{t+2} = (I + A_1)A_0 + A_1^2 z_t.$$

The two-step-ahead forecast error is:

$$z_{t+2} - E_t z_{t+2} = A_0 + A_1 A_0 + A_1^2 z_t + A_1 e_{t+1} + e_{t+2} - A_0 - A_1 A_0 - A_1^2 z_t$$

$$z_{t+2} - E_t z_{t+2} = e_{t+2} + A_1 e_{t+1}.$$

From this it follows that the *n*-step-ahead forecast is:

$$E_t z_{t+n} = (I + A_1 + A_1^2 + \cdots + A_1^{n-1})A_0 + A_1^n z_t.$$

The associated forecast error is:

$$e_{t+n} + A_1 e_{t+n-1} + A_1^2 e_{t+n-2} + \cdots + A_1^{n-1} e_{t+1}. \quad [61]$$

These forecast errors can also be expressed in terms of the vector moving average form of the structural model represented by equation [56]. VMA and VAR representations contain the same information but it is useful to describe the forecast errors in terms of the $\{\varepsilon_t\}$ sequence. Using equation [56] to conditionally forecast z_{t+1}, the one-step-ahead forecast error is $\phi_0 \varepsilon_{t+1}$. In general the following holds:

$$z_{t+n} = \mu + \sum_{i=0} \phi_i \, \varepsilon_{t+n-i}.$$

In this case the n-period forecast error is:

$$z_{t+n} - E_t z_{t+n} = \sum_{i=0}^{n-1} \phi_i \, \varepsilon_{t+n-1}.$$

Looking at the $\{x_t\}$ sequence, the n-step-ahead forecast error is:

$$x_{t+n} - E_t x_{t+n} = \phi_{11}(0)\varepsilon_{xt+n} + \phi_{11}(1)\varepsilon_{xt+n-1} + \cdots + \phi_{11}(n-1)\varepsilon_{xt+1}$$

$$+\phi_{12}(0)\varepsilon_{yt+n} + \phi_{12}(1)\varepsilon_{yt+n-1} + \cdots + \phi_{12}(n-1)\varepsilon_{yt+1}. \quad [62]$$

Let the n-step-ahead forecast error variance of x_{t+n} be denoted by $\zeta_x(n)^2$:

$$\sigma_x(n)^2 = \sigma_x^2[\phi_{11}(0)^2 + \phi_{11}(1)^2 + \cdots + \phi_{11}(n-1)^2]$$

$$+\sigma_y^2[\phi_{12}(0)^2 + \phi_{12}(1)^2 + \cdots + \phi_{12}(n-1)^2]. \quad [63]$$

Since all the values of $\phi_{jk}(i)^2$ are non-negative, the variance of the forecast error increases as the forecast horizon n increases. It is possible to decompose the n-step-ahead forecast error variance into the proportions due to each shock. The proportions of $\zeta_x(n)^2$ due to shocks in the $\{\varepsilon_{xt}\}$ and $\{\varepsilon_{yt}\}$are, respectively:

$$\sigma_x^2[\phi_{11}(0)^2 + \phi_{11}(1)^2 + \cdots + \phi_{11}(n-1)^2]/\sigma_x(n)^2 \quad \text{and}$$

$$\sigma_y^2[\phi_{12}(0)^2 + \phi_{12}(1)^2 + \cdots + \phi_{12}(n-1)^2]/\sigma_x(n)^2. \quad [64]$$

The forecast error variance decomposition reveals the proportion of the movements in a sequence due to its own shocks in comparison to shocks to the other variable. If ε_{yt} shocks explain none of the forecast error variance of $\{x_t\}$ then the $\{x_t\}$ sequence is exogenous. Hence, the $\{x_t\}$ sequence evolves independently of ε_{yt} and of the sequence $\{y_t\}$. On the other hand, ε_{yt} shocks could explain all of the forecast error variance of the $\{x_t\}$ sequence at all forecast horizons, hence $\{x_t\}$ is endogenous. In practical applications it is common for a variable to explain almost all of its forecast error variance at short horizons and smaller proportions at longer horizons (Ewing, 2001: 75).

The same problem that was present in impulse response functions analysis is present in variance decomposition, namely the Cholesky ordering. In order to properly identify the $\{\varepsilon_{xt}\}$ and $\{\varepsilon_{yt}\}$ sequences it is necessary to place some restrictions. The Cholesky decomposition used in equations [57] and [58] necessitates that all of the one-period forecast error variance of y_t is due to ε_{yt}. Using the alternative ordering, all of the one-period forecast variance of x_t is due to ε_{xt}. The effects of these assumptions are less severe in the long run. For this reason it is useful to determine the variance decomposition at various forecast horizons. As n increases the variance decomposition should converge.

3.5 Block Exogeneity

Block exogeneity tests are quite simply multivariate generalizations of the Granger causality tests. These tests aim to show whether the lags of any variables Granger cause any other variable in the system. This is tested by restricting all the lags of a particular variable to zero (Brooks, 2008: 297). Suppose for example there is a three variable VAR with 2 lag lengths:

$$\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} a_{10} \\ a_{20} \\ a_{30} \end{pmatrix} + \begin{pmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{pmatrix} \begin{pmatrix} x_{t-1} \\ y_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} c_{11} & c_{12} & c_{13} \\ c_{21} & c_{22} & c_{23} \\ c_{31} & c_{32} & c_{33} \end{pmatrix} \begin{pmatrix} x_{t-2} \\ y_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} e_x \\ e_y \\ e_z \end{pmatrix} \quad [65]$$

This can be written as follows:

$$x_t = a_{10} + b_{11}x_{t-1} + b_{12}y_{t-1} + b_{13}z_{t-1} + c_{11}x_{t-2} + c_{12}y_{t-2} + c_{13}z_{t-2} + e_{xt}$$

$$y_t = a_{20} + b_{21}x_{t-1} + b_{22}y_{t-1} + b_{23}z_{t-1} + c_{21}x_{t-2} + c_{22}y_{t-2} + c_{23}z_{t-2} + e_{yt}$$

$$z_t = a_{30} + b_{31}x_{t-1} + b_{32}y_{t-1} + b_{33}z_{t-1} + c_{31}x_{t-2} + c_{32}y_{t-2} + c_{33}z_{t-2} + e_{zt} \quad [66]$$

where e_i are the error terms. Assuming that the variables are stationary, the joint hypotheses can be tested using an F-test, since each individual set of restrictions involves parameters from only one equation. For example, suppose the test was that lagged values of x do not explain current values of y. The restrictions would be that $b_{21} = c_{21} = 0$. These equations would be estimated with OLS to obtain the unrestricted *RSS*. Then the restrictions are placed to estimate restricted *RSS*. The two values of *RSS* are compared with standard F-tests. In this study the tests will be carried out to see which lagged values of foreign markets influence current values of the SA market.

3.6 Normality Tests

3.6.1 Jarque-Bera Statistic

A formal procedure to test for normality of OLS residuals can be done with the Jarque-Bera statistic (1980, 1987).

$$JB = n\left(\frac{S^2}{6} + \frac{(K-3)^2}{24}\right) \sim \chi_2^2 \text{ (asymptotically)} \qquad [67]$$

where S and K are the skewness and kurtosis coefficients calculated as follows:

$$S = \hat{\mu}_3/(\hat{\sigma}^2)^{3/2} = \frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^3 \Big/ \left(\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2\right)^{3/2}$$

$$K = \hat{\mu}_4/(\hat{\sigma}^2)^2 = \frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^4 \Big/ \left(\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2\right)^2$$

where $\hat{\mu}_3$ and $\hat{\mu}_4$ are the estimates of the third and fourth central moments, respectively, $\bar{x}$ is the sample mean and $\hat{\sigma}^2$ is the estimate of the variance. For a normal distribution, $S = 0$ and $K = 3$. The null hypothesis is the joint hypothesis that the skewness and kurtosis are 0 and 3, respectively.

3.5.2 Shapiro-Wilk Statistic

Proposed in 1965 by Samuel Shapiro and Martin Wilk, the Shapiro-Wilk W-statistic tests whether or not a sample comes from a normal distribution. The null hypothesis is that the data are normally distributed and small values of the W-statistic indicate a departure from normality. The statistic is given as follows:

$$W = \left(\sum_{i=1}^{n} a_i x_{(i)}\right)^2 \Big/ \sum_{i=1}^{n}(x_i - \bar{x})^2 \qquad [68]$$

where $x_{(i)}$ are the ordered sample values, $x_{(1)}$ being the smallest and $x_{(n)}$ being the largest values in the sample and the a_i are constants generated as follows:

$$(a_1, \ldots, a_n) = m \textstyle\sum^{-1}/(m \sum^{-1}\sum^{-1} m)^{1/2}$$

where $m = (m_1, \ldots, m_n)$ and $m_{(i)}$ are the expected values of the corresponding standard normal order statistics and $\sum$ is the variance-covariance matrix of those order statistics.

Many authors agree that this is the most reliable test for normality for small to medium sized samples. Failure to reject the null hypothesis does not automatically indicate that the data are normally distributed, it is merely to be treated as evidence in the investigation into normality (Royston, 1995; Conover, 1999).

Chapter 4

Results

4.1 Preliminary Results

Before looking at the cointegration results it is necessary to investigate some of the descriptive statistics of the data. For price indices data, skewness results indicate that some of the series have negative and some have positive skewness. However, the skewness is generally different from zero. Only for the markets of Argentina and South Korea are the absolute values of the skewness less than 0.01. Kurtosis for the data is generally around 3, with most of the data being just below it. For MSCI indices, the skewness results are similar to that for the price indices. However, China and Hong Kong exhibit absolute values for the skewness of less than 0.1. Kurtosis results are also very similar when compared to those obtained using the price indices. The Shapiro-Wilk test for normality revealed that all the data series except for the Hong Kong MSCI index are not normally distributed at the 1% level of significance. The results of the Shapiro-Wilk test can be found in Appendix A. These results are in contrast to the Efficient Market Hypothesis which has as one of its assumptions that market data should ideally be normally distributed (Fama, 1970). All the appendices mentioned can be found on the attached CD.

Before performing the EG test it was necessary to make sure that the series were non-stationary and integrated of the same order. In line with assumptions about financial data, all the MSCI and price indices were found to be $I(1)$ using the Augmented Dickey-Fuller test (ADF). The unit root test results for South Africa are given in Table 4.1 and for the other markets they can be found in the Appendix B.

Table 4.1 Unit root test *p*-value results for SA MSCI and Price indices.

	ADF Statistic	
	Level	1st difference
SA MSCI	0.9257	0.0000
SA Price index	0.9209	0.0000

Figure 4.1 shows two time series plots, where no cointegration was found (*cf* Sections 4.2 and 4.3) for SA and Japan, and SA and USA.

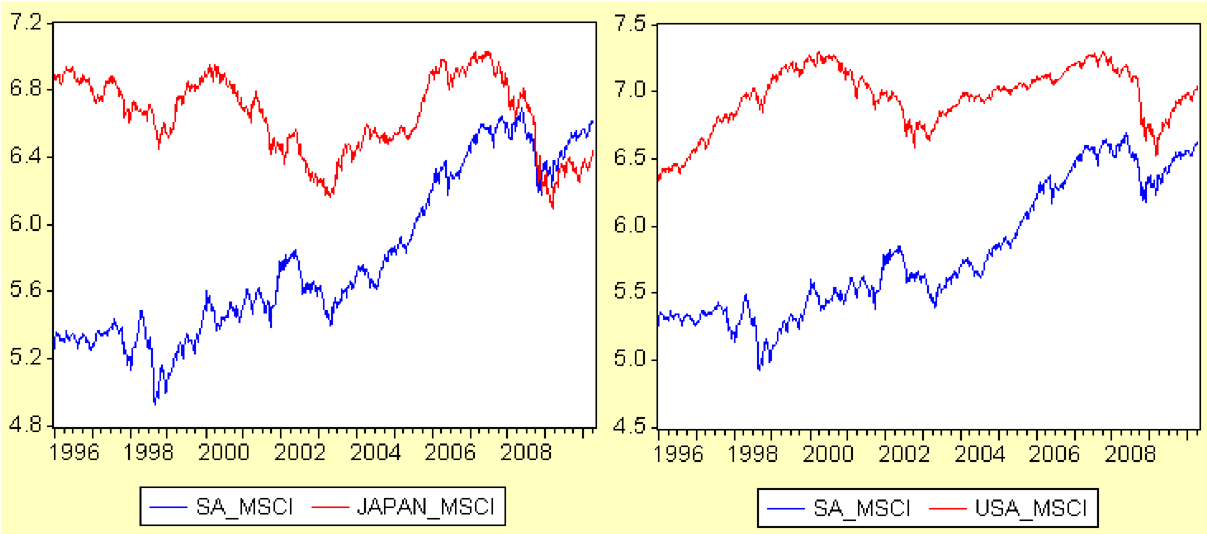

Fig. 4.1 Time series plots of SA and Japan (MSCI), and SA and USA (Price index) where cointegration is not present.

From Figure 4.1 it is not clear that a linear combination of them would be stationary and each of the series seems to follow its own pattern. Figure 4.2 shows pair-wise time series plots where cointegration was found (*cf* Sections 4.2 and 4.3) for SA with Brazil and SA with Mexico.

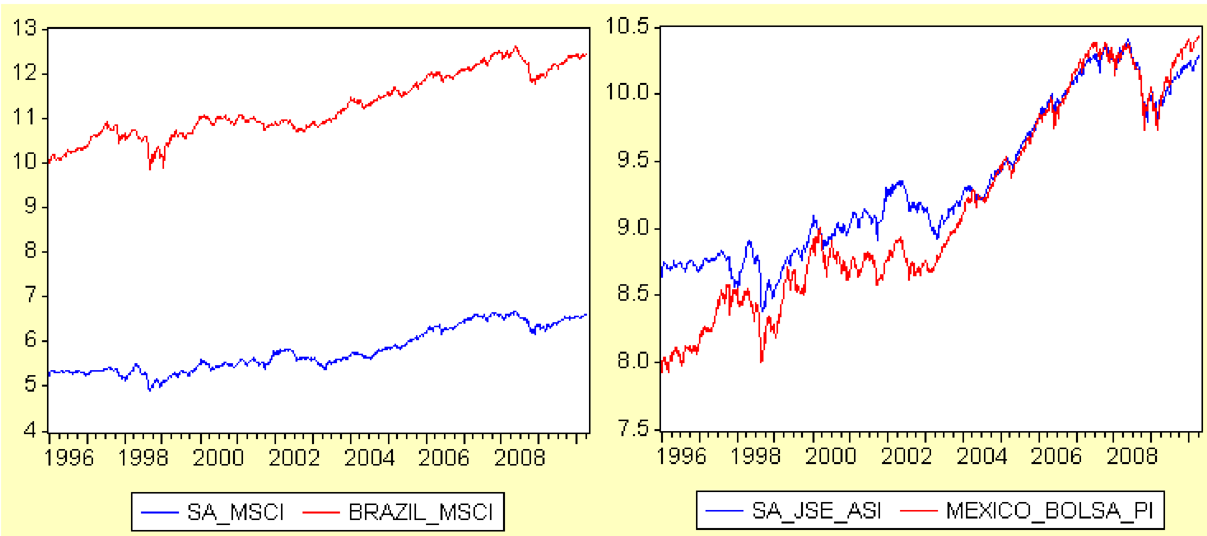

Fig. 4.2 Time series plots of SA and Turkey (MSCI), and SA and Mexico (Price index) where cointegration is present.

Compared with series where no cointegration was found, the series in Figure 4.2 seem to roughly mimic each other's movements. This shows that when dealing with bivariate cointegration it is possible to visually see whether or not there is any indication of cointegration. For bivariate cointegration looking at time series plots should be done as a preliminary step to see if there is any cointegration. The same is not true for multivariate cointegration.

The time series plots in Figures 4.1 and 4.2 indicate that after 2003 the series follow each other's movements more closely than before 2003. For this reason the study also tested post-2003 to April 2010 data for cointegration.

4.2 Bivariate Cointegration

4.2.1 Engle-Granger Test

Using the EG methodology, pair-wise comparisons are made because this method only produces one cointegrating vector. First, each variable is taken as the dependent one and the other one as the independent one and afterwards the two are swopped and the test is done again. When formulating a unit root test on the residuals, it is necessary to specify the deterministic trend assumption. Theoretical specifications and previous research suggest that it is a big assumption that there is a trend in financial data, hence the form chosen was "intercept only". However, this can be a subjective assumption and hence results using the forms "no trend or intercept" and "trend and intercept" are included as well for comparative purposes.

One of the major problems is the question of what lag to select when testing the estimated residuals for a unit root. The choice of lag length may greatly affect the results; too few lags could invalidate the test and too many lags could result in a loss of power (Gutiérrez *et al.*, 2009: 30). For purposes of comparison, it was necessary that all the vectors of residuals had the same lag length. At a lag length of zero, the residuals were autocorrelated, hence it was necessary to use the Augmented Engle-Granger test which added lagged differenced values of the residuals when testing the residuals for stationarity. All the residuals become white noise after 1 lag and hence this lag was used for all the residuals. The results of the EG test at 1 lag are given in Tables 4.2 to 4.5.

Using the modified AIC, all regressions had the unit root test carried out with automatic lag selection procedures. The number of lag lengths selected ranged from between 0 and 19 but the majority of the number of lag selections was one. The tables of results using the optimal number of lag lengths are provided in Appendix D. For comparative procedures, the unit root test was performed on a random selection of the series with lag lengths from 0 to 14 to see whether or not results were sensitive to the number of lag lengths used. The results showed that adjusting the number of lag lengths affected the *p*-values by between 0.05 and 0.1 In general, for cointegrated series changing the number of lag lengths increased the *p*-values but for non-cointegrated series the *p*-values hovered around a certain range. Using 1 lag length gave the best results, especially for cointegrated series.

Table 4.2 Bivariate EG cointegration results using MSCI indices and SA as the dependent variable.

MSCI: Country pairs – dependent variable 1st	*p*-value for unit root tests on residuals with 1 lag Intercept only	No trend/intercept	Trend and Intercept
SA – Argentina	0.2187	0.0291	0.3829
SA – Australia	0.2984	0.0462	0.3962
SA – Brazil	0.0099	0.0006	0.0416
SA – Canada	0.4457	0.0895	0.3212
SA – China	0.8147	0.3632	0.2837
SA – Colombia	0.2131	0.0280	0.4480
SA – Egypt	0.4143	0.0786	0.5519
SA – France	0.9782	0.7708	0.3319
SA – Germany	0.9762	0.7597	0.2600
SA – Hong Kong	0.5985	0.1585	0.2712
SA – India	0.0551	0.0046	0.1431
SA – Indonesia	0.2062	0.0267	0.4659
SA – Japan	0.9213	0.5730	0.3953
SA – South Korea	0.1037	0.0104	0.2737
SA – Mexico	0.0366	0.0028	0.1322
SA – Morocco	0.6565	0.1958	0.3248
SA – Netherlands	0.9268	0.5871	0.3669
SA – Nigeria	0.3162	0.0504	0.4919
SA – Pakistan	0.2482	0.0349	0.2333
SA – Philippines	0.8770	0.4742	0.1592
SA – Poland	0.4812	0.1027	0.0319
SA – Russia	0.3312	0.0544	0.1635
SA – Spain	0.8288	0.3860	0.2062
SA – Switzerland	0.9529	0.6658	0.2125
SA – Turkey	0.3445	0.0581	0.3445
SA – UK	0.9636	0.7040	0.2723
SA – USA	0.9765	0.7616	0.3027

Table 4.3 Bivariate EG cointegration results using MSCI indices and SA as the independent variable.

MSCI: Country pairs - dependent variable 1st	*p*-value for unit root tests on residuals with 1 lag		
	Intercept only	No trend/intercept	Trend and Intercept
Argentina – SA	0.1899	0.0238	0.4621
Australia – SA	0.1702	0.0204	0.4515
Brazil – SA	0.0054	0.0003	0.0373
Canada – SA	0.1028	0.0104	0.3690
China – SA	0.4653	0.0968	0.8904
Colombia – SA	0.2376	0.0328	0.5290
Egypt – SA	0.3924	0.0718	0.7146
France – SA	0.2000	0.0258	0.5129
Germany – SA	0.2849	0.0432	0.5487
Hong Kong – SA	0.2048	0.0265	0.4984
India – SA	0.0505	0.0041	0.1766
Indonesia – SA	0.2612	0.0377	0.6050
Japan – SA	0.4411	0.0877	0.7295
South Korea – SA	0.0869	0.0083	0.2535
Mexico – SA	0.0251	0.0018	0.1292
Morocco – SA	0.3226	0.0524	0.6310
Netherlands – SA	0.1940	0.0246	0.4022
Nigeria – SA	0.2208	0.0295	0.5971
Pakistan – SA	0.1314	0.0143	0.3500
Philippines – SA	0.3920	0.0718	0.8441
Poland – SA	0.0436	0.0035	0.1083
Russia – SA	0.0749	0.0068	0.2254
Spain – SA	0.0522	0.0044	0.2579
Switzerland – SA	0.1480	0.0169	0.3887
Turkey – SA	0.0142	0.0009	0.1950
UK – SA	0.2278	0.0309	0.4855
USA – SA	0.1324	0.0146	0.3914

Table 4.4 Bivariate EG cointegration results using price indices and SA as the dependent variable.

Price Index: Country pairs – dependent variable 1st	*p*-value for unit root tests on residuals with 1 lag		
	Intercept only	No trend/intercept	Trend and Intercept
SA – Argentina, Merval	0.4057	0.0760	0.6770
SA – Australia, ASX	0.4221	0.0812	0.4587
SA – Bangladesh, Dhaka	0.3354	0.0556	0.7239
SA – Brazil, Bovespa	0.0527	0.0044	0.1278
SA – Canada, TSI	0.4224	0.0814	0.2725
SA – China, Shanghai	0.4952	0.1084	0.2048
SA – China, Shenzhen	0.1140	0.0118	0.1573
SA – Egypt, Cairo	0.5712	0.1436	0.7439
SA – France, CAC 40	0.9903	0.8480	0.3584
SA – Germany, DAX 30	0.9494	0.6541	0.2570
SA – Hong Kong, Hangseng	0.3694	0.0649	0.2751
SA – India, BSE	0.1222	0.0130	0.3046
SA – Japan, Nikkei	0.8522	0.4261	0.6088
SA – Japan, Topix	0.9227	0.5766	0.4968
SA – South Korea, KSE	0.0379	0.0029	0.0956
SA – Mexico, Bolsa	0.0103	0.0006	0.0473
SA – Netherlands, ASE	0.9515	0.6594	0.4165
SA – Philippines, PSE	0.6655	0.2036	0.5695
SA – Poland, Warsaw	0.1188	0.0125	0.0457
SA – Russia, RTS	0.4224	0.0813	0.4275
SA – Spain, IBEX 35	0.8742	0.4692	0.2205
SA – Spain, MSE	0.7982	0.3391	0.2598
SA – Switzerland, SE	0.9727	0.7435	0.1962
SA – Thailand, SET	0.4767	0.1030	0.4143
SA – Turkey, ISE	0.2671	0.0392	0.2032
SA – UK, FTSE 100	0.9530	0.6658	0.2862
SA – USA, NYSE	0.8468	0.4169	0.2799

Table 4.5 Bivariate EG cointegration results of price indices and SA as the independent variable.

Price Index: Country pairs – dependent variable 1st	*p*-value for unit root tests on residuals with 1 lag		
	Intercept only	No trend/intercept	Trend and Intercept
Argentina, Merval – SA	0.3747	0.0665	0.7086
Australia, ASX – SA	0.2345	0.0322	0.5105
Bangladesh, Dhaka – SA	0.5792	0.1476	0.8938
Brazil, Bovespa – SA	0.0265	0.0019	0.1249
Canada, TSI – SA	0.1213	0.0129	0.3254
China, Shanghai – SA	0.0991	0.0099	0.3034
China, Shenzhen – SA	0.0448	0.0036	0.1674
Egypt, Cairo – SA	0.5695	0.1428	0.8525
France, CAC 40 – SA	0.2655	0.0389	0.5554
Germany, DAX 30 – SA	0.2210	0.0297	0.4687
Hong Kong, Hangseng – SA	0.1348	0.0148	0.3571
India, BSE – SA	0.1245	0.0133	0.3500
Japan, Nikkei – SA	0.3154	0.0504	0.6586
Japan, Topix – SA	0.4549	0.0927	0.7604
South Korea, KSE – SA	0.0268	0.0019	0.1260
Mexico, Bolsa – SA	0.0083	0.0005	0.0429
Netherlands, ASE – SA	0.2129	0.0281	0.4084
Philippines, PSE – SA	0.4431	0.0886	0.8657
Poland, Warsaw – SA	0.0301	0.0022	0.0862
Russia, RTS – SA	0.2195	0.0293	0.4977
Spain, IBEX 35 – SA	0.1119	0.0116	0.3239
Spain, MSE – SA	0.0971	0.0097	0.3367
Switzerland, SE – SA	0.1582	0.0185	0.3695
Thailand, SET – SA	0.0408	0.0032	0.2472
Turkey, ISE – SA	0.0140	0.0009	0.1580
UK, FTSE 100 – SA	0.2660	0.0389	0.5237
USA, NYSE – SA	0.1387	0.0155	0.3653

All other EG cointegration test results are shown in the tables in Appendix D.

The residuals were also tested for normality using the Jarque-Bera statistic and were found to be non-normal. However, this is not a requirement for cointegration, the important issue to note is that the residuals are not autocorrelated. These results are provided in Appendix T.

4.2.1.1 Intercept Only

The following results were obtained when including an intercept term but no trend in the model.

When the foreign country was the dependent variable in the regression (Tables 4.3 and 4.5), the SA market cointegrated with Brazil, Mexico, Poland and Turkey for values of the MSCI indices and with Brazil, China (Shenzhen), South Korea, Mexico, Poland, Thailand and Turkey for values of the price indices. All other pair-wise combinations with SA showed no cointegration at the 5% level of significance. Comparing the two indices gave similar results in this case.

Treating SA as the dependent variable (Tables 4.2 and 4.4) gave results that SA was cointegrated with Brazil and Mexico for values of MSCI and South Korea and Mexico for the price indices at the 5% level of significance. The general trend was that the more developed the country, the less cointegration there was with South Africa - with France, Germany, Japan, the Netherlands, Switzerland, the UK and the USA having *p*-values of over 0.9 for MSCI. There was inconsistency about whether or not there was cointegration, which, as mentioned earlier, is one of the possible drawbacks of the EG test.

However despite this, from the EG test results it can be seen that when cointegration was present, it was with other emerging markets and not developed ones which is consistent with the majority of other findings.

4.2.1.2 No Trend or Intercept

If there was no trend or intercept included in the cointegration test, the results gave very small *p*-values. This specification model is severely biased towards finding cointegration, with almost all the series being cointegrated with SA, particularly when a foreign country is the dependent variable in the regression, regardless whether the price or MSCI indices are compared.

4.2.1.3 Trend and Intercept

Including a trend and intercept had the opposite effect to not including them in the model. Treating SA as the dependent variable, cointegration was present for Brazil and Poland for the MSCI indices; and only Mexico and Poland for the price indices. Treating the foreign country as dependent there was cointegration with Brazil only when using MSCI; and Mexico only when using the price indices.

4.2.1.4 EG Cointegration Results with Optimal Lag Lengths

The cointegration results using the optimal number of lag lengths as selected by the MAIC are very similar to the results at 1 lag with the following changes for the intercept only specification. These results can be found in Appendix D. For MSCI indices and SA as the independent variable, Poland is no longer cointegrated with South Africa whereas Russia and Spain now are at the 5% level of significance. With the price indices and South Africa as the dependent variable, Mexico is no longer cointegrated with SA. Treating SA as the independent variable the results show that SA is no longer pair-wise cointegrated with Brazil, China and Poland. The results using the lag length at which autocorrelation first disappears are preferred because they give results that are more in line with *a priori* assumptions.

4.2.1.5 Results for Data from 2003 – 2010

Using the data from 2003 to 2010, the results obtained were the opposite of what was expected. At 1 lag, autocorrelation disappeared for all the series, hence this model was used on all the residuals. For the intercept only specification and treating SA as the dependent variable, the results showed that SA was only cointegrated with Mexico using MSCI indices and cointegrated with South Korea and Mexico for price indices at the 5% level of significance (Tables 4.6 and 4.8). Treating the foreign country as the dependent variable, there was cointegration of SA with Brazil, India, South Korea, and Mexico for MSCI indices; and India, South Korea and Mexico for price indices (Tables 4.7 and 4.9).

For the model without a trend or an intercept term and having a foreign country as the dependent variable, the reduced dataset gave fewer significant cointegration results than when the whole dataset (1995 to 2010) was included for both MSCI and price indices.

Including both a trend and an intercept term and treating SA as the dependent variable or the independent variable the reduced dataset gave the results that SA is cointegrated with Mexico for the MSCI indices and with South Korea and Mexico for the price indices. These cointegration results differed from those when using the whole dataset except for the price indices cointegration with Mexico.

Overall there was no increase in cointegration in the period 2003-2010 compared with the period 1995-2010. This result was unexpected since increased cointegration was suspected from visual inspection of the time series plots.

Table 4.6 Bivariate cointegration results of weekly MSCI indices from 2003 to 2010, and SA as the dependent variable.

MSCI: Country pairs – dependent variable 1st	*p*-value for unit root tests on residuals with 1 lag (since 2003)		
	Intercept only	No trend/intercept	Intercept and Trend
SA – Argentina	0.2440	0.0340	0.2131
SA – Australia	0.6174	0.1695	0.5547
SA – Brazil	0.0501	0.0041	0.1742
SA – Canada	0.4939	0.1074	0.2857
SA – China	0.2580	0.0370	0.5362
SA – Colombia	0.3110	0.0492	0.6032
SA – Egypt	0.4253	0.0821	0.4569
SA – France	0.8464	0.4155	0.2298
SA – Germany	0.8476	0.4169	0.3406
SA – Hong Kong	0.5298	0.1232	0.3885
SA – India	0.0607	0.0052	0.1614
SA – Indonesia	0.1438	0.0161	0.3940
SA – Japan	0.8335	0.3935	0.0572
SA – South Korea	0.0690	0.0061	0.1156
SA – Mexico	0.0089	0.0005	0.0310
SA – Morocco	0.0772	0.0071	0.2520
SA – Netherlands	0.6626	0.2030	0.1429
SA – Nigeria	0.6968	0.2258	0.5378
SA – Pakistan	0.6082	0.1634	0.0674
SA – Philippines	0.2463	0.0345	0.2494
SA – Poland	0.8280	0.3836	0.1877
SA – Russia	0.7193	0.2464	0.2129
SA – Spain	0.6811	0.2132	0.3770
SA – Switzerland	0.8483	0.4184	0.4324
SA – Turkey	0.3217	0.0519	0.4255
SA – UK	0.6809	0.2149	0.4791
SA – USA	0.6755	0.2144	0.5692

Table 4.7 Bivariate cointegration results of weekly MSCI indices from 2003 to 2010, and SA as the independent variable.

MSCI: Country pairs – dependent variable 1st	*p*-value for unit root tests on residuals with 1 lag		
	Intercept only	No trend/intercept	Trend and Intercept
Argentina – SA	0.2212	0.0295	0.3796
Australia – SA	0.6154	0.1684	0.7997
Brazil – SA	0.0464	0.0037	0.1610
Canada – SA	0.3227	0.0521	0.4223
China – SA	0.2286	0.0310	0.5228
Colombia – SA	0.2676	0.0391	0.5846
Egypt – SA	0.3100	0.0490	0.5416
France – SA	0.7648	0.2959	0.7857
Germany – SA	0.6696	0.2053	0.6894
Hong Kong – SA	0.2688	0.0394	0.4261
India – SA	0.0477	0.0039	0.1646
Indonesia – SA	0.1583	0.0183	0.3724
Japan – SA	0.7844	0.3204	0.6482
South Korea – SA	0.0427	0.0034	0.1290
Mexico – SA	0.0093	0.0005	0.0411
Morocco – SA	0.1168	0.0122	0.2956
Netherlands – SA	0.7007	0.2308	0.8195
Nigeria – SA	0.5992	0.1585	0.7868
Pakistan – SA	0.3789	0.0675	0.4671
Philippines – SA	0.1511	0.0173	0.3158
Poland – SA	0.5351	0.1259	0.5238
Russia – SA	0.5160	0.1169	0.6065
Spain – SA	0.5518	0.1333	0.6691
Switzerland – SA	0.7623	0.2931	0.8009
Turkey – SA	0.2155	0.0284	0.4556
UK – SA	0.5214	0.1196	0.6972
USA – SA	0.5750	0.1457	0.6669

Table 4.8 Bivariate cointegration results of weekly price indices from 2003 to 2010, and SA as the dependent variable.

Price index: Country pairs – dependent variable 1st	*p*-value for unit root tests on residuals with 1 lag		
	Intercept only	No trend/intercept	Trend and Intercept
SA – Argentina, Merval	0.3437	0.0577	0.4153
SA – Australia, ASX	0.7566	0.2857	0.6337
SA – Bangladesh, Dhaka	0.1443	0.0163	0.4371
SA – Brazil, Bovespa	0.1069	0.0108	0.3027
SA – Canada, TSI	0.5583	0.1366	0.1766
SA – China, Shanghai	0.0917	0.0092	0.5084
SA – China, Shenzhen	0.2120	0.0281	0.7099
SA – Egypt, Cairo	0.4105	0.0772	0.4763
SA – France, CAC 40	0.8649	0.4492	0.1360
SA – Germany, DAX 30	0.4669	0.0968	0.1694
SA – Hong Kong, Hangseng	0.2930	0.0448	0.3649
SA – India, BSE	0.0514	0.0042	0.1565
SA – Japan, Nikkei	0.8708	0.4613	0.1250
SA – Japan, Topix	0.7974	0.3416	0.4814
SA – South Korea, KSE	0.0036	0.0002	0.0076
SA – Mexico, Bolsa	0.0005	0.0000	0.0031
SA – Netherlands, ASE	0.7260	0.2600	0.0606
SA – Philippines, PSE	0.1729	0.0208	0.2828
SA – Poland, Warsaw	0.5964	0.1569	0.1929
SA – Russia, RTS	0.3456	0.0582	0.2887
SA – Spain, IBEX 35	0.6636	0.1999	0.2801
SA – Spain, MSE	0.8120	0.3570	0.4538
SA – Switzerland, SE	0.8624	0.4447	0.4160
SA – Thailand, SET	0.7977	0.3384	0.4084
SA – Turkey, ISE	0.3056	0.0478	0.5556
SA – UK, FTSE 100	0.6858	0.2183	0.4095
SA – USA, NYSE	0.8280	0.3838	0.1854

Table 4.9 Bivariate cointegration results of weekly price indices from 2003 to 2010, and SA as the independent variable.

Price index: Country pairs – dependent variable 1st	*p*-value for unit root tests on residuals with 1 lag		
	Intercept only	No trend/intercept	Trend and Intercept
Argentina, Merval – SA	0.1786	0.0218	0.3870
Australia, ASX – SA	0.6881	0.2199	0.8047
Bangladesh, Dhaka – SA	0.3978	0.0730	0.3197
Brazil, Bovespa – SA	0.1033	0.0103	0.2318
Canada, TSI – SA	0.3358	0.0555	0.3563
China, Shanghai – SA	0.3769	0.0674	0.6785
China, Shenzhen – SA	0.4321	0.0847	0.7522
Egypt, Cairo – SA	0.2947	0.0453	0.5339
France, CAC 40 – SA	0.7481	0.2768	0.7371
Germany, DAX 30 – SA	0.2961	0.0456	0.3352
Hong Kong, Hangseng – SA	0.1698	0.0203	0.3654
India, BSE – SA	0.0332	0.0025	0.1312
Japan, Nikkei – SA	0.6431	0.1865	0.4930
Japan, Topix – SA	0.7984	0.3395	0.6236
South Korea, KSE – SA	0.0023	0.0001	0.0107
Mexico, Bolsa – SA	0.0006	0.0000	0.0022
Netherlands, ASE – SA	0.7440	0.2724	0.7964
Philippines, PSE – SA	0.1289	0.0139	0.3202
Poland, Warsaw – SA	0.4012	0.0745	0.4158
Russia, RTS – SA	0.3065	0.0481	0.5213
Spain, IBEX 35 – SA	0.5314	0.1236	0.5982
Spain, MSE – SA	0.7116	0.2397	0.7480
Switzerland, SE – SA	0.7511	0.2803	0.7585
Thailand, SET – SA	0.1042	0.0106	0.1251
Turkey, ISE – SA	0.2588	0.0371	0.5579
UK, FTSE 100 – SA	0.5251	0.1212	0.6706
USA, NYSE – SA	0.6002	0.1595	0.6240

4.2.2 Johansen Test

For the Johansen test the ordering of the variables does not matter. Using the maximum eigenvalue statistic, specifying intercept only, no trend and a lag length of 1, SA was cointegrated with Brazil and Turkey when using MSCI indices; and Brazil, Mexico and Turkey when using price indices. As with the EG test, tests were also carried out using the lag length at which autocorrelation first disappeared as determined by the Bresuch-Godfrey LM test and the lag length selected by the various criteria. Here, the modified AIC was not used alone but 5 different criteria, AIC, Schwarz IC, Hannan-Quinn IC, final prediction error and modified likelihood ratio statistic. The lag length that was chosen by the majority was then selected as the optimal lag length. However, at this lag length, autocorrelation was sometimes present. Hence, the method that selected the lag length at which autocorrelation first disappeared was preferred. The results using the optimal number of lag lengths are given in the Tables 4.10 and 4.11, with the others test results given in Appendix G.

As with the EG test, increasing the number of lag lengths increased the *p*-values with 1 lag again providing the optimal results. With 3 lags, for example, Brazil was no longer significantly cointegrated with SA for MSCI indices (Table 4.10).

With no trend or intercept in the cointegrating equation (CE) or the VAR, there was cointegration of SA with South Korea, Mexico (Trace only) and Turkey for MSCI indices and Brazil, South Korea, Thailand and Turkey for price indices (Tables 4.10 and 4.11). With trend and intercept in the CE and intercept only in the VAR, SA was cointegrated with Poland for price indices (Max eigenvalue only) and with Morocco for MSCI indices (Max eigenvalue only). With intercept in the CE and the VAR, SA was cointegrated with Turkey for MSCI indices and Brazil for the price indices.

Tables of results using the number of lag lengths selected by the information criteria are given in Appendix G. The only changes from Tables 4.10 and 4.11 are as follows: For price indices, Mexico is now cointegrated with SA using no trend or intercept in the CE or the VAR (Max eigenvalue only) and when using an intercept in the CE and the VAR (Trace only). Poland is no longer cointegrated with SA using the trend and intercept in CE and intercept in VAR specification.

Table 4.10 Bivariate cointegration results using the Johansen method for MSCI indices. Optimal lag lengths used are given in parentheses.

MSCI	***p*-values**											
Trend/intercept	No trend/intercept in the C.E. or VAR				Intercept in C.E. and VAR				Intercept and trend in C.E., no trend in VAR			
Test method	Trace		Max Eigenvalue		Trace		Max Eigenvalue		Trace		Max Eigenvalue	
Hypothesized no. of CE's	None	At most one	None	At most one	None	At most one	None	At most one	None	At most one	None	At most one
SA – Arg. (3)	0.7170	0.2845	0.8477	0.2845	0.8524	0.7825	0.8036	0.7825	0.8038	0.7870	0.7811	0.7870
SA – Aus. (1)	0.6715	0.5176	0.6740	0.5176	0.4874	0.4704	0.5536	0.4704	0.6694	0.7364	0.6384	0.7364
SA – Brazil (3)	0.3747	0.1556	0.5879	0.1556	0.1052	0.5099	0.0830	0.5099	0.2460	0.3841	0.3297	0.3841
SA – Canada (1)	0.7307	0.5581	0.7254	0.5581	0.4929	0.6218	0.4629	0.6218	0.5995	0.6106	0.6403	0.6106
SA – China (1)	0.5008	0.1467	0.7679	0.1467	0.9349	0.7015	0.9598	0.7015	0.7638	0.8677	0.6623	0.8677
SA – Col. (1)	0.1944	0.4059	0.1930	0.4059	0.3302	0.2256	0.5655	0.2256	0.8825	0.8815	0.8293	0.8815
SA – Egypt (1)	0.2418	0.2882	0.2873	0.2882	0.5252	0.5358	0.5560	0.5358	0.7950	0.9959	0.5174	0.9959
SA – France (1)	0.8597	0.9016	0.8060	0.9016	0.5019	0.6366	0.4650	0.6366	0.5234	0.5176	0.6129	0.5176
SA – Ger. (1)	0.8962	0.8159	0.8603	0.8159	0.8200	0.7650	0.7892	0.7650	0.5369	0.6777	0.5119	0.6777
SA – HK (1)	0.7895	0.6123	0.7747	0.6123	0.7927	0.6847	0.7978	0.6847	0.2490	0.7181	0.1731	0.7181
SA – India (1)	0.1591	0.0687	0.4001	0.0687	0.2410	0.3772	0.2903	0.3772	0.4516	0.7690	0.3523	0.7690
SA – Indon. (1)	0.2041	0.0836	0.4529	0.0836	0.6451	0.5162	0.7192	0.5162	0.5685	0.7220	0.5201	0.7220
SA – Japan (1)	0.7176	0.7835	0.6537	0.7835	0.8860	0.5431	0.9589	0.5431	0.5407	0.8359	0.4074	0.8359
SA – S. Korea (1)	0.0171	0.3216	0.0169	0.3216	0.1812	0.8797	0.0847	0.8797	0.0770	0.0837	0.3143	0.0837
SA – Mexico (1)	0.0141	0.0308	0.0654	0.0308	0.0733	0.1641	0.1510	0.1641	0.3667	0.6007	0.3530	0.6007
SA – Moroc. (1)	0.0591	0.3013	0.0641	0.3013	0.3628	0.9029	0.2051	0.9029	0.1103	0.9435	0.0330	0.9435
SA – Ned. (1)	0.9028	0.9712	0.8581	0.9712	0.6935	0.7446	0.6347	0.7446	0.3647	0.6093	0.3456	0.6093
SA – Nigeria (4)	0.1156	0.0614	0.3178	0.0614	0.6480	0.5838	0.6001	0.5838	0.7924	0.9383	0.6326	0.9383
SA – Pakistan (1)	0.2230	0.1136	0.4215	0.1136	0.7423	0.6041	0.7813	0.6041	0.6604	0.8393	0.5479	0.8393
SA – Philpp. (1)	0.4725	0.3105	0.5548	0.3105	0.9147	0.7901	0.9072	0.7901	0.3578	0.8078	0.2370	0.8078
SA – Poland (1)	0.7911	0.4197	0.8461	0.4197	0.4144	0.6736	0.3462	0.6736	0.1703	0.6485	0.1221	0.6485
SA – Russia (1)	0.1066	0.1878	0.1551	0.1878	0.5249	0.7096	0.4512	0.7096	0.3936	0.6363	0.3643	0.6363
SA – Spain (1)	0.6885	0.4200	0.7357	0.4200	0.2553	0.6157	0.2039	0.6157	0.3643	0.5249	0.3975	0.5249
SA – Sui. (1)	0.8615	0.9702	0.8052	0.9702	0.5595	0.6633	0.5183	0.6633	0.5254	0.6046	0.5496	0.6046
SA – Turkey (1)	0.0049	0.0490	0.0165	0.0490	0.0242	0.3513	0.0224	0.3513	0.2329	0.3799	0.3128	0.3799
SA – UK (1)	0.8675	0.8445	0.8210	0.8445	0.6481	0.6227	0.6528	0.6227	0.6320	0.4897	0.7711	0.4897
SA – USA (1)	0.8457	0.7255	0.8126	0.7255	0.3944	0.6321	0.3440	0.6321	0.4514	0.4232	0.5952	0.4232

Table 4.11 Bivariate cointegration results using the Johansen method for price indices. Optimal lag lengths used are given in parentheses.

Price index	***p*-values**											
Trend/intercept.	No trend/intercept in the C.E. or VAR				Intercept in C.E. and VAR				Intercept and trend in C.E., no trend in VAR			
Test method	Trace		Max Eigenvalue		Trace		Max Eigenvalue		Trace		Max Eigenvalue	
Hypothesized no. of CE's	None	At most one	None	At most one	None	At most one	None	At most one	None	At most one	None	At most one
SA – Arg. (1)	0.2064	0.1049	0.4080	0.1049	0.6652	0.5802	0.7013	0.5802	0.7894	0.7135	0.8104	0.7135
SA – Aus.(2)	0.5979	0.8732	0.5137	0.8732	0.4622	0.4849	0.5110	0.4849	0.6360	0.5765	0.7118	0.5765
SA – Bang. (1)	0.2042	0.3008	0.2356	0.3008	0.4464	0.5453	0.4518	0.5453	0.7581	0.7364	0.7547	0.7364
SA – Brazil (1)	0.0015	0.0164	0.0116	0.0164	0.0161	0.1481	0.0323	0.1481	0.1512	0.6452	0.1059	0.6452
SA – Canada (1)	0.5940	0.5512	0.5764	0.5512	0.3591	0.4563	0.3977	0.4563	0.5451	0.7107	0.4990	0.7107
SA – China 1 (1)	0.0519	0.1677	0.0637	0.1677	0.2579	0.7465	0.1682	0.7465	0.3873	0.6934	0.3246	0.6934
SA – China 2 (1)	0.1301	0.0699	0.3297	0.0699	0.3368	0.2563	0.5372	0.2563	0.7718	0.7401	0.7702	0.7401
SA – Egypt (1)	0.3174	0.4845	0.3025	0.4845	0.6887	0.7429	0.6295	0.7429	0.8483	0.9897	0.6287	0.9897
SA – France (1)	0.6591	0.7395	0.5973	0.7395	0.2651	0.3916	0.3143	0.3916	0.4876	0.5828	0.5167	0.5828
SA – Ger. (1)	0.6954	0.7363	0.6378	0.7363	0.6318	0.5023	0.7127	0.5023	0.6538	0.7158	0.6333	0.7158
SA – HK (1)	0.4972	0.5021	0.4882	0.5021	0.3938	0.5382	0.3920	0.5382	0.2690	0.5951	0.2415	0.5951
SA – India (1)	0.1613	0.0624	0.4256	0.0624	0.3477	0.3047	0.5016	0.3047	0.6253	0.7675	0.5585	0.7675
SA – Japan 1 (1)	0.3802	0.7480	0.3140	0.7480	0.5921	0.5823	0.6089	0.5823	0.1688	0.7247	0.1030	0.7247
SA – Japan 2 (1)	0.3361	0.8414	0.2645	0.8414	0.6354	0.6643	0.6109	0.6643	0.6176	0.8323	0.5000	0.8323
SA – S. Korea (1)	0.0060	0.1068	0.0116	0.1068	0.1097	0.5962	0.0750	0.5962	0.0693	0.3832	0.0769	0.3832
SA – Mexico (3)	0.0738	0.0251	0.3521	0.0251	0.1266	0.5550	0.0984	0.5550	0.3399	0.5205	0.3686	0.5205
SA – Ned. (1)	0.6532	0.9886	0.5660	0.9886	0.3837	0.3566	0.5052	0.3566	0.2890	0.6870	0.2232	0.6870
SA – Philipp. (1)	0.2809	0.1966	0.4027	0.1966	0.8318	0.7274	0.8252	0.7274	0.5303	0.8007	0.4200	0.8007
SA – Poland (1)	0.0843	0.0366	0.3197	0.0366	0.1081	0.3162	0.1352	0.3162	0.1171	0.8695	0.0454	0.8695
SA – Russia (3)	0.3615	0.1915	0.5208	0.1915	0.7411	0.8716	0.6671	0.8716	0.7037	0.6177	0.7665	0.6177
SA – Spain 1 (1)	0.5158	0.6580	0.4635	0.6580	0.2553	0.2731	0.3899	0.2731	0.5676	0.6262	0.5879	0.6262
SA – Spain 2 (1)	0.2828	0.1062	0.5401	0.1062	0.2127	0.3717	0.2546	0.3717	0.4999	0.6861	0.4606	0.6861
SA – Sui. (1)	0.6829	0.9279	0.5998	0.9279	0.3420	0.3860	0.4234	0.3860	0.5469	0.6286	0.5596	0.6286
SA – Thai. (1)	0.0178	0.1604	0.0271	0.1604	0.2151	0.7102	0.1412	0.7102	0.1997	0.2011	0.4281	0.2011
SA – Turkey (4)	0.0053	0.0628	0.0150	0.0628	0.0848	0.3259	0.0793	0.3259	0.1740	0.3283	0.2561	0.3283
SA – UK (1)	0.6824	0.8860	0.6021	0.8860	0.6159	0.3903	0.7774	0.3903	0.7332	0.7113	0.7395	0.7113
SA – USA (1)	0.6115	0.8119	0.5346	0.8119	0.2408	0.3465	0.3092	0.3465	0.4894	0.5093	0.5746	0.5093

4.2.3 Comparison of EG and Johansen Bivariate Cointegration Results

Generally speaking, the two methods both found evidence of pair-wise cointegration between SA and other emerging markets, namely Mexico, Turkey for MSCI indices and Brazil, Thailand and Turkey for price indices. For the EG test, the model specification made a great difference to the results. For example, when no trend or intercept is included in the model there was a greater number of significant cointegrations, especially when SA was the independent variable. The exact opposite was true when the trend and intercept specification was used, where almost no cointegration was found in all cases. The differences in results for the different specifications were not as severe for the Johansen test and it is more stable in this regard.

The Johansen test is stricter than the EG test and finds less evidence of cointegration overall than the EG test. For example, for the intercept only in CE and VAR specification there was only one significant cointegration for the MSCI and price indices. Also in some cases cointegration was found in different markets when using the EG or Johansen test, so there was some inconsistency here.

The disadvantage of the EG test is that different results are obtained depending on whether or not SA is the dependent or independent variable and the Johansen test suffers from occasional contradiction between the trace and maximum eigenvalue statistics. Overall though, the Johansen test is preferred as it is more stable.

Focusing on the intercept only specification and comparing the results for the price indices with the results for the MSCI indices, for the EG test Mexico was the only market where cointegration was found using both the MSCI and price indices. Brazil was cointegrated for both indices as well, except for when SA was the dependent variable for the price index. Poland and Turkey were cointegrated with SA using both MSCI and price indices when SA was the independent variable. South Korea was cointegrated with SA for the price indices regardless of whether SA was dependent or independent. Thailand and the Chinese market at Shenzhen were cointegrated with SA using the price indices when SA was the independent variable. China (Shenzhen), South Korea and Thailand were all pair-wise cointegrated with SA when using the price indices but not the MSCI indices. All these markets are in Asia so it is an interesting observation that when using price indices there is increased evidence of cointegration between SA and Asian markets.

For the Johansen test, and focusing on any model specification and either trace or maximum eigenvalue statistics, pair-wise cointegration was found between SA and South Korea, and SA and Turkey for both MSCI and price indices. Cointegration of SA with Mexico and Morocco was found only for the MSCI indices and with Brazil, Poland and Thailand for the price indices. Once again there is more cointegration when using the price indices than when using the MSCI indices.

4.2.4 Vector Error Correction Mechanism (VECM)

From this section onwards, only the results using the price indices are reported. This is done to keep the study focused, at a reasonable length and for the following reasons. Firstly, price indices data are preferred as they are the original data reported by the various equity markets unlike the MSCI data. Secondly, MSCI indices are generally not as reliable for emerging markets as they are for developed ones, hence its best to use MSCI indices when comparing developed markets only. Finally, MSCI indices are calculated by grouping all the equity markets in one particular country into one, so for example, all the Japanese equity markets are weighted and grouped into one index. The price indices, on the other hand, report indices for a particular stock market.

Once it was established which equity market series were cointegrated with SA, in other words, they had a long-run equilibrium, it was necessary to determine how much of any disequilibrium was corrected in each time period. The ECM test gave the coefficients of the α matrix, which showed the adjustments to long-run equilibrium of the cointegrated system. Placing the foreign country first in the ordering and SA second showed that the adjustment to long-run equilibrium was slow. Even for cointegrated markets the adjustments to equilibrium did not exceed 2.5% per time period, which were slow but are generally consistent with literature pertaining to movements in equity markets. For non-cointegrated markets the adjustment coefficients rarely exceed 1%.

Table 4.12 shows the adjustment coefficients of the price indices data for countries where cointegration was found with either the Johansen or Engle-Granger methods. For the EG test, the model specification considered was intercept only. Considering all specifications would result in reporting results for nearly all the markets. For the Johansen test all the specifications were considered as there were not that many markets that were found to be pair-wise cointegrated with SA.

Table 4.12 VECM adjustment coefficients of price indices markets for countries where cointegration is present with SA.

Adjustment coefficients assuming 1 C.E. for price indices		
	Market 1	Market 2
Brazil – SA	-0.014114	0.015337
China, Shenzhen – SA	-0.017131	0.001762
South Korea – SA	-0.018155	0.012460
Mexico – SA	-0.002262	0.035276
Poland – SA	-0.020291	-0.003270
Thailand – SA	-0.009008	0.003572
Turkey – SA	-0.009136	-0.000440

The interpretation of the adjustment coefficients is, for example, for Brazil – SA: for every time period about 1.41% of the long-run disequilibrium is corrected by changes in Brazilian market and about 1.53% by changes in SA market. These results seem low but are even lower for non-cointegrated series, with few of the coefficients exceeding 0.5%. From the cointegration results it is interesting to note that South Korea is the only developed country where pair-wise cointegration with SA was found. Unlike Morocco, where cointegration was found with only one specification model, the cointegration with South Korea was found for several specifications using the price indices.

4.2.5 Impulse Response Function (IRF)

As shown by the low values of the vector error correction model, the adjustment to long-run equilibrium is slow. The IRF will eventually stabilize and achieve long-run equilibrium. However, because of the low coefficients of the α matrix this adjustment will be slow and hence it is necessary to take a long period to see what the equilibrium is. The Cholesky ordering is important and the results are given when SA is first in the ordering and when it is second.

From IRF plots in Appendices H and I, comparing the price indices of SA pair-wise to all the other markets shows that the response to shocks in the SA market is between 2.5% and 3.5% in the first period and this response generally decreases for cointegrated series; and for non-cointegrated series it can go either way. Figure 4.3 shows the IRF plots of price indices for South Africa and Mexico where significant cointegration was found. Both Cholesky orderings of Mexico – South Africa and South Africa – Mexico are used. On the top is the Cholesky ordering SA – Mexico and on the bottom is the ordering Mexico – SA.

The IRF graphs show what effect a one unit shock will have on the series at different time periods. For example referring to the top-left panel in Figure 4.3, this shows the response of the SA market to shocks in the residuals. In the first time period a one unit shock in the residuals will cause the SA market to increase by roughly 3%. In succeeding periods this value falls and achieves an equilibrium of roughly 1.1% in the 55th period. Usually the more cointegrated the series, the quicker the adjustment to equilibrium. For example, comparing Mexico and SA the equilibrium is achieved after roughly 50 periods. For Japan and SA the equilibrium is not reached even after 200 periods. The equilibrium is defined as the value of the IRF which roughly stays the same for succeeding time periods. So, for example, in Figure 4.3 the graph starts to smooth out after approximately 50 periods whereas in Figure 4.4 the smoothness of the curve and hence equilibrium is not achieved even after 200 periods. Generally cointegrated series reach equilibrium quicker than non-cointegrated ones, as shown by Figs 4.3 and 4.4. Adjusting the Cholesky ordering in this study did not have a great effect on the IRFs, with the values hovering around the same ones as before.

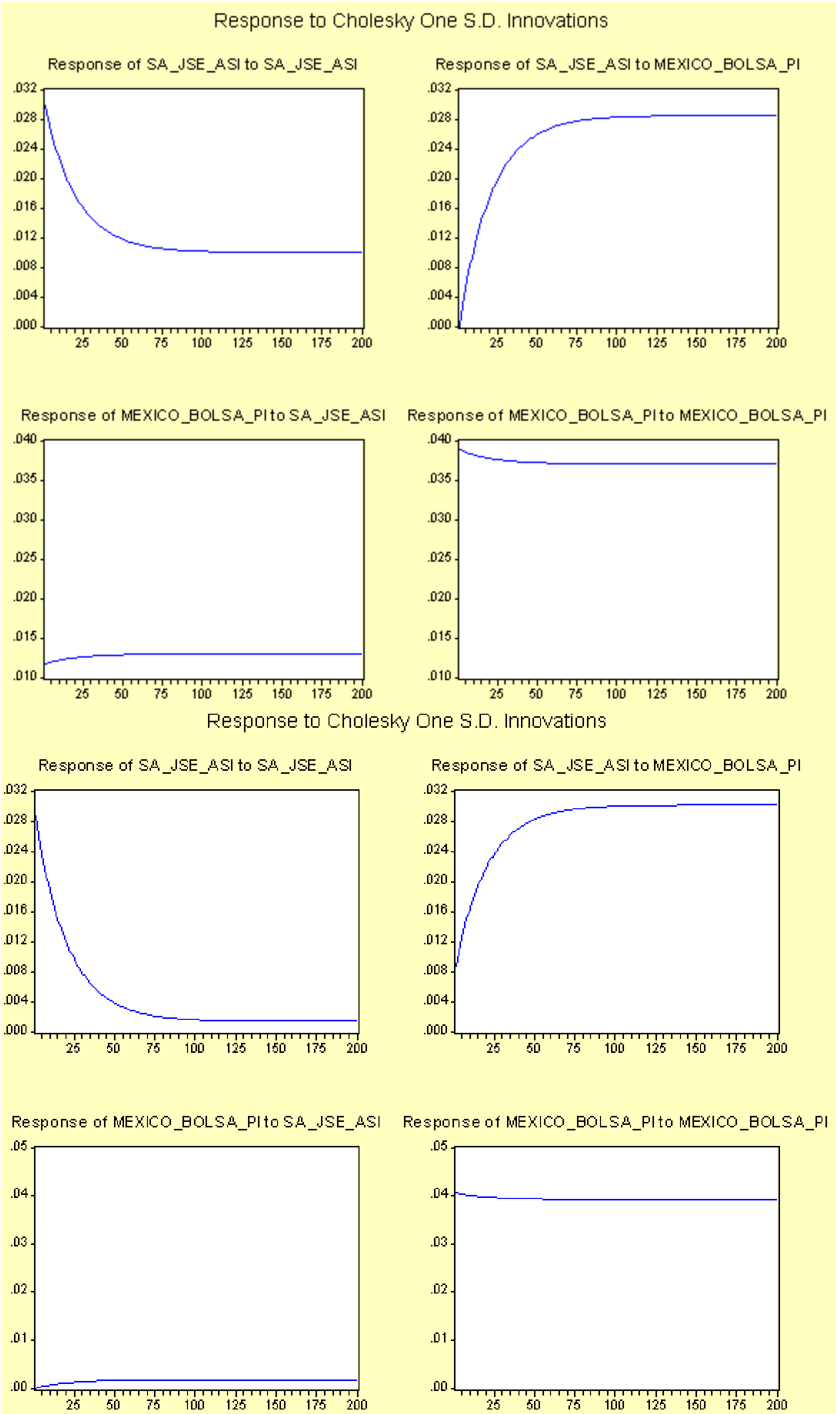

Fig. 4.3 IRF plots of price indices for South Africa and Mexico where significant cointegration is present. Cholesky ordering: Top: SA – Mexico; Bottom: Mexico – SA.

Figure 4.4 shows the IRF plots of price indices for South Africa and Japan where no significant cointegration was found. On the top is the Cholesky ordering SA – Japan and on the bottom is the ordering Japan – SA.

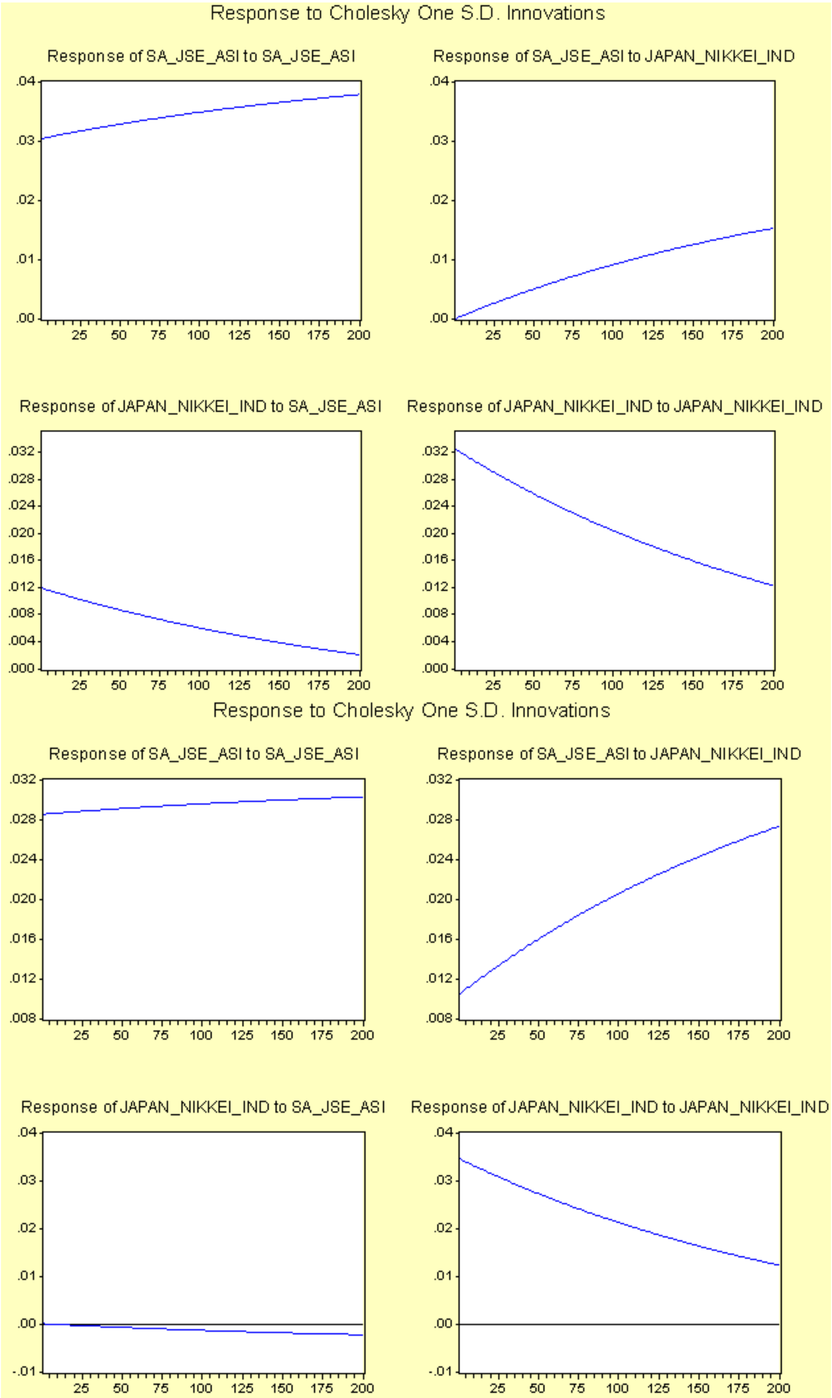

Fig. 4.4 IRF plots of price indices for South Africa and Japan where no significant cointegration is present. Cholesky ordering: Top: SA – Japan; Bottom: Japan – SA.

Comparing the two sets of IRF graphs, it can be seen that in the case of Mexico and SA the equilibrium is achieved quicker than in the case of SA and Japan and the price indices series respond to shocks at various time horizons similarly. For Japan and SA, it appears that equilibrium is not achieved even after 200 time periods and the impulse responses either increase or decrease. These observations generally hold true for all other pair-wise combinations of SA and other countries. Where SA is found to be cointegrated, the IRFs achieve equilibrium much quicker than when cointegration is not found.

IRFs for different lag lengths and specifications gave very similar results and hence the results here are presented at 1 lag length and for the intercept in the CE specification.

4.2.6 Variance Decomposition

Once again the Cholesky ordering is important and is done for both pairs. Figure 4.5 shows the variance decompositions of price indices between two pair-wise cointegrated series, SA and Mexico, using both pairs of Cholesky orderings. Figure 4.6 shows the variance decompositions of price indices for two non-cointegrated series, SA and Japan, using both pairs of Cholesky orderings.

From Figure 4.5, the country that is placed first in the Cholesky ordering has nearly all of its variance explained by itself in the first period and this number gradually decreases. From the top-left panel of Figure 4.5, in the first period the percentage of SA variance due to changes in SA is 100%, meaning that SA explains all of its variance. This percentage decreases over time and the influence of Mexico becomes more prevalent. After 200 time periods, 80% of the variance in SA is explained by Mexico and 20% by SA. This shows that the SA market is sensitive to changes in the Mexican market. The 2nd top-left panel of Figure 4.5 shows the percentage of the variance in the Mexican market explained by SA. In this case roughly 10% of the variance in Mexico is explained by SA and the rest is explained by Mexico. This proportion of the variance explained does not vary greatly over time, showing that the Mexican market is not very sensitive to changes in SA. From the graphs below it can be seen that when constructing pair-wise variance decomposition, the two graphs are mirror images of each other, for example if one market explains 20% of the variance, the other one will explain the other 80%.

In Figure 4.6, the variance decomposition results for non-cointegrated series, of SA and Japan are different from the results in Figure 4.5. As before, the country that is placed first in the Cholesky ordering explains all of its variance in the first time period. However, unlike with the variance decomposition between SA and Mexico the graphs are generally not curved and the adjustment to long-run equilibrium does not occur. Even after 200 time periods the gradient of the graphs does not change greatly and the curve is in fact closer to a straight line.

Equilibrium could occur at a much later period or it could never occur. The point here is that the adjustment to long-run equilibrium in variance decomposition is slower for non-cointegrated series than for cointegrated series.

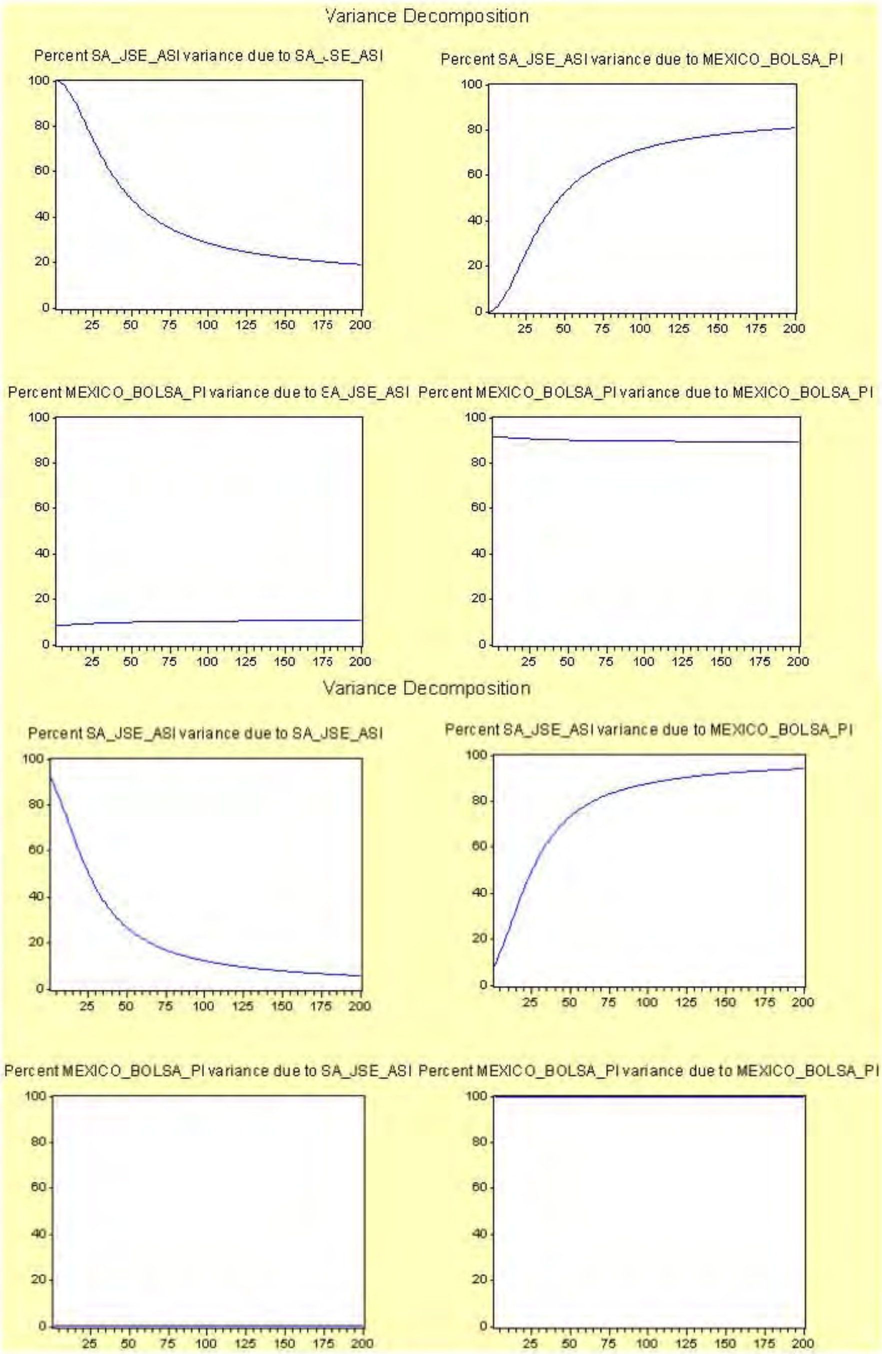

Fig. 4.5 Variance decomposition plots of price indices for South Africa and Mexico where significant cointegration is present. Cholesky ordering: Top: SA – Mexico; Bottom: Mexico – SA.

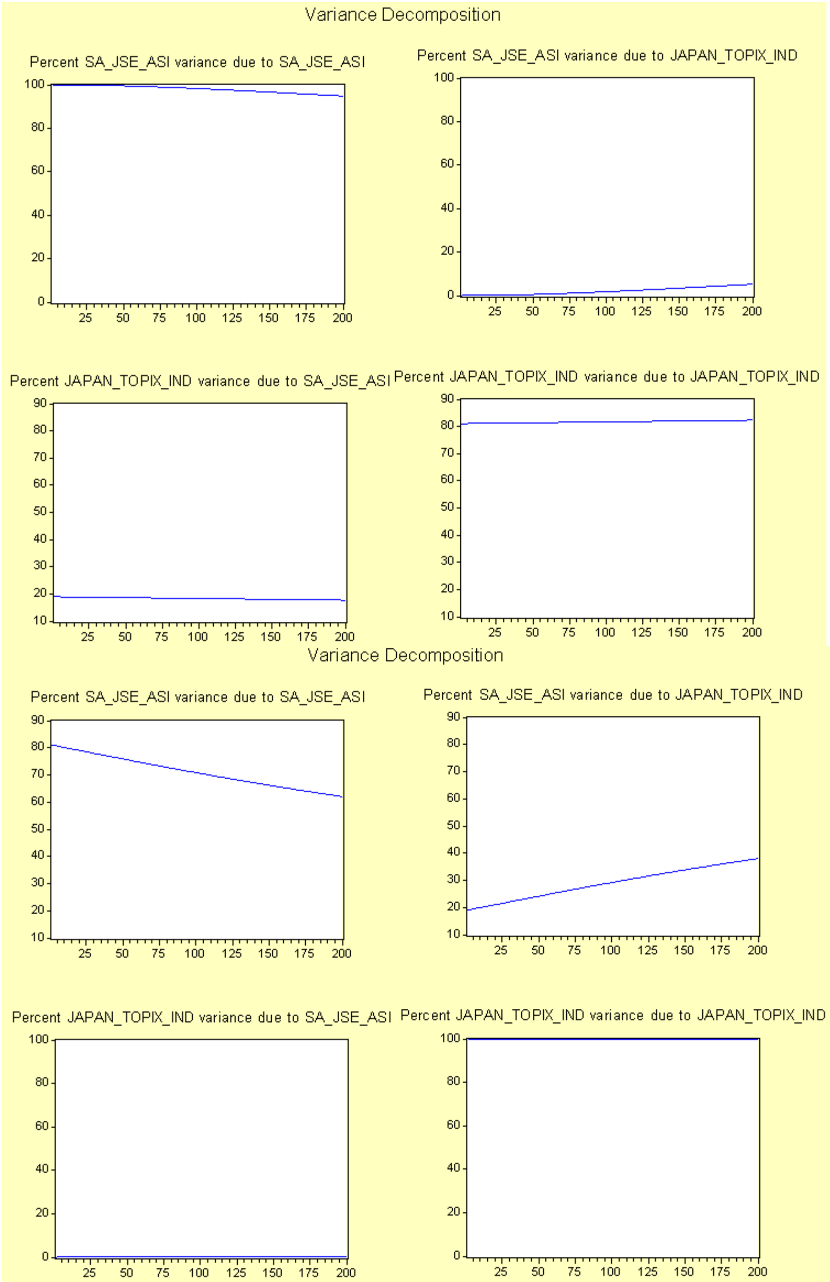

Fig. 4.6 Variance decomposition plots of price indices for South Africa and Japan where no significant cointegration is present. Cholesky ordering: Top: SA – Japan; Bottom: Japan – SA.

The variance decomposition results for all the pair-wise combinations with SA are given in Appendices J and K. The general trend is as follows: the country that is placed first in the Cholesky ordering has nearly all of its variance explained by itself at least in the first time period, this then either increases or decreases. The second country has between 70% and 90% of its variance explained by itself. Conversely virtually none of the variance in the first country was due to changes in the second and between 10% and 30% of changes in the second was due to changes in the first.

As with the impulse responses, price indices series that are cointegrated are more curved and achieve their equilibrium quicker than those of non-cointegrated series. Because of the nature of the Cholesky ordering, the country that is placed first in the ordering will at 1 time horizon explain all its variance. For cointegrated series this influence starts to fall whereas for non-cointegrated series it remains roughly constant.

Variance decomposition for different lag lengths and specifications gave very similar results and hence the results here are presented at 1 lag length and for the intercept in the CE specification.

4.3 Multivariate Cointegration

Pair-wise cointegration is of limited use as it is rare that an investor will only hold stocks from two countries if his/her goal is a hedging strategy. Investment theory suggests that unsystematic risk decreases exponentially as the portfolio widens (Howells and Bain, 2005: 174). Hence, a typical international portfolio will include stocks from more than two countries. Multivariate cointegration procedures were carried out using the Johansen procedure on samples of 4, 6 and 8 markets including South Africa. Markets to be tested were selected using the criteria that each one of them must not be pair-wise cointegrated with South Africa and that it be a common global market that has often been used in previous empirical studies. It should be noted that, as Allen and MacDonald (1995) pointed out, the absence of bivariate cointegration between series does not automatically imply that a combination of such portfolios will not have a long-run relationship.

Results were calculated using the price indices. Three possible portfolios were selected for each of the sizes from 4, 6 and 8 markets. The following portfolios were selected for 4 markets:

Portfolio A: SA, USA, UK, Germany.

Portfolio B: SA, Australia, Hong Kong, Japan.

Portfolio C: SA, Canada, China, France.

For a sample of 6 markets, the following 3 portfolios were selected:

Portfolio D: SA, USA, UK, Germany, Egypt, Japan.

Portfolio E: SA, Australia, Hong Kong, Japan, Philippines, Argentina.

Portfolio F: SA, Canada, China, France, Switzerland, Russia.

For a sample of 8 markets, the following 3 portfolios were selected:

Portfolio G: SA, USA, UK, Germany, Egypt, Japan, Canada, France.

Portfolio H: SA, Australia, Hong Kong, Japan, Philippines, Argentina, Russia, USA.

Portfolio I: SA, Canada, China, France, Switzerland, Russia, Egypt, USA.

It must be noted that the Chinese market here refers to Shanghai where no significant cointegration was found and not Shenzhen where pair-wise cointegration with SA was found for one of the specifications. For all the portfolios the lag length was selected using the democratic method. The methods to select optimal lag length that were used are the sequential modified likelihood ratio test statistic, the final prediction error, the Akaike information criterion, the Schwarz information criterion and the Hannan-Quinn information criterion. The lag length that was selected most commonly by these 5 procedures was then selected as the optimal lag. For all portfolios, at least 2 of the criteria selected lag lengths of 2 as the optimal lag length. Hence the lag length of 2 was used for all pairs. These lag length choices can be confirmed by looking at Appendices L and M.

However in most cases at a lag length of 2 autocorrelation of the residuals was still present. Hence, it was necessary to increase the lag length until autocorrelation in the residuals disappeared. It is important that the residuals are not autocorrelated. The preferred results are, therefore, the ones using the lag length at which the residuals are white noise. For the sake of comparisons, the results are also provided using a lag length of 2.

When calculating the IRFs and variance decompositions, the results at different lag lengths varied quite significantly unlike with bivariate cointegration, hence results are presented at two sets of lags length. The specification did not greatly affect results and hence, the same specification as for bivariate cointegration, intercept in the CE, is used.

In order to keep the study focused, the results reported will be mainly from a South African perspective with only brief mentions of results for other countries.

In this section, the results of the block exogeneity tests are in Appendix O, the multivariate cointegration in Appendix P, the VECM rates in Appendix Q, the IRFs in Appendix R and the variance decompositions in Appendix S. The Granger causality results which were used to calculate the Cholesky orderings are in Appendix N.

4.3.1 Results – 4 Market Portfolios

Portfolio A

For *Portfolio A*, the Breusch-Godfrey test revealed that autocorrelation disappeared at 4 lag lengths, an inconsistency between the two methods of lag length selection. As mentioned previously, the various criteria selected two lags as optimal for all portfolios. Cointegration was carried out at both 2 and 4 lag lengths and the results compared.

One significant cointegrating vector was found at 2 lag lengths when including a trend and an intercept term and no cointegration was found for other model specifications. With 4 lag lengths, there was no significant cointegration found regardless of the model specification

The VECM for 2 lag lengths showed that including trend and intercept greatly increased the error adjustment rates; this is not surprising because the cointegrating vector was found when both trend and intercept were included. Hence, the adjustment rates are expected to be higher when at least one cointegrating vector exists. For 4 lag lengths, no significant cointegrating vectors were found and hence the adjustments to equilibrium rates were low. The VECM rates were below 4.1% at both sets of lag lengths. The highest VECM rates were for SA with a trend and intercept in the CE, and intercept only in the VAR at 2 lag lengths. For the other two specifications at both sets of lag lengths, the error adjustment rates for SA were below 0.1%

For both sets of lag lengths the impulse response functions showed that the USA market is dominant in all markets and achieves its equilibrium rate quickly. USA dominance was decreased when using the generalized ordering as opposed to the Cholesky ordering. The SA market responded mainly to its own innovations, with the majority of foreign innovation coming from USA at both sets of lag lengths, and when using Cholesky and generalized orderings. In the first time period the response of SA to changes in SA market was between

2.4% and 3%. This would then take a quick dip but within 5 periods the impulse response was back to what it was in the first period and then remained close to the original value. With the Cholesky ordering, the USA was almost as dominant as SA in the SA market. However, when using the GIRF, the influence of the USA decreased, it was still the most dominant foreign market but the other markets were close to the level of the USA.

Variance decompositions at 2 and 4 lag lengths were similar; the USA market explained a large proportion of the local market's variance at short time periods but the influence in successive periods fell, while the influence of the local market rose. SA variance was self-explained with some effects from USA. At both pairs of lag lengths the SA market explained 65% of its variance in the first time period. By the end of the 10th period the curve was almost flat and by the 30th time period 55% and 60% of the variance in SA was explained by SA at 2 and 4 lag lengths, respectively. The USA was the dominant foreign market in SA, explaining 25% of the variance at both sets of lag lengths. The influence of USA increased at roughly the same rate at which the influence of SA decreased and by the 30th period, 35% of the variance in SA was explained by USA at 2 lag lengths and 43% at 4 lag lengths.

Block exogeneity tests were carried out to see if previous values of foreign data affected local current data. The results showed that the USA market affected all of the other markets with none of the other markets affecting each other or the USA market. The SA market was influenced by the USA and Germany at 4 lag lengths but not at 2.

Portfolio B

Autocorrelation disappeared at 1 lag length, but no evidence of cointegration was found at either 1 or 2 lag lengths. As a result the error adjustment rates were low for all combinations of trend and intercept with none of the rates exceeding 5.5%. The highest coefficient found was 5.4% for Hong Kong when using a trend and intercept in the CE and intercept only in the VAR at 2 lag lengths. At 2 lag lengths the VECM rates for SA were below 0.1% for all specifications and at 1 lag length the rate was below 0.1% with a trend and intercept in the CE and intercept only in the VAR and between 1.2% and 1.4% for the other specifications.

IRF plots showed that the local market was more dominant when compared with *Portfolio A*. When foreign influence was present it was mainly from Japan or Hong Kong. At 2 lag lengths innovation from Hong Kong increased influence over SA over time whereas the influence of SA innovations fell over time. At 1 lag the influence of all markets remained constant over time. For SA the response to shocks in SA were between 2.1% and 3% in the first time period. For the Cholesky ordering at 2 lag lengths this influence decreased and did not approach equilibrium. By the 30^{th} time period it had fallen to 1.8% and was still falling. On the other hand, the influence of Hong Kong increased from 0.9% in the first period to just below 2% by the 30^{th} time period. Response to Japanese shocks started at 1.1% and within 3 time periods it achieved its long-run equilibrium of 1.4%. For the GIRF at 2 lag lengths the SA response to SA shocks started at 3% and gradually fell to 2.8% by the 30^{th} period. Response to shocks from Australia and Hong Kong started around 1.5% and rose to over 2% by the end. At 1 lag length the response of SA to shocks in SA was similar for both Cholesky and generalized ordering, with response being 3% at first and gradually falling to 2.8% by the end. Foreign influence for GIRF was from Australia and Hong Kong which gradually increased and reached 2% by the end and for the Cholesky ordering it was from Hong Kong which rose to 1% by the end.

Similar conclusions are made with the variance decomposition, where the majority of the variance was explained by the local market. At 2 lag lengths SA variance was explained by itself with foreign influence increasing over time. SA explained 65% of it variance at first and this gradually fell to 45%. Japan started at 12% and soon reached its equilibrium of 20%. Hong Kong started below Japan but it gradually rose and reached 28% by the end. At 1 lag length almost all the variance in SA was self-explained as it was first in the Cholesky ordering.

Block exogeneity tests showed that SA is influenced by Hong Kong and Japan but not Australia. Japan is the most exogenous market with none of the other three having an influence.

Portfolio C

Time series plots for price indices from markets included in *Portfolio C* are given in Figure 4.7. The Breusch-Godfrey test suggests that autocorrelation is present up to 4 lag lengths. Hence, cointegration was carried out with 2 and 4 lag lengths. As with *Portfolio B*, no significant cointegration was found at both lag lengths and the error adjustment rates were below 2%. The highest VECM rate was just under 1.8% for France at 4 lag lengths with a trend and intercept in the CE and intercept only in the VAR. The impulse response by SA was below 0.1% at both lag lengths and for all specifications.

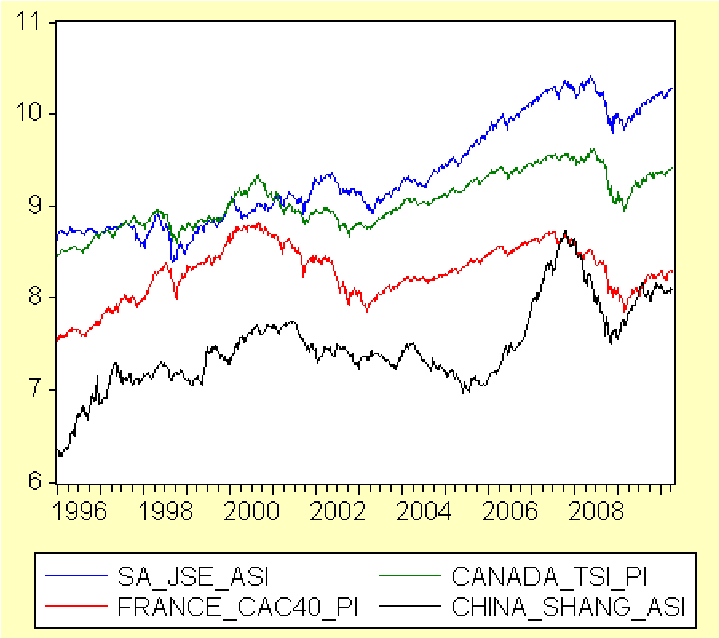

Fig. 4.7 Time series plots for price indices from markets included in *Portfolio C*.

IRF plots at 2 lag lengths showed that shocks from France, SA and Canada all contribute to each other with the Chinese market being responsible for its own shocks. Using the Cholesky ordering, SA's response was 3% in the first period and this stayed the same throughout. Response from foreign markets was negligible. For the GIRF, the response to SA shocks stayed the same but now foreign influence increased to 1.8% from France and 1.3% from Canada. At 4 lag lengths the patterns were similar, only the French market was slightly more dominant and Canadian shocks had more effect at longer time periods. At 2 lag lengths innovations in foreign markets had little influence on SA, and at 4 lag lengths innovations in France had a slight effect on SA with the majority of the influence still being from SA. The SA influence dropped to 2.5% and French influence increased to 2%. For the GIRF, the SA influence was the same as at 2 lag lengths and the French influence was the same as at 4 lag lengths for the Cholesky ordering. The IRF plots at 4 lag lengths using both the Cholesky ordering determined by Granger causality and when using the generalized ordering are given in Figure 4.8. As can be seen in both cases the local market was dominant. Also in both cases China was not affected greatly by foreign shocks. SA was affected by France when using Cholesky ordering, and when using the GIRF, France and Canada to a lesser extent.

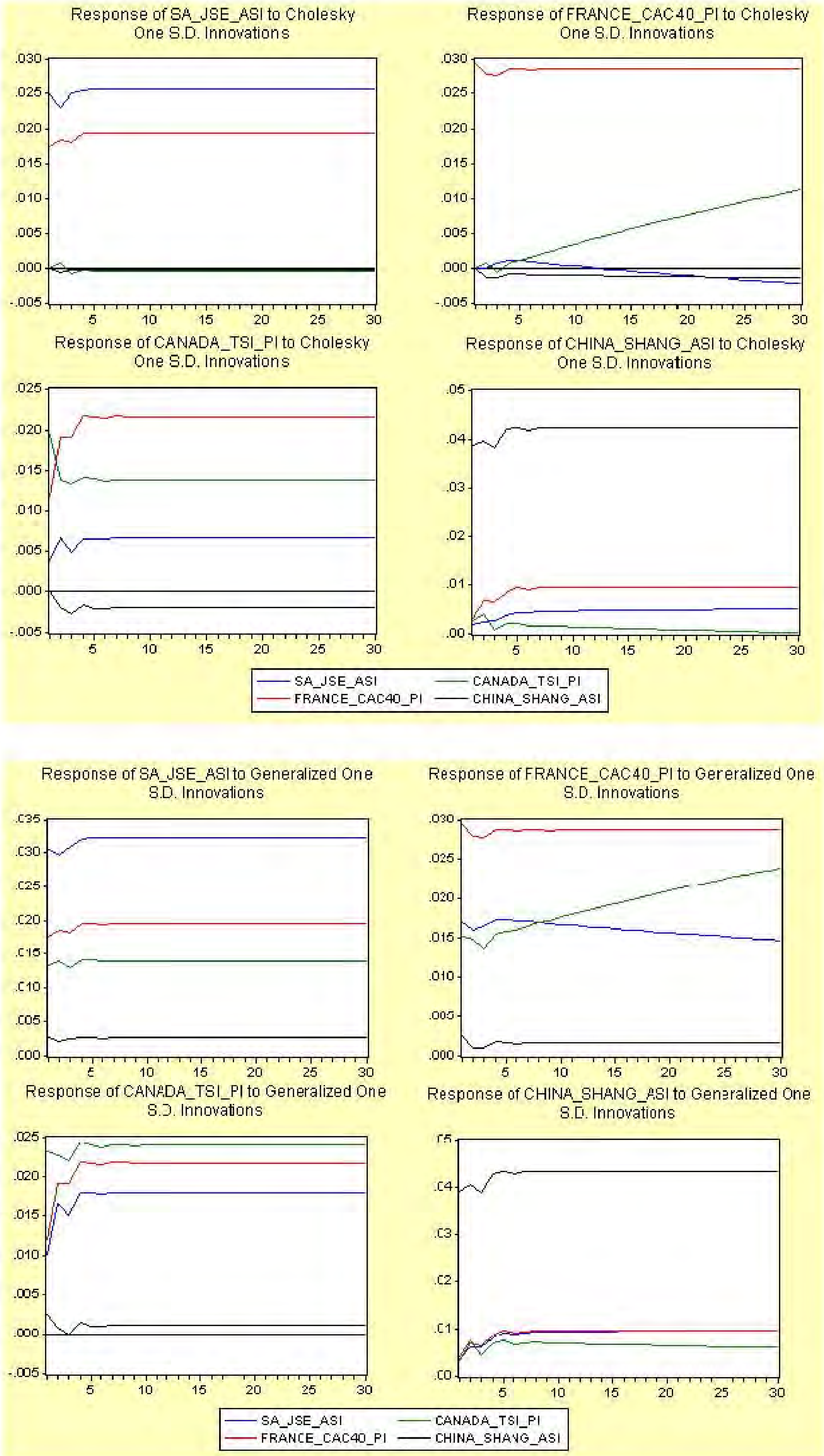

Fig. 4.8 IRF plots for price indices markets included in *Portfolio C* at 4 lag lengths. Top: Cholesky ordering: France – SA – Canada – China; Bottom: GIRF.

At both sets of lag lengths the variance decompositions showed that the French and Chinese markets are nearly wholly responsible for their own variances. The variances in the SA and Canadian markets were partly explained by foreign markets. As in the bivariate case the market placed first in the Cholesky ordering explained all its variance in the first period, which is why SA has all its variance explained by itself at 2 lag lengths. At 4 lag lengths SA explained most of its variance, 65% at first and 63% by the end, with France being the main foreign contributor, 33% at first and 35% by the end (Figure 4.9). An interesting result is that China and France did not have their variance significantly explained by any of the other markets.

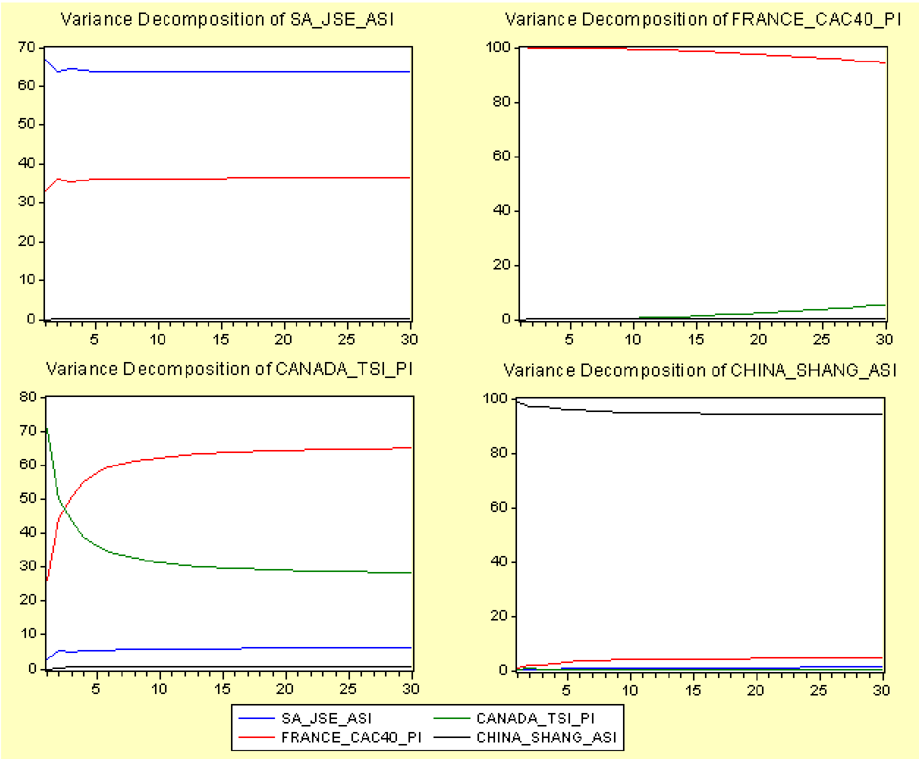

Fig. 4.9 Variance decomposition plots for price indices markets included in *Portfolio C* at 4 lag lengths using Cholesky ordering: France – SA – Canada – China.

Block exogeneity results revealed that the SA market was not influenced by the other markets at 2 or 4 lag lengths. An interesting result is the Canadian market was influenced by all the other three at 2 lag lengths and by all except China at 4 lag lengths.

4.3.2 6 Market Portfolios

Portfolio D

Autocorrelation was present up to 11 lag lengths. At all lag lengths and for all combinations of trend and intercept there was 1 cointegrating vector, except when trend and intercept were included in the model at 11 lag lengths, there was no significant cointegration. VECM rates were relatively high and the highest rate was 5.2% for Japan at 11 lag lengths with trend and intercept in the CE and intercept only in the VAR. The SA rates were between 2.6% and 2.8% at 2 lag lengths and 1.2% and 2.5% at 11 lag lengths, the highest results being achieved for the trend and intercept in CE and intercept only in VAR specification.

IRF plots show that local shocks are dominant, with the USA and UK markets being the main foreign contributors at short and long periods, respectively. At 11 lag lengths the IRF plots lose their smoothness and become more haphazard and the market being analyzed becomes more sensitive to shocks from other markets. For SA the IRF plot shows that innovations in SA are the most influential, with USA and UK being the major foreign contributors. For SA at 2 lag lengths, the response to shocks in the first time period was 2.4% and 3% for the Cholesky ordering and GIRF, respectively. The rates fell slightly but by 5 time periods they returned close to the original values. The dominant foreign market was the UK, which started slowly at around 1% and then rose to 1.7% for Cholesky and 2.2% for GIRF. For the Cholesky ordering the USA was also dominant in SA and stayed at about 1.7% throughout. For the GIRF the USA remained at 1.7%, with Germany just below it. Japan and Egypt stayed just over and just below 1%, respectively for the GIRF. At 11 lag lengths the response in the first period to SA shocks was around 2.6% for both orderings. This gradually fell to 2% by the end. The USA influence started at 1.4%, rose and then returned to 1.4% by the end for both orderings. The UK started at 0% and 1% with the Cholesky and GIRF orderings and gradually rose to 1.3% and 1.7%, respectively. Egypt also had a gradual increase for both orderings with none of the other markets having significant effects.

Variance decompositions showed that USA was the main foreign contributor in explaining variance, with less variance being explained at shorter time periods and progressively more variance as time increases. For the SA market at both lag lengths, variance was explained mostly by itself, 65% and 75% at 2 and 11 lag lengths, respectively in the first period. This dropped to 55% at both lag lengths with the USA market having increased influence over time. The USA started at 25%, rose and then fell slightly to its equilibrium of roughly 30% for both lag lengths.

Block exogeneity tests focusing on South Africa showed that the USA has a high influence with none of the other four markets having a significant influence at 11 lag lengths. Quite surprising is that Egypt is the dominant market at 2 lag lengths with it influencing all of the markets except SA and UK. At 11 lag lengths the results are very different, with SA influenced by USA and UK, and Egypt no longer being dominant. These results are more in line with *a priori* assumptions which state that the USA market is expected to be more dominant than the Egyptian market. This suggests that 11 lag lengths is a better choice in this case.

Comparing *Portfolio D* with *A*, the addition of two markets, Japan and Egypt has resulted in increased evidence of cointegration with most of the *p*-values dropping. The VECM rates have also increased which is expected since there is more evidence of cointegration. With respect to IRFs, for *Portfolio A* the USA was the most dominant foreign market whereas for *Portfolio D* the influence of the UK increased as well, in some cases surpassing the USA. For the variance decomposition, in *Portfolio D* the UK has increased influence over SA variance than in *Portfolio A*, where SA and the USA are the only markets that have a significant effect on SA variance.

Portfolio E

Time series plots for price indices from markets included in *Portfolio E* are given in Figure 4.10. Autocorrelation was present up to 3 lag lengths. There was no evidence of cointegration at all combinations of trend and intercept at both 2 and 3 lag lengths. However, contrary to expectation, the range of VECM rates was higher, with the highest being 6.8% for Hong Kong at 2 lag lengths with trend and intercept in the CE and intercept only in the VAR. At 2 lag lengths, the VECM rates for SA ranged from 1.1% to 1.7% and at 3 lag lengths they ranged from 0.7% for no trend or intercept in the CE or the VAR to 2.1% with trend and intercept in the CE and intercept only in the VAR.

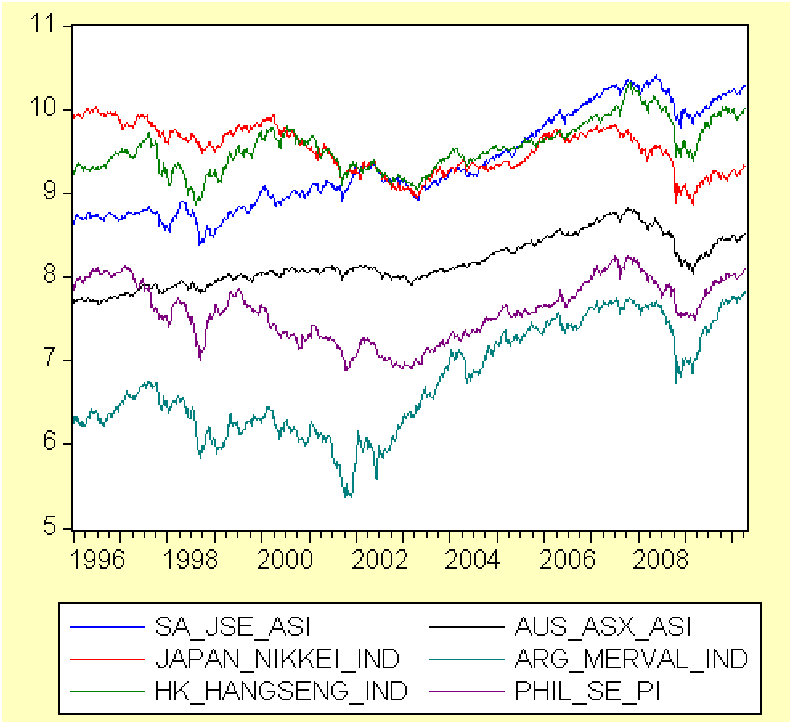

Fig. 4.10 Time series plots for price indices from markets included in *Portfolio E*.

IRF plots show that markets generally respond to their own shocks. Exceptions are SA and Australia where foreign shocks in all the other markets have larger effects on the local markets. At 2 lag lengths with Cholesky ordering the main foreign influence in SA was from Hong Kong, and with generalized ordering, from Australia. With a lag length of 2, the SA response to its own shocks started at 2.5% and 3% for Cholesky and GIRF orderings, respectively. This then fells to 2% and 2.9%, respectively by the 30th time period. For the Cholesky ordering, foreign influence came from Hong Kong and Australia, which started at around 0.7% and increased to 1.8% and 1.2%, respectively. The Japanese influence stayed constant, starting at 1% then rose rapidly and gradually fell back to 1%. For the GIRF, Hong Kong and Australia again increased their influence over time and the influence from the Philippines also increased, ending at 1.7%. The Japanese influence stayed the same as before at 1%. The IRF plots at 3 lag lengths for both Cholesky and generalized orderings are given in Figures 4.11 and 4.12, respectively. At 3 lag lengths with Cholesky ordering Hong Kong innovations explained more than SA ones in the SA market from the 24th period onwards. However, this was reversed when using generalized ordering. For SA, the response to local shocks was almost the same as at 2 lag lengths, Hong Kong influence started at about 1% and ended roughly at 2.3% for both orderings. Response to Japanese shocks started at 1% and quickly reached 1.4%. For the GIRF, Australia closely mimicked the movements of Hong Kong, and Argentina followed the Japanese movements. Using the Cholesky ordering, foreign shocks have a greater impact than the GIRF.

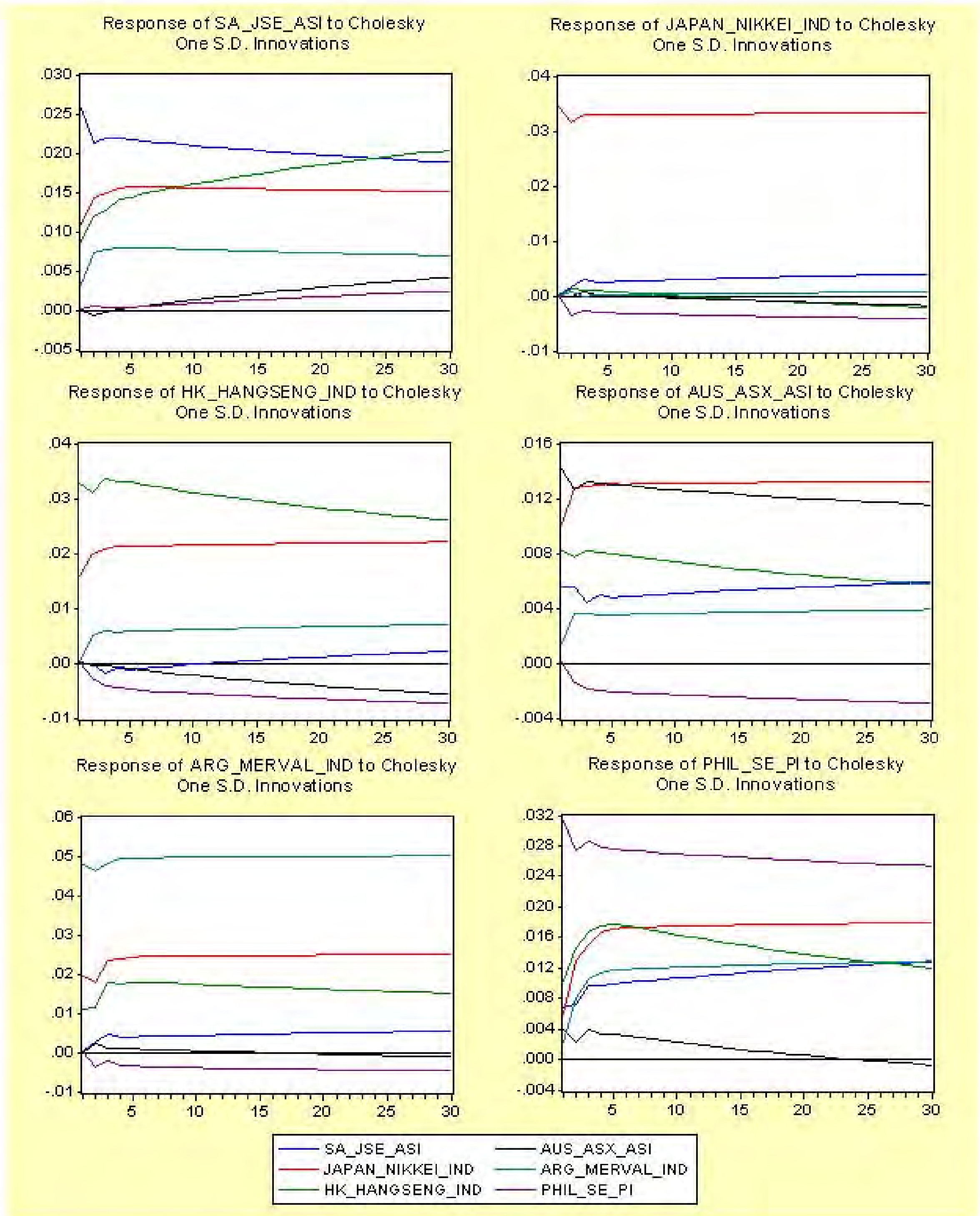

Fig. 4.11 IRF plots for price indices markets included in *Portfolio E* at 3 lag lengths using Cholesky ordering: Japan – HK – Argentina – SA – Australia – Philippines.

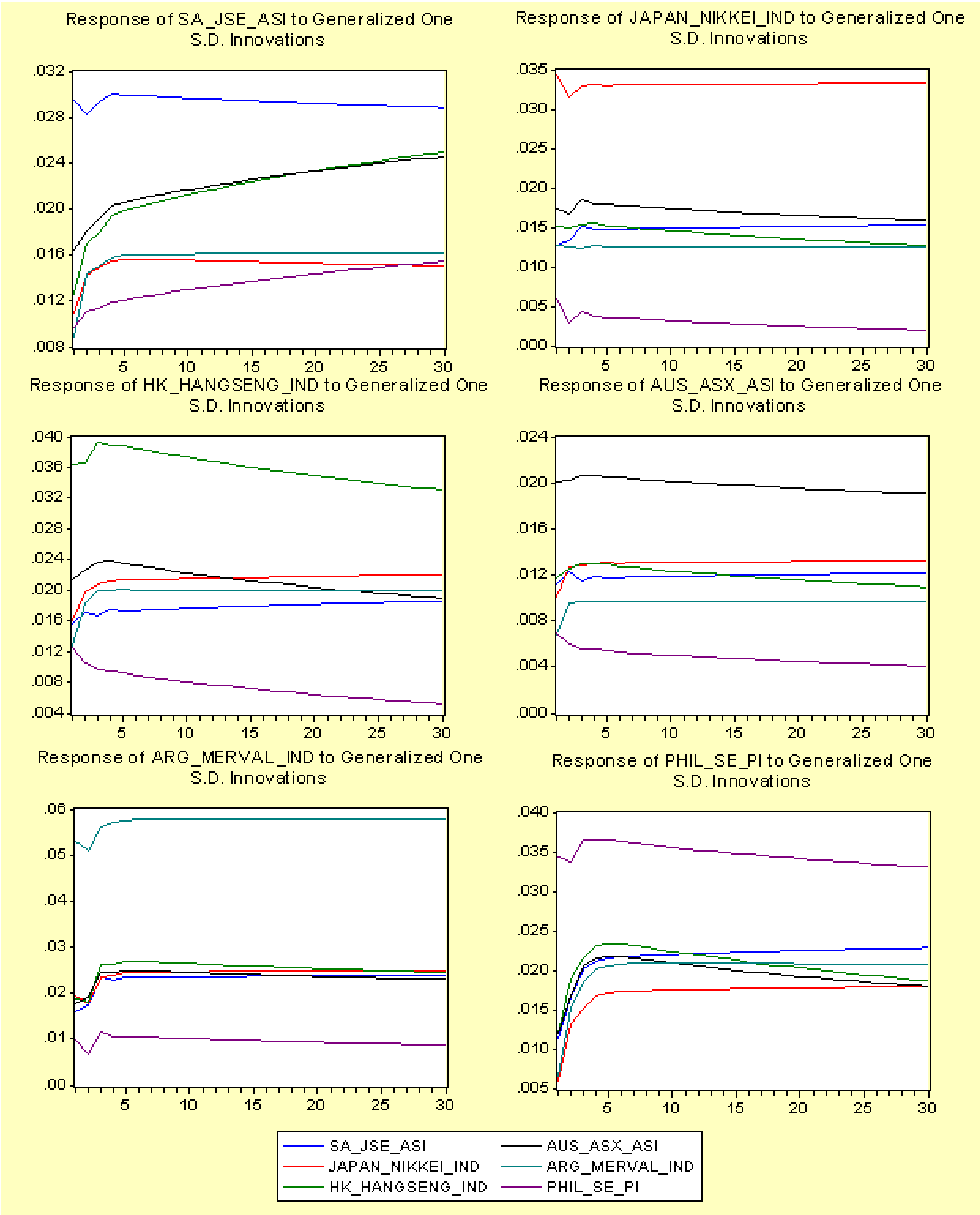

Fig. 4.12 IRF plots for price indices markets included in *Portfolio E* at 3 lag lengths using generalized ordering.

The variance decomposition plots for price indices markets included in *Portfolio E* at 3 lag lengths are given in Figure 4.13 and at 2 lag lengths in Appendix S. Variance decomposition results are similar to that of *Portfolio D*, only now it is Japan and Hong Kong that are the main foreign contributors to the variances and not the USA. SA explains most of its variance, with Hong Kong having increased influence at both sets of lag lengths. SA explained 65% and 75% of its variance in the first time period at 2 and 3 lag lengths, respectively. This fell to 45% by the 30th period. In both cases, Hong Kong started at approximately 10% then increased the proportion of variance explained to 20% and 25% at 2 and 3 lag lengths, respectively. The Japanese effect on variance in SA started at 14% and rose to 22% at 3 lag lengths and at 2 lag lengths rose but then fell back to 14%. Here SA explained most of its variance at short time horizons but the influence of Hong Kong and Japan increased over time.

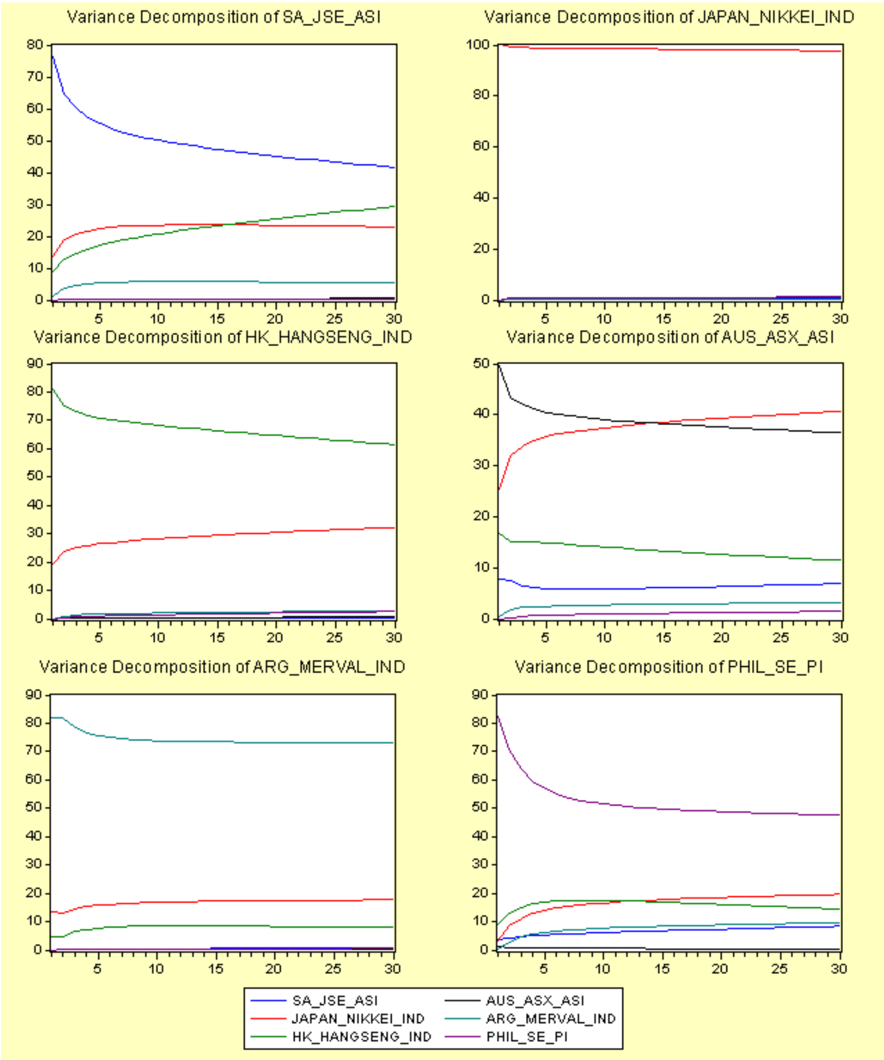

Fig. 4.13 Variance decomposition plots for price indices markets included in *Portfolio E* at 3 lag lengths using Cholesky ordering: Japan – HK – Argentina – SA – Australia – Philippines.

The block exogeneity tests reveal that SA is sensitive to markets from Hong Kong and Argentina at 2 and 3 lag lengths. Surprisingly Argentina is the dominant market, with Japan being influenced by the Philippines at both lag lengths.

Comparing *Portfolio E* with *B*, with the addition of Argentina and Philippines to the portfolio, there is no clear trend with regards to cointegration as some *p*-values are higher and some are lower than before. The same conclusion applies to the VECM rates. The IRFs of SA are roughly the same for both *Portfolios B* and *E*. The major foreign influence in both cases is from Hong Kong and Australia with Japan being influential in certain cases. The variance decomposition of SA at 2 lag lengths shows that SA, Hong Kong, Japan and Australia are, in that order, responsible for explaining SA's variance. The new additions of Argentina and Philippines do very little towards explaining the variance in SA.

Portfolio F

Autocorrelation was present up to 4 lag lengths. There was no evidence of cointegration when using the preferred maximum eigenvalue statistic with 4 lag lengths. The VECM rates were below 8%, the maximum being at 4 lag lengths for Russia with trend and intercept in the CE and intercept only in the VAR, indicating that there may be some cointegration for other lag lengths. At 2 lag lengths the VECM rates for SA were below 1% and at 4 lag lengths two of the specifications were below 1% with trend and intercept in the CE and intercept only in the VAR being just over 1%.

IRFs show that shocks in the foreign markets have effects on the local markets. The exception is China where shocks from other markets have very little effect. Foreign innovations are not very high in the SA market with SA innovation being dominant. However, the innovations are still more influential than in China. At 2 lag lengths, the SA market response to its own shocks is roughly 2.5% and 3% for the Cholesky and GIRF orderings, respectively in the first period. This falls to about 2.3% for the Cholesky ordering and stays constant for the GIRF. For the Cholesky ordering, significant foreign influence comes from Switzerland and Russia whose IRFs are 1.5% and 1%, respectively. For the Cholesky ordering, all the markets have some effect with the responses being between 1.3% and 1.8% at all time periods. The exception here is China. At 4 lag lengths with the Cholesky ordering, SA response to its own shocks starts at 2.5% then falls and rises again back to the original value. Foreign influence again comes from Switzerland and Russia which have responses similar to those at 2 lag lengths. For the GIRF the SA response stays at roughly 3% throughout and again SA responds to shocks from all markets except from China.

Variance decomposition shows that local markets account for the majority of their variance. SA explains most of its variance with increased influence from Switzerland over time. SA explains 72% of its variance in the first time period and this falls to 60% by the 30th period. Switzerland and Russia start at 20% and 9%, respectively and this increases to 26% for Switzerland at 2 lag lengths and 32% at 4 lag lengths and Russia's explanation of SA variance rises to 10% at both lag lengths.

The SA market is influenced by Switzerland and Russia, with those two markets being dominant in that they influence every market and in turn are not influenced by any. At 4 lag lengths France and Switzerland influence SA and once again the results are more in line with *a priori* expectations.

Comparing *Portfolios C* and *F*, there was increased evidence of cointegration for *Portfolio F* as opposed to *Portfolio C*. The *p*-values were lower and cointegrating vectors were found for some of the specifications. Error adjustment rates were quicker for *Portfolio F* with the majority of rates being higher than for *Portfolio C*. For the IRFs of *Portfolio C*, France and Canada were the countries whose shocks had an effect on SA, whereas for *Portfolio F* the major foreign influence was from Switzerland and Russia with France and Canada only occasionally having an effect. The variance decomposition revealed a similar story. For *Portfolio C* the only foreign influence on variance was from France at 4 lag lengths whereas for *Portfolio F* the percentage of foreign influence increased and it was from Switzerland and Russia.

4.3.3 8 Market Portfolios

Portfolio G

Autocorrelation of the residuals was present up to 8 lag lengths. At 2 lag lengths as suggested by the information criteria, there was at least one cointegrating vector for all combinations except for the maximum eigenvalue test with trend and intercept. VECM rates ranged from between 0% and just below 7%. The highest rate being 6.7% for Japan at 8 lag lengths, using the no trend or intercept in the CE or the VAR specification. The SA VECM rates were between 3.4% and 3.9% at 2 lag lengths and 4.4% and 4.7% at 8 lag lengths.

IRFs show that the local market shocks are most dominant with the USA being the most dominant foreign market for Cholesky ordering at 2 lag lengths. Using the GIRF, the USA was no longer as dominant. For example, Germany and France were more dominant than the USA in each other's markets. In SA the main foreign influence came from the UK at longer time horizons. France, Germany, the USA and Canada had approximately the same effect on SA. At 8 lag lengths with the Cholesky ordering the influence of the USA was not as high as with two lag lengths. In the SA market, Japan, Canada and Germany had negative impulse responses. This means that shocks in those markets have negative effects on SA. Using the GIRF, for the SA market all the other foreign markets had a positive influence either in the short or long-term. At 2 lag lengths and with the Cholesky ordering, the initial SA response to SA shocks was 2.4% which then fell and then rose back to the original value. For the GIRF the initial response was 3% which fell to 2.9% and remained there throughout. Using the Cholesky ordering, the response to USA shocks started at 1.5% and increased to 1.6%. The UK started at 0% and had a smooth increase to 1.2%. France remained constant at about 0.8% throughout. With the GIRF, USA, German and French shocks had almost identical effects on SA. They started at 1.6%, rose and then fell to between 1.5% and 1.7%. UK and Canada both started at 1.2%, then increased to 2% and 1.7%, respectively. Japan and Egypt ended just above and just below 1%, respectively. At 8 lag lengths with the Cholesky ordering, SA shocks started at 2.4% and ended at 2%. The USA started at 1.4% then rose and fell with France doing the opposite, starting at 1% then falling and rising. By the 30th period, USA, UK, French and Egyptian shocks had an effect on SA ranging from between 0.8% and 1.2%. All the other markets had negative shocks on SA.

The variance decomposition of SA at both 2 and 8 lag lengths shows that the majority of the variance is explained by SA, with the USA market being the major foreign influence. None of the other markets have an effect. At 2 lag lengths 63% of the variance is explained by SA and at 8 lag lengths it is 67%. This then falls to 56% at 2 lag lengths and 50% at 8 lag lengths. At both lag lengths the USA starts at 24% then rises and falls back to its original. At 8 lag lengths the rise then fall is greater than at 2 lag lengths. None of the other markets explain more than 10% of SA's variance.

Block exogeneity tests show that at 2 lag lengths the USA and Hong Kong markets are the only markets that have an effect on SA. At 8 lag lengths, the US, the UK and Hong Kong Granger cause the SA market.

Comparing *Portfolio G* with *A* and *D*, *Portfolio G* had at least one cointegration vector for almost all specifications, with *p*-values comparable to those of *Portfolio D*. VECM rates for *Portfolio G* were similar to those of *Portfolio D* as well. Comparing the responses, the USA was dominant in all 3 portfolios and the UK was fairly dominant in *Portfolios D* and *G*. France also had an influence in *Portfolios D* and *G*, although this influence was not as high as that of the UK. The variance decomposition for all three portfolios was generally the same; SA explains most of its own variance with the USA being the major foreign contributor. All other variables are negligible except for the UK which exerts influence in a few cases.

Portfolio H

Autocorrelation of the residuals was present up to 4 lag lengths. At 2 lag lengths cointegration exists for all combinations except for the maximum eigenvalue test with a trend and intercept. At 4 lag lengths cointegration exists for all combinations except for intercept only and trend and intercept using the maximum eigenvalue test. The interesting observation here is for the values of the VECM. They are comparable to previous values being up to 7%. The only exception is Russia, which has error correction rates between 13% and 20%. This is an unusual result and suggests that with this combination of markets, the Russian market responds quickly to any disequilibrium. The maximum VECM rate is 20% for Russia at 2 lag lengths with a trend and intercept in the CE and intercept only in the VAR. Apart from this sudden surge, the next highest market is Argentina at 4 lag lengths which is 8.8% for the same specification model as Russia. For SA the error correction rates range between 1.9% and 3.4% at 2 lag lengths and 1.4% and 5% at 4 lag lengths, with the highest rates being for the trend and intercept in CE and intercept only in VAR specification.

The impulse responses for SA at 2 lag lengths show that the USA is the most dominant market but all the other markets have an influence on the SA market. The same is true for 4 lag lengths. However, with the GIRF, Australia becomes the most dominant foreign market. With the Cholesky ordering at 2 lag lengths, SA response to its own shocks starts at 2.4% and ends at 1.8%. Major foreign influence is from USA which starts and ends at approximately 1.5%. Australia and Hong Kong start at 0.05% and end at 1% and none of the other markets have influence beyond 1% at any time period. Using the GIRF, SA influence starts at 3% and falls to 2.7%. Influence of Australia and Hong Kong gradually increases over time and ends at 2% and 1.7%, respectively. USA, Russian and Philippine influences fall and end at 1.6%, 1.2% and 0.9%, respectively. Japanese and Argentine influences stay roughly the same throughout at 1.3%. With the Cholesky ordering at 4 lag lengths, the response to SA and USA shocks is very similar with the response at 2 lag lengths. Hong Kong ends up being the only market whose shocks have more than 1% effect on SA, and it reaches this close to the 30th period. The same pattern of movement is repeated with the GIRF ordering at 4 lag lengths as it was with the GIRF at 2 lag lengths. The only difference is that Argentina's influence falls slightly over time and does not remain constant.

Variance decomposition at both lag lengths has the same conclusions. SA explains the majority of its variance with the USA being the main foreign contributor in explaining variance; none of the other markets having a significant contribution towards explaining SA variance. SA explains 63% and 72% of its own variance at 2 and 4 lag lengths, respectively. This falls to 45% at both lag lengths. The major foreign influence is the USA which starts at 25% and rises to 35% at 2 lag lengths and 30% at 4 lag lengths. None of the other markets explain more than 10% of SA's variance at any time period.

The block exogeneity test shows that SA is influenced by past values from markets in Argentina and Hong Kong. Surprisingly, unlike in other cases, the USA does not influence SA. At 4 lag lengths, results conform to expectation and the USA market once again influences SA. The other dominant foreign market is Argentina.

Portfolio H had strong evidence of cointegration compared with *Portfolios B* and *E*. As a result the VECM rates were high as well, going as high as 20% for Russia which was unusual given that the next highest VECM rate for all portfolios was 8%. In *Portfolio H*, shocks from Hong Kong are still a significant contributor to the SA market. The influence of Australia has fallen in some instances and USA influence has increased. The foreign influences in the variance decomposition have greatly changed. The foreign contributor towards SA variance is now the USA, Hong Kong and Japan no longer have a significant effect on the variance.

Portfolio I

Time series plots for price indices from markets included in *Portfolio I* are given in Figure 4.14. Autocorrelation of the residuals disappears at 9 lag lengths. For 2 lag lengths there is no clear presence of cointegration. Three of the six specifications suggest cointegration and the other three do not. At 9 lag lengths all the specifications find at least one cointegrating vector, with some finding up to three. The error correction rates are very low, with none of them exceeding 1% at either 2 or 9 lag lengths. This is unusual given the high prevalence of cointegration, *a priori* assumptions state that error correction rates are expected to be high when cointegration is present. The maximum VECM rate is 1.3% for Russia at 9 lag lengths with the trend and intercept in CE and intercept only in VAR specification. SA adjustment rates do not exceed 0.1% at 2 lag lengths and 9 lag lengths, and are the lowest they have been for all the portfolios.

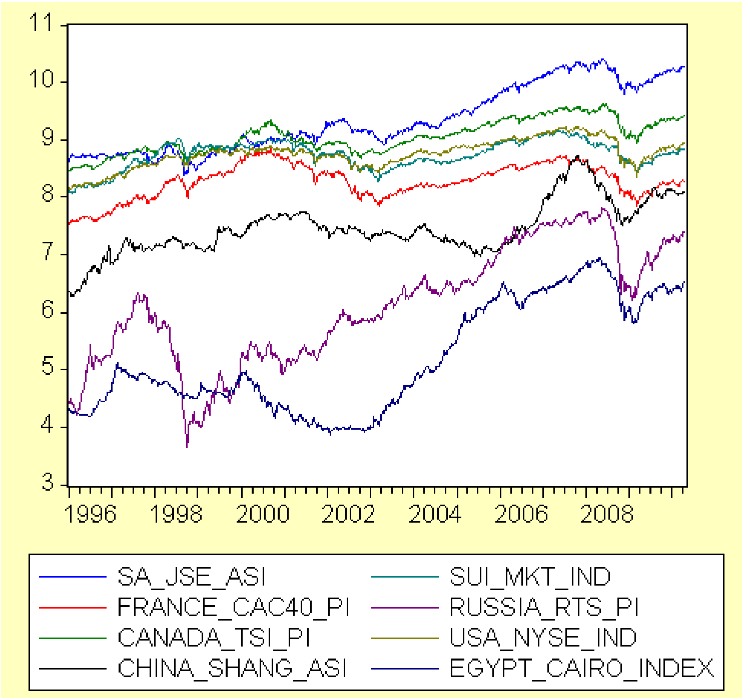

Fig. 4.14 Time series plots for price indices from markets included in *Portfolio I*.

Using the Cholesky ordering at 2 lag lengths, the IRF plots show that all the markets have an effect on SA, with Canada having a negative coefficient. SA starts at 2.5% and soon falls to its equilibrium of 2.2%. The major foreign shock is from the USA which starts at 1.5%, rises then falls back to 1.5%. Russia is the only other market to exceed 1% which it achieves by the 30th period. Using the GIRF plots, the major foreign influence in terms of shocks is France. SA starts at 3% and falls to 2.8% by the end. France rises at the beginning and then remains constant throughout at 1.7%. The influence of USA shocks is the same as with the Cholesky ordering. Russia and Switzerland also have responses exceeding 1% with China, Canada and Egypt being below 1%. At 9 lag lengths the conclusions are exactly the same as with 2 lag lengths, only the curves are more jagged than with 2 lag lengths (Figures 4.15 and 4.16). The IRFs after 30 periods are almost the same as with 2 lag lengths and the same markets have almost the same influence for both Cholesky ordering and GIRF. In both cases for SA, most of the other foreign shocks have an impact on SA, but SA is still the dominant market locally.

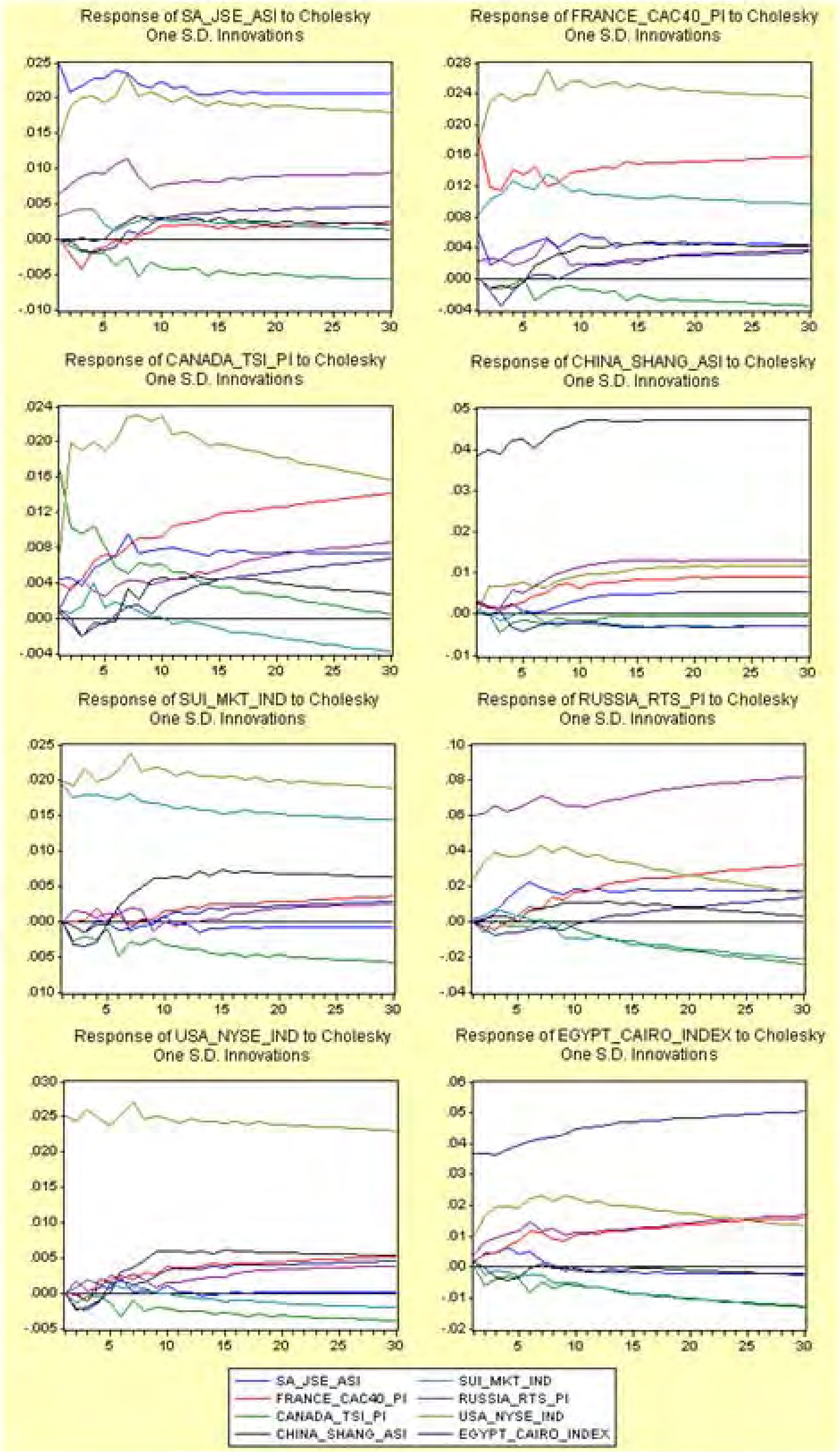

Fig. 4.15 IRF plots for price indices markets included in *Portfolio I* at 9 lag lengths using Cholesky ordering: USA – Switzerland – Russia – SA – France – China – Egypt – Canada.

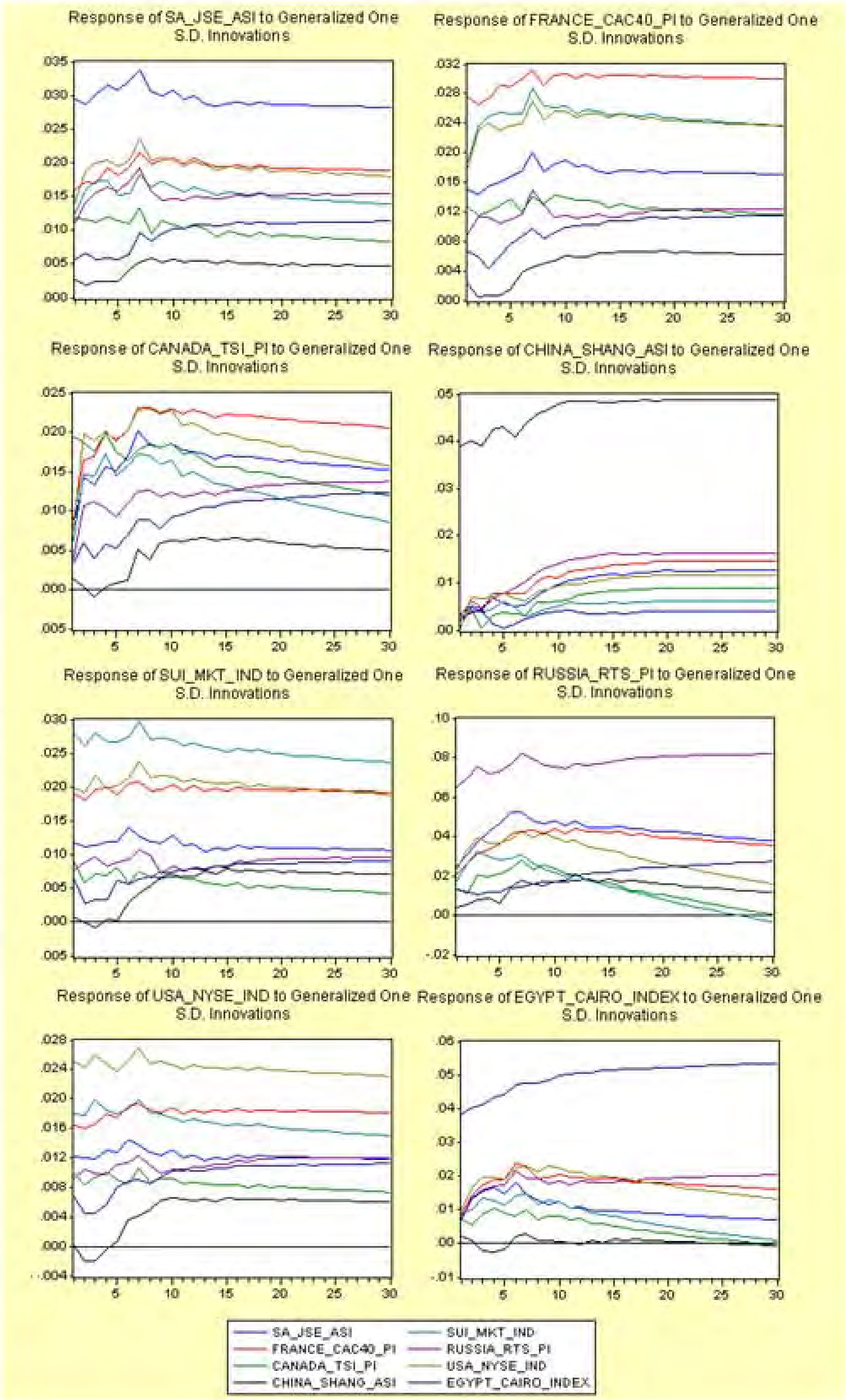

Fig. 4.16 IRF plots for price indices markets included in *Portfolio I* at 9 lag lengths using generalized ordering.

Variance decomposition as usual shows that SA explains most of its own variance with the USA being the main foreign contributor to variance. Some slight yet noticeable explanation of the variance comes from Russia (Figure 4.17). SA initially explains 70% of its variance at both lag lengths and this falls to 56% at 2 lag lengths and 49% at 9 lag lengths. The USA starts at 25% and ends at 30% and 35% for 2 and 9 lag lengths, respectively. Russian influence starts at 5% and ends just below 10% at both sets of lag lengths.

At 2 lag lengths the USA market is the only market that Granger causes SA. At 9 lag lengths the markets that Granger cause SA are the USA and France.

The *p*-values for cointegration are lower for *Portfolio I* than for *Portfolios C* and *F*, indicating that there is increased cointegration. However, contrary to expectation, the VECM rates are lower than for *Portfolios C* and *F*. The IRFs are different for all three portfolios and for *Portfolio I* the USA shocks are now dominant in SA. In some cases French shocks exceed Swiss and Russian ones and in other cases they do not, meaning that it is not clear which is the second dominant foreign market in SA. The variance decomposition between *Portfolios F* and *I* is similar, only that the USA replaces Switzerland in *Portfolio I*. The SA and Russian influence on SA variance remains similar for both portfolios.

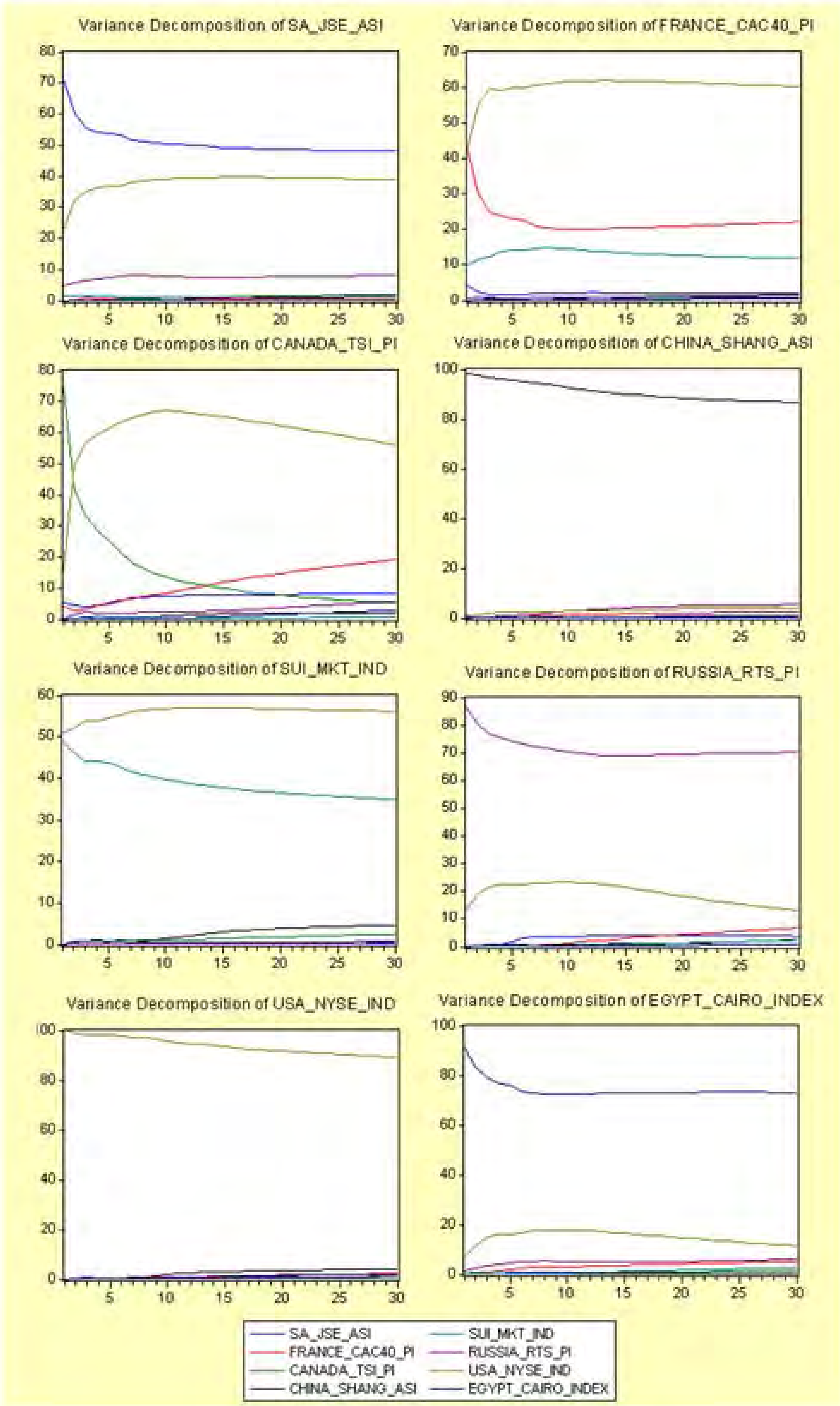

Fig. 4.17 Variance decomposition plots for price indices markets included in *Portfolio I* at 9 lag lengths using Cholesky ordering: USA – Switzerland – Russia – SA – France – China – Egypt – Canada.

4.4 Conclusions

This chapter discussed the results that were obtained when applying the methods to data, with specific focus on South Africa. Descriptive statistics showed that the data were not normally distributed with some skewness present. Bivariate cointegration found some cointegration with other emerging markets all around the world, but not with developed markets. Multivariate cointegration showed cointegration existed with some combinations of markets which were not pair-wise cointegrated. However, in the majority of cases coefficients of cointegration were negative, indicating that there is a negative relationship between SA and the particular market.

Vector error correction rates were low and showed that markets return to equilibrium slowly, even when cointegration existed. This shows that even if cointegration is present then there may be benefits from investing in those markets as is it possible to take advantage of arbitrage opportunities before the market returns to equilibrium. However, it will be more beneficial to invest in non-cointegrated markets.

Impulse response functions and variance decompositions showed that in the majority of cases the local market either responded mostly to its own shocks or explained most of its variance. This is especially true for countries that were placed first in the Cholesky ordering. The results from the Cholesky ordering of IRFs and the generalized IRFs were in most cases similar.

The block exogeneity tests revealed that previous values of foreign markets do not influence the SA market, the exception being the USA which influences SA and other markets as well.

One of the major questions that arose was which of the two criteria to choose when selecting the lag length: (i) the one chosen by the various information criteria or (ii) the lag length at which autocorrelation disappeared. The method favoured is to use the second option. The reason for this is that autocorrelation is a serious problem and can lead to spurious regression. In addition, the results obtained when using the lag lengths at which there was no autocorrelation were more in line with *a priori* assumptions which intuitively suggests that this is the better option.

Another problem encountered was whether to include a trend and intercept, intercept only or neither in the model specification. The results varied greatly at times whilst at other times they showed no significant differences. In line with what theory suggests, the most cointegration using both Engle-Granger and Johansen procedure was reported when neither trend nor intercept were used and the least amount of cointegration was found when using a trend and an intercept. By including trend and intercept the number of parameters in the model increases and this then makes it more difficult to find a stationary combination of variables, and hence cointegration. Economic theory suggests that when dealing with equity market data it is best not to include a trend. In this study some of the data exhibit trends while others do not. Hence, for the sake of consistency, it is best to include an intercept term only. This is also a "middle-of-the-road" specification as the other two usually either understate or overstate cointegration.

The problem of what model specification to use has always been a source of concern for econometricians. This study has shown that the results vary greatly depending on the specification used. Quite often in economic articles, authors will simply use one of the specifications and either ignore the others completely or briefly mention that others exist but do not focus on them (Botha and Pretorius, 2009; Kucukcolak, 2008). As was the case in this study, it may well be that other specifications provide very different results. Hence, it is in the researcher's best interests to try all the specifications, particularly because the choice of specification is often a subjective choice; robust results will be those that do not vary depending on the specification of the model.

What was also observed is that the introduction of the USA into a portfolio resulted in the USA dominating that portfolio in terms of the impulse responses and the variance decomposition. This gives further evidence to the claim that the USA market is a dominant global equity market.

One of the objectives was to try and define the terms short-term and long-term by giving them actual time spans. This can be done by looking at IRF plots and variance decomposition. From this, the point at which all curves become relatively straight and do not change any more is the long-run. This is different for all series but from the multivariate graphs the equilibrium is reached after approximately 8 lag lengths. This corresponds to a period of eight weeks and hence, time periods less that 8 lag lengths are the short-run and more than 8 weeks are the long-run.

Chapter 5

Summary of Study and Implications

5.1 Summary

The ultimate goal of this study was to determine the existence of long-run relationships between the South African equity market and other developed and emerging equity markets. Another objective was to analyse the short-run dynamics between these markets.

The first step was to review existing literature. The conclusion here was that since the 1970s levels of cointegration have improved significantly. Another finding was that developed markets move together while the same cannot be said about emerging markets. It was found that emerging markets are generally cointegrated with other emerging markets and not with developed markets. Chapter 3 outlined the methods that would be used in the study with derivations of the more important results.

The next chapter applied the results to the data. Firstly, the data were tested for stationarity using the Augmented Dickey-Fuller test and were all found to be $I(1)$. Secondly, bivariate cointegration was carried out using the Engle-Granger and Johansen procedure which had similar results. South Africa was found to be cointegrated with some emerging markets. Different lag lengths were tried out which provided slightly inferior results. The data from 2003 onwards were tested for cointegration and there was no statistical evidence that cointegration levels increased after 2003.

The bivariate cointegration results show that the South African equity market is by and large not cointegrated with other equity markets, especially developed markets and markets in Africa. There is some cointegration with other emerging markets all over the world, such as Brazil, Mexico and Poland. This means that it is potentially beneficial for a South African investor to hedge his risk by investing in the markets with which SA is not cointegrated, for example, Germany and USA. Hedging against risk by investing in South Africa and Mexico would be a bad idea because these markets are cointegrated and if there were a downwards trend in one market, the other one would be expected to fall as well.

Multivariate cointegration results did not reveal much cointegration. Innovation accounting methods are used to capture the relationships between markets in the short-run. They show that the response to external shocks is in general quite slow. The error correction mechanism shows that the adjustment to equilibrium is slow, which is inline with the findings of Masih and Masih (2002) who found that because of the slow adjustment to equilibrium short-term profits may still be attained.

Block exogeneity results show that previous values of the USA market influence the SA market. Hong Kong also has an influence but to a lesser degree. The SA market does not influence any of the markets chosen in the different portfolios.

The results also have implications for the efficient market hypothesis, since the existence of cointegration implies that causality must at least run from one direction. So, if two stock markets move together in the long-run they will be violating the weak-form efficiency as this indicates that one equity index can be predicted by the other. Stock prices from two distinct efficient equity markets cannot be cointegrated. This suggests that the markets that are not cointegrated with SA are efficient. It must be noted that the non-existence of cointegration invalidates the existence of a long-run equilibrium relationship but does not invalidate any short-run relations which may occur due to profit seeking activities. Hence, it is possible that the SA market indices could be predicted by other indices in the short-run.

5.2 Choosing the Portfolios

From these results one of the main points of interest will be which portfolio to select. When choosing between two portfolios, it will be beneficial to invest in SA and a market with which it is not cointegrated. From the study this means that it will be best to invest in developed markets as SA is cointegrated with developing markets. This is still quite a substantial list and to narrow it down it is advisable to look at the error correction rates. The markets that have the lowest error adjustment coefficient with SA are France, Germany and Japan and so a pair-wise portfolio with stocks from any of these countries would be recommended.

With a choice of four portfolios, *Portfolio C* is recommended because unlike *Portfolio A* there is no cointegration present, and unlike *Portfolio B* none of the markets Granger cause SA. This means that SA is the most independent of the other markets in *Portfolio C*. The error correction rates are also low meaning that it is possible to make profits in the short-run before the markets adjust to equilibrium.

From a choice of six portfolios, *Portfolio E* is recommended as it has the least evidence of cointegration and the smallest error correction rates. The SA market is not quite as isolated as with *Portfolio C*. This is expected as the more markets are included the more links between them are expected to be found.

For eight markets, the choice becomes trickier and depends on what the investor's objective is. If the choice is a long-term hedging strategy then *Portfolio H* is appropriate as it has limited evidence of cointegration. However, the error correction rates are higher than in all other cases. As a result, if the goal is short-term profiteering then *Portfolio I* is appropriate as it has much lower error correction rates and it is possible to take advantage of arbitrage opportunities before the market returns to equilibrium.

5.3 Future Research

Initially this study attempted to focus more on cointegration within Africa. However, African stock market data are either hard to obtain, unreliable or listed in months, whereas this study used weekly data. Hence, if and when more African data become available it will be interesting to carry out cointegration analysis.

This study could also be carried out using monthly rather than weekly data. This would have the advantage of using a wider range of data owing to the availability of monthly African data. However, using monthly data when carrying out financial analysis is not common practice because markets respond rapidly to changes in other markets and monthly data may miss some of the short-term dynamics.

It is unclear which method is more important when selecting a lag length, the one chosen by the information criteria or the one at which autocorrelation first disappears. The literature available on this topic is vague. This study presented both pairs of lag lengths for the sake of comparison and the method chosen to select the preferred lag length was not based on statistical methodology. It may be of use to develop such a method, perhaps combining the two methods of the information criteria and the test for autocorrelation.

Another area of possible interest is to improve economic theory regarding what specification of the model to use, i.e. with trend and intercept, intercept only or neither. At present it is up to the econometrician to select the specification based on his/her experience in the field. To gain credibility it is useful to develop a scientific method for the choice of the specification.

Finally, each of the indices in this study contains stocks from various sectors and industries and is of different size. It will require a vast amount of resources to have each of the stocks in the markets. It may be the case that a random selection of the stocks will not reflect the performance of the index and may under or over perform relative to it. Hence, it will be useful to use index tracking techniques to select a combination of a handful of stocks that closely mimic the indices in which they are contained. These techniques will select stocks that when taken in combination, will roughly follow the movements of the index.

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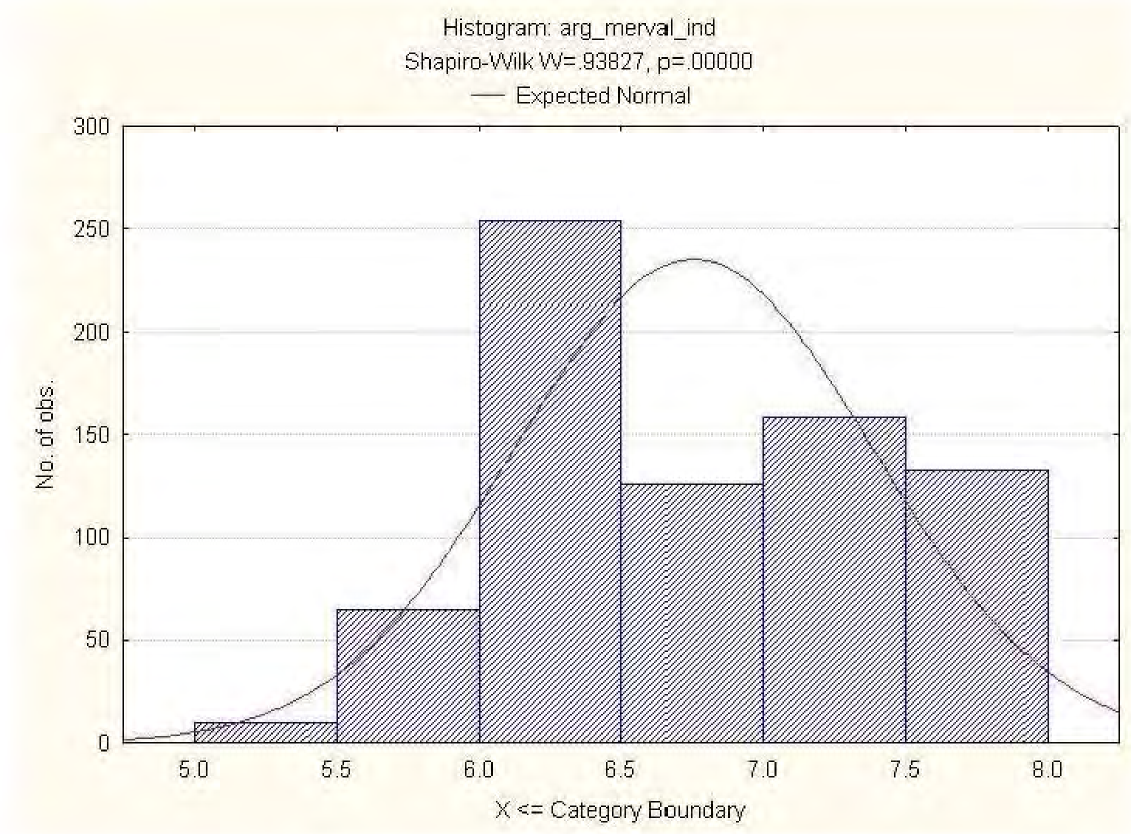
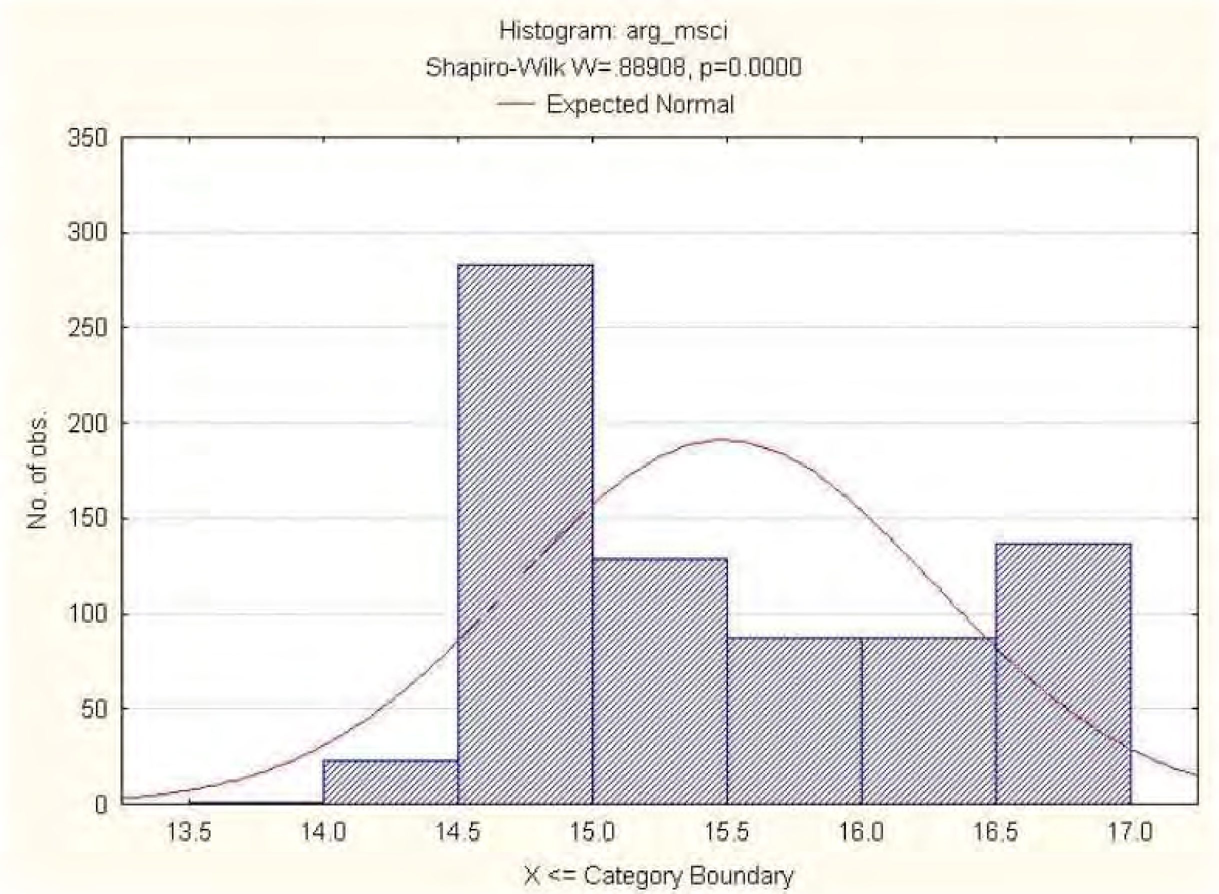
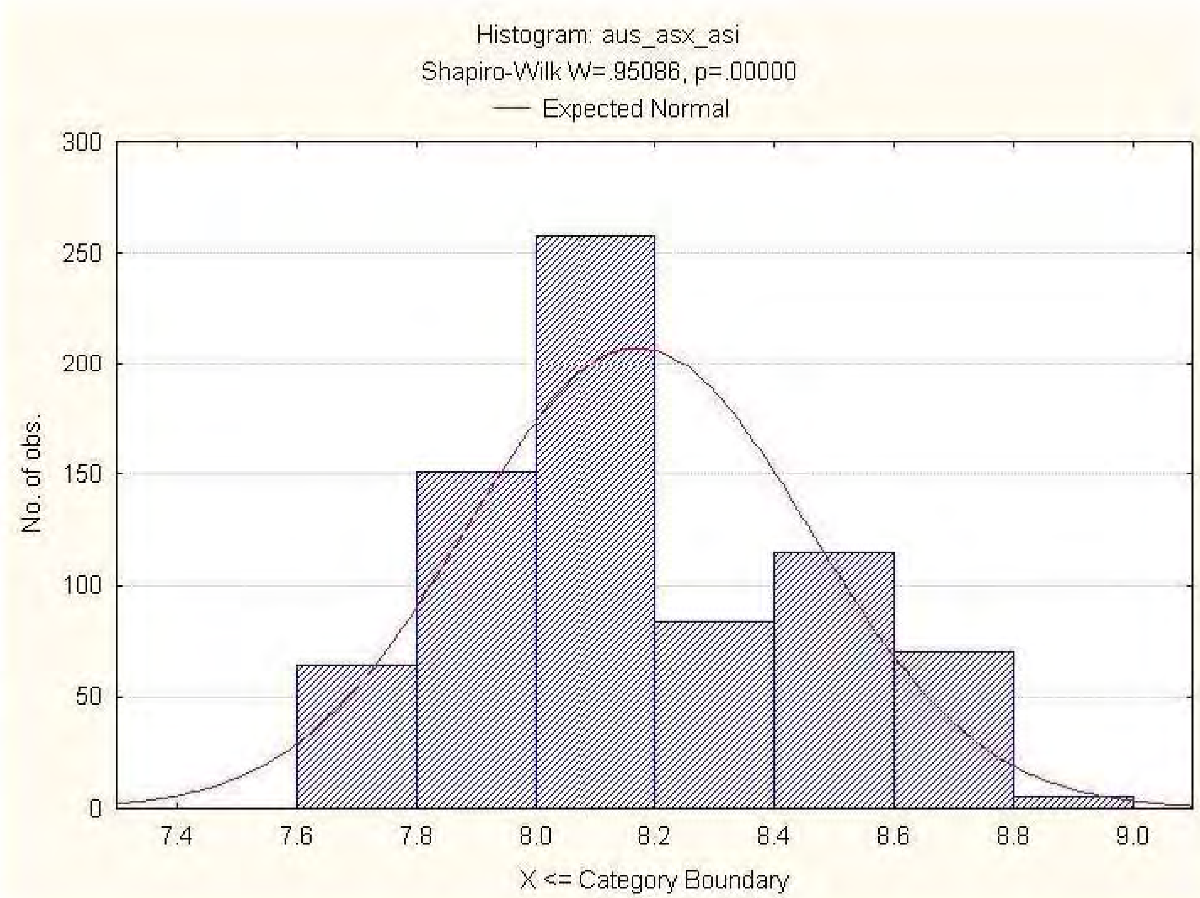
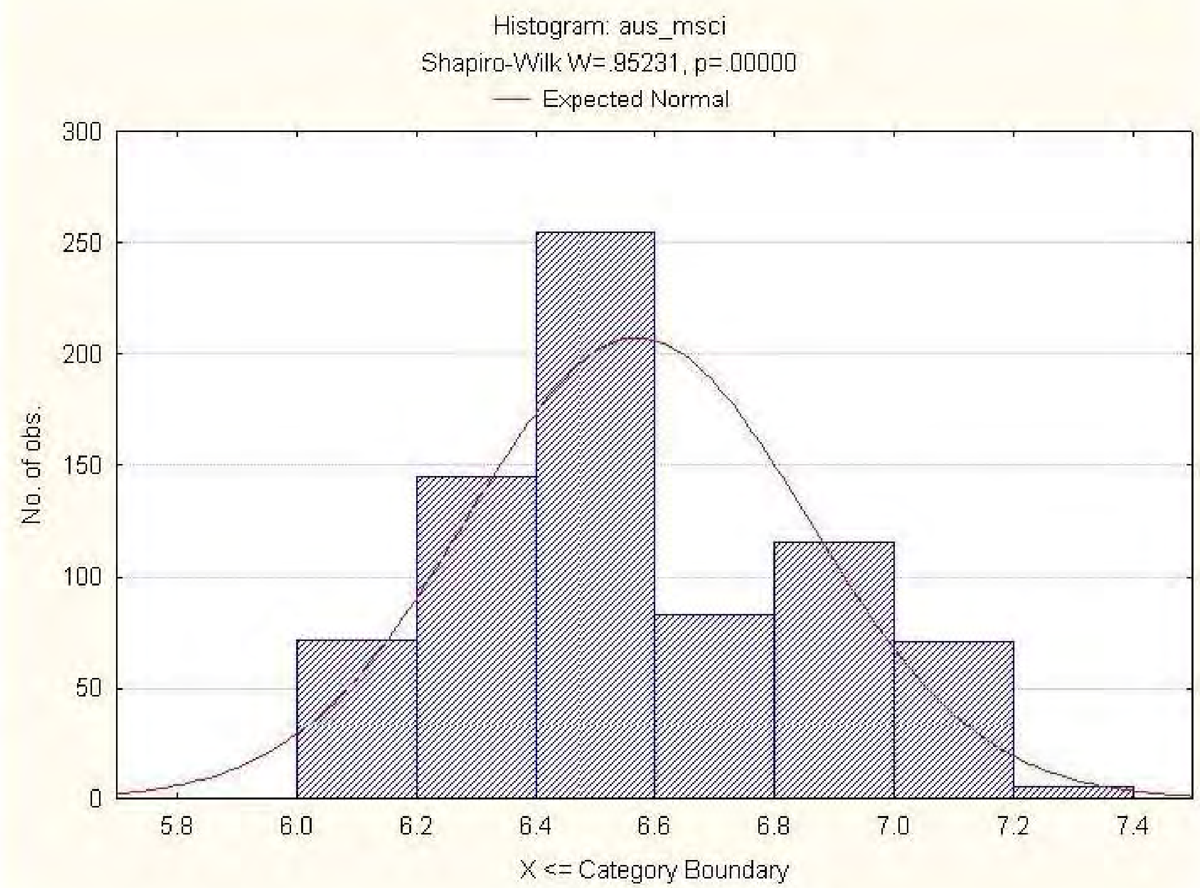
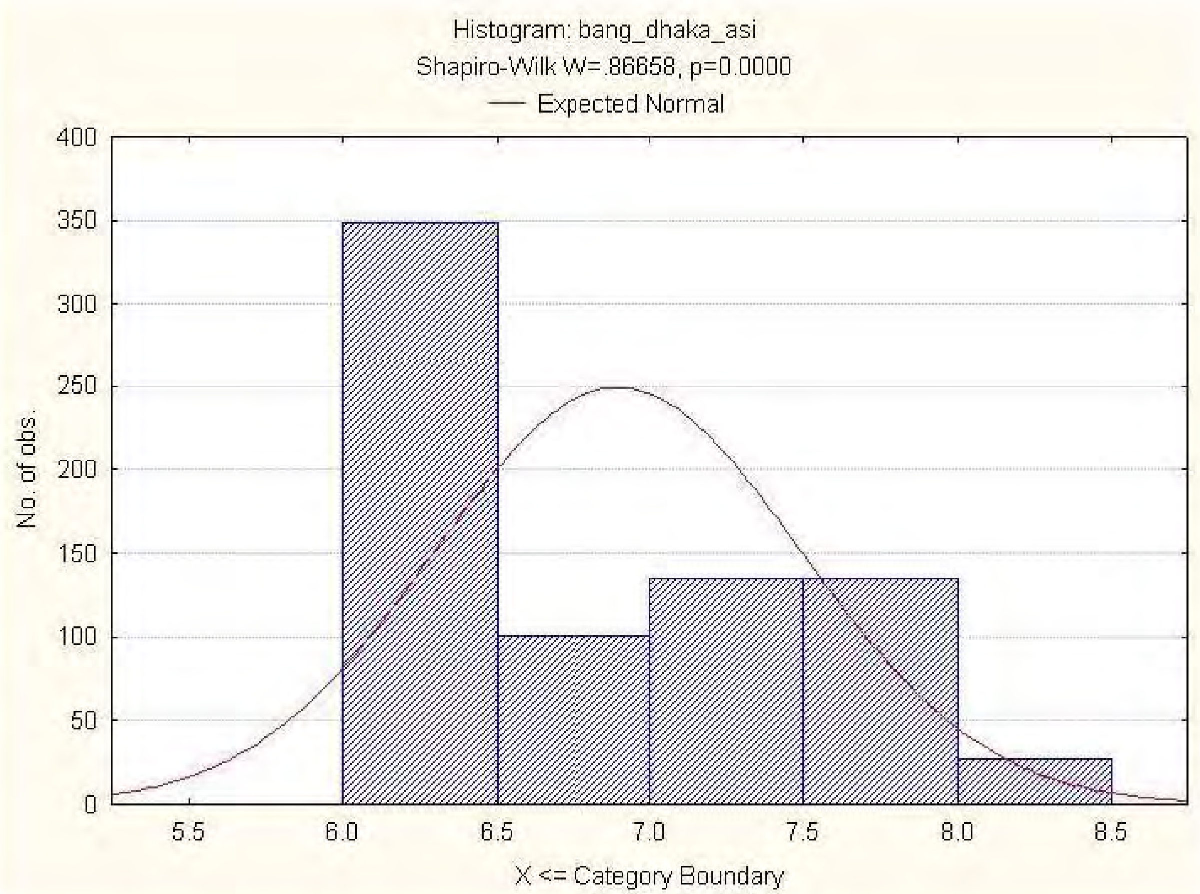
Appendix A – Shapiro-Wilk normality test results






Histogram: aus_asx_asi
Shapiro-Wilk W=.95086, p=.00000
Expected Normal
No. of obs.
300
250
200
150
100
50
0
7.4
7.6
7.8
8.0
8.2
8.4
8.6
8.8
9.0
X <= Category Boundary


Histogram: aus_msci
Shapiro-Wilk W=.95231, p=.00000
Expected Normal
No. of obs.
300
250
200
150
100
50
0
5.8
6.0
6.2
6.4
6.6
6.8
7.0
7.2
7.4
X <= Category Boundary


Histogram: bang_dhaka_asi
Shapiro-Wilk W=.86658, p=0.0000
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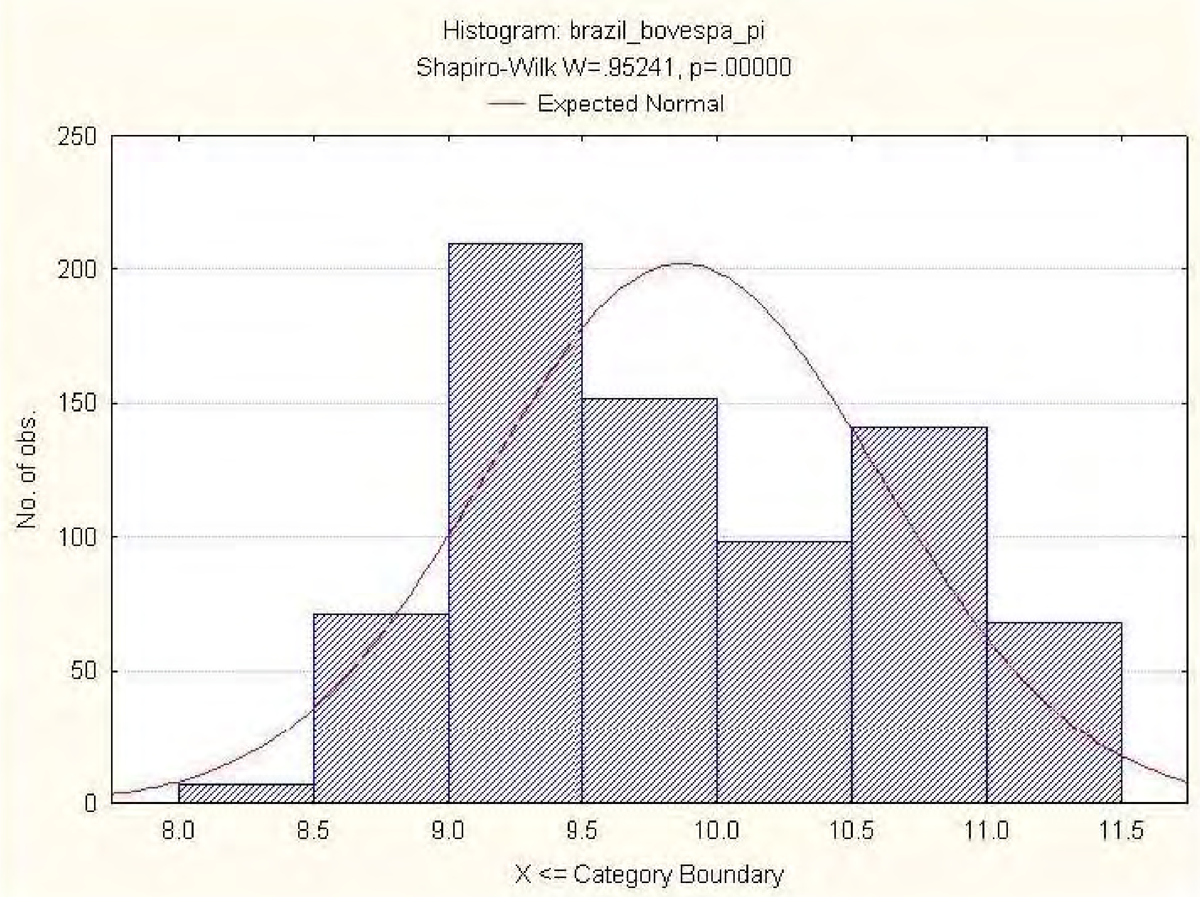
No. of obs.
X <= Category Boundary


Histogram: brazil_bovespa_pi
Shapiro-Wilk W=.95241, p=.00000
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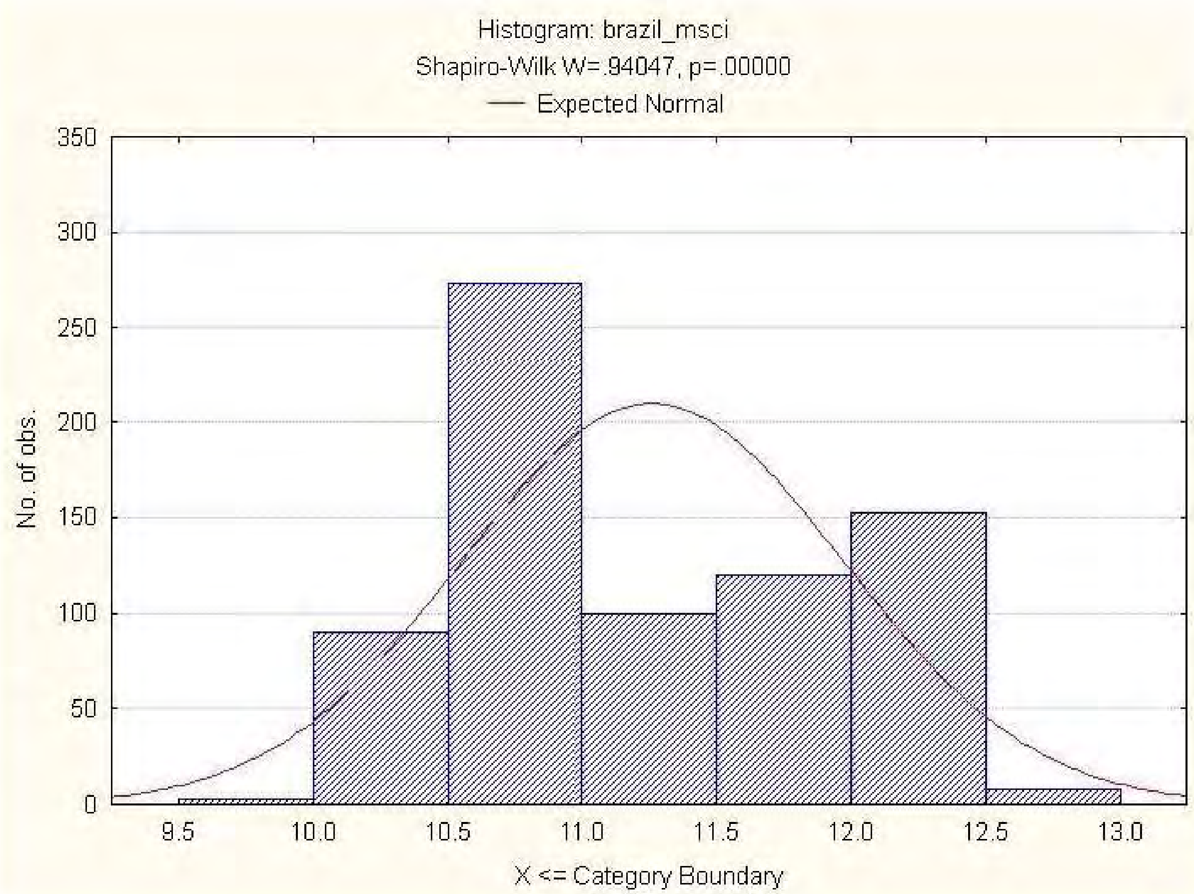
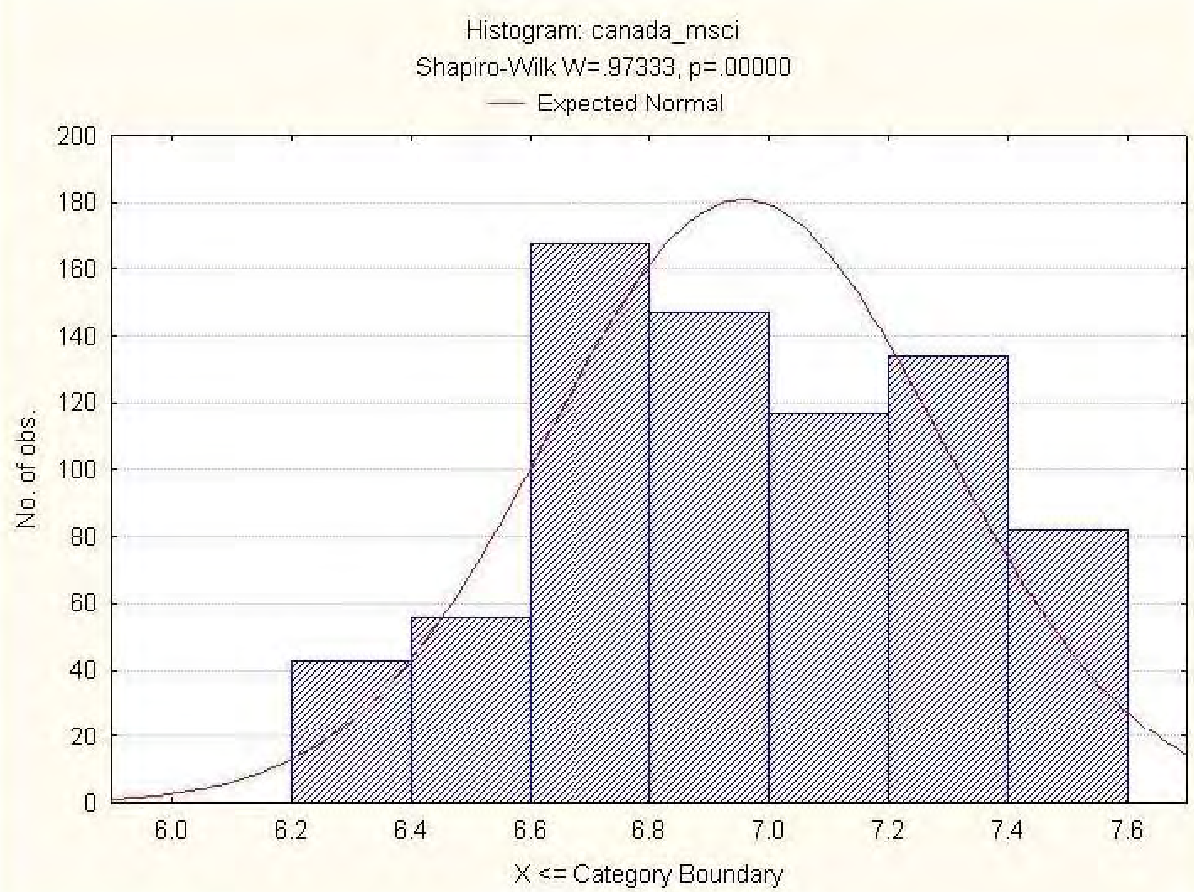
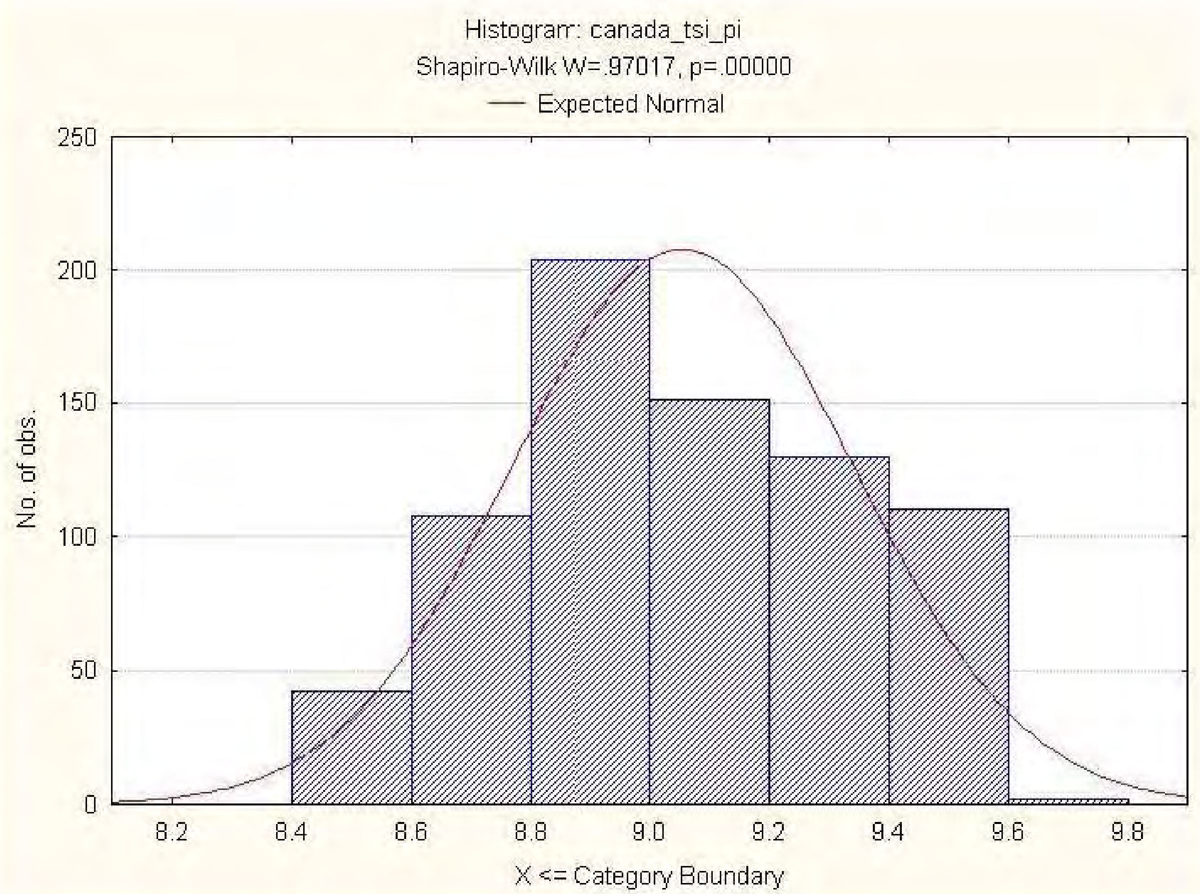
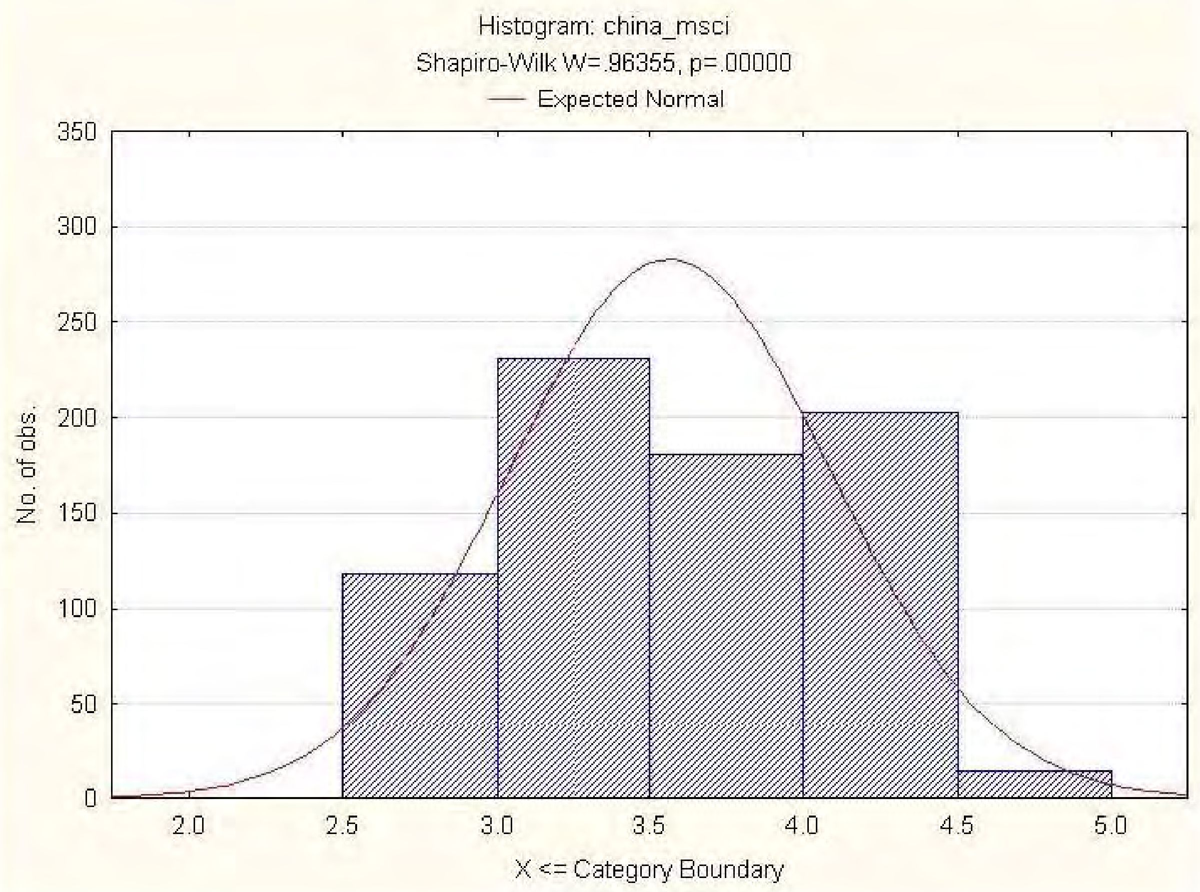
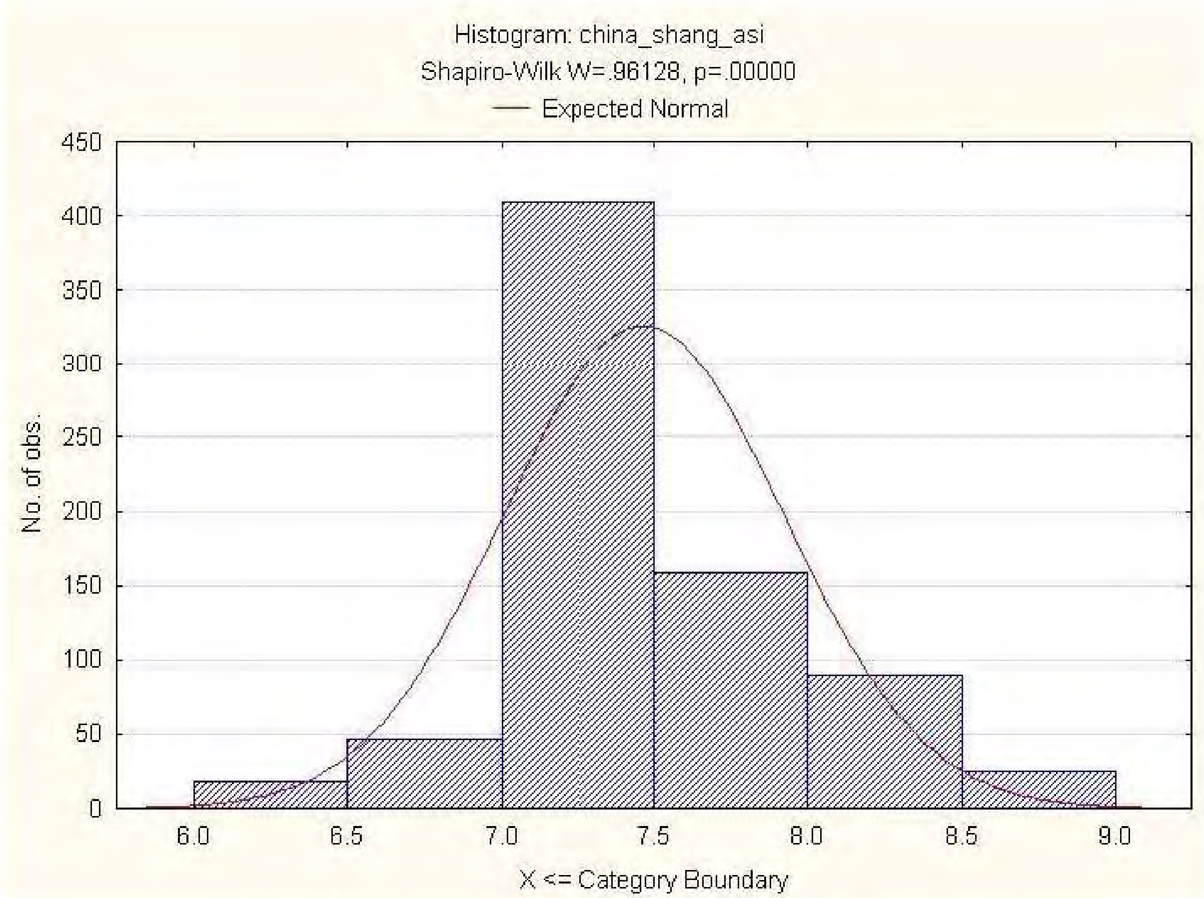
No. of obs.
X <= Category Boundary


Histogram: brazil_msci
Shapiro-Wilk W=.94047, p=.00000
Expected Normal
350
300
250
200
150
100
50
0
No. of obs.
9.5
10.0
10.5
11.0
11.5
12.0
12.5
13.0
X <= Category Boundary

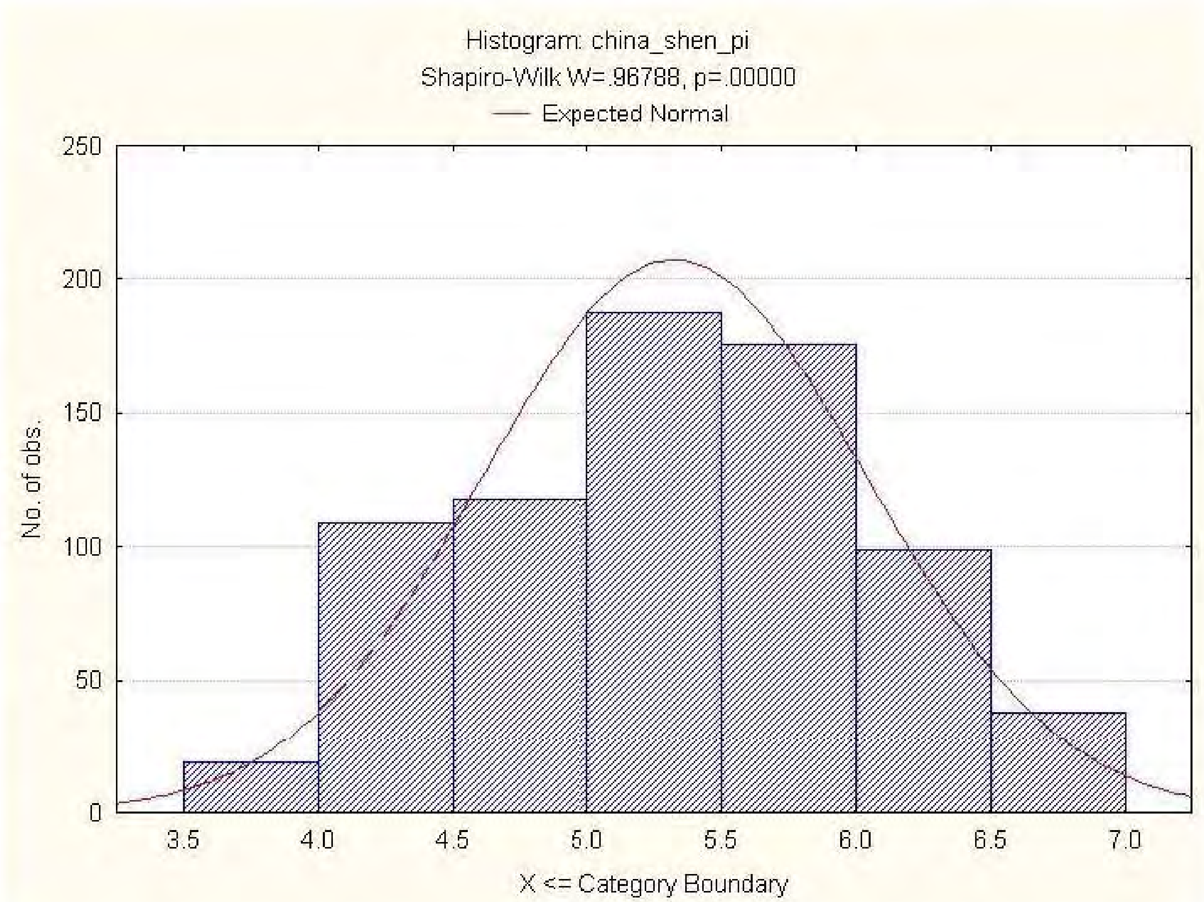

Histogram: canada_msci
Shapiro-Wilk W=.97333, p=.00000
Expected Normal
200
180
160
140
120
100
80
60
40
20
0
No. of obs.
6.0
6.2
6.4
6.6
6.8
7.0
7.2
7.4
7.6
X <= Category Boundary


Histogram: canada_tsi_pi
Shapiro-Wilk W=.97017, p=.00000
Expected Normal
No. of obs.
X <= Category Boundary

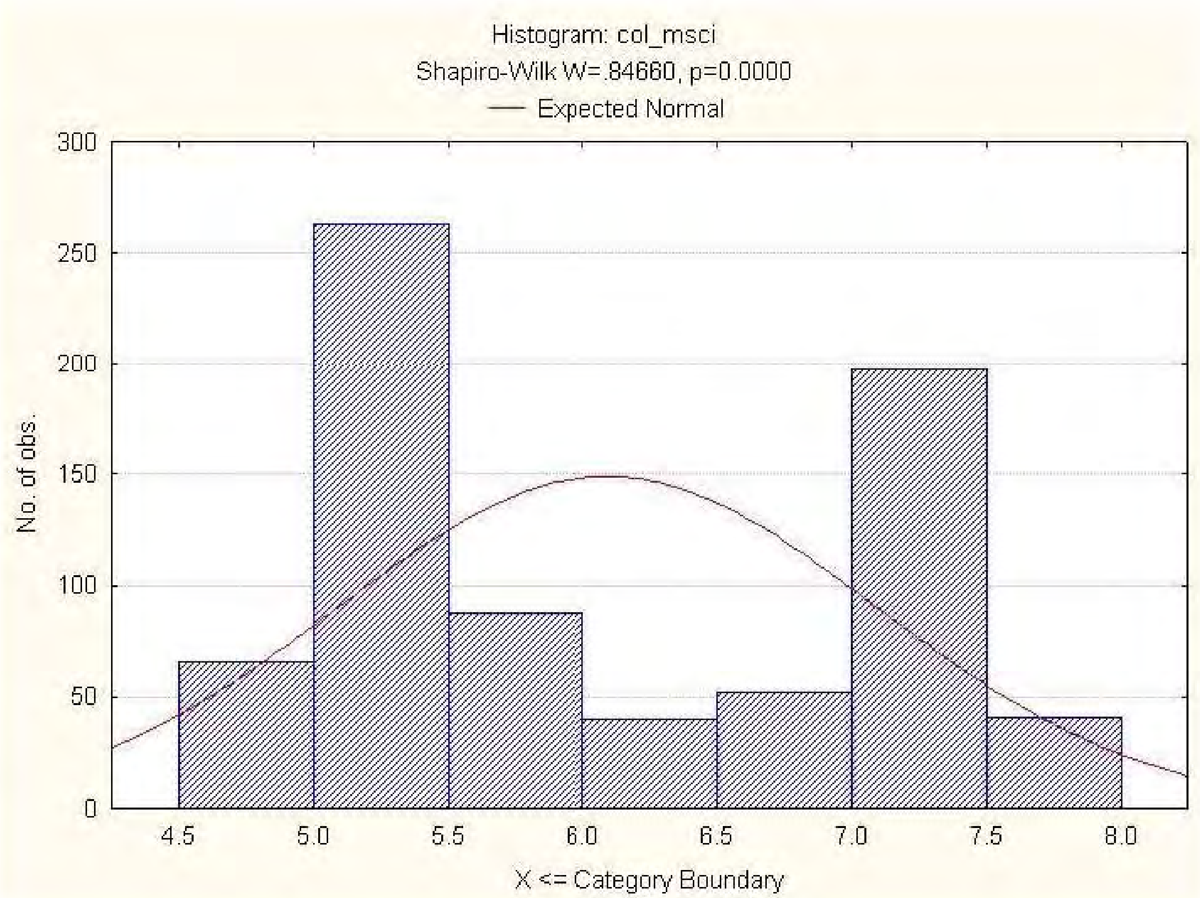

Histogram: china_msci
Shapiro-Wilk W=.96355, p=.00000
Expected Normal
No. of obs.
X <= Category Boundary

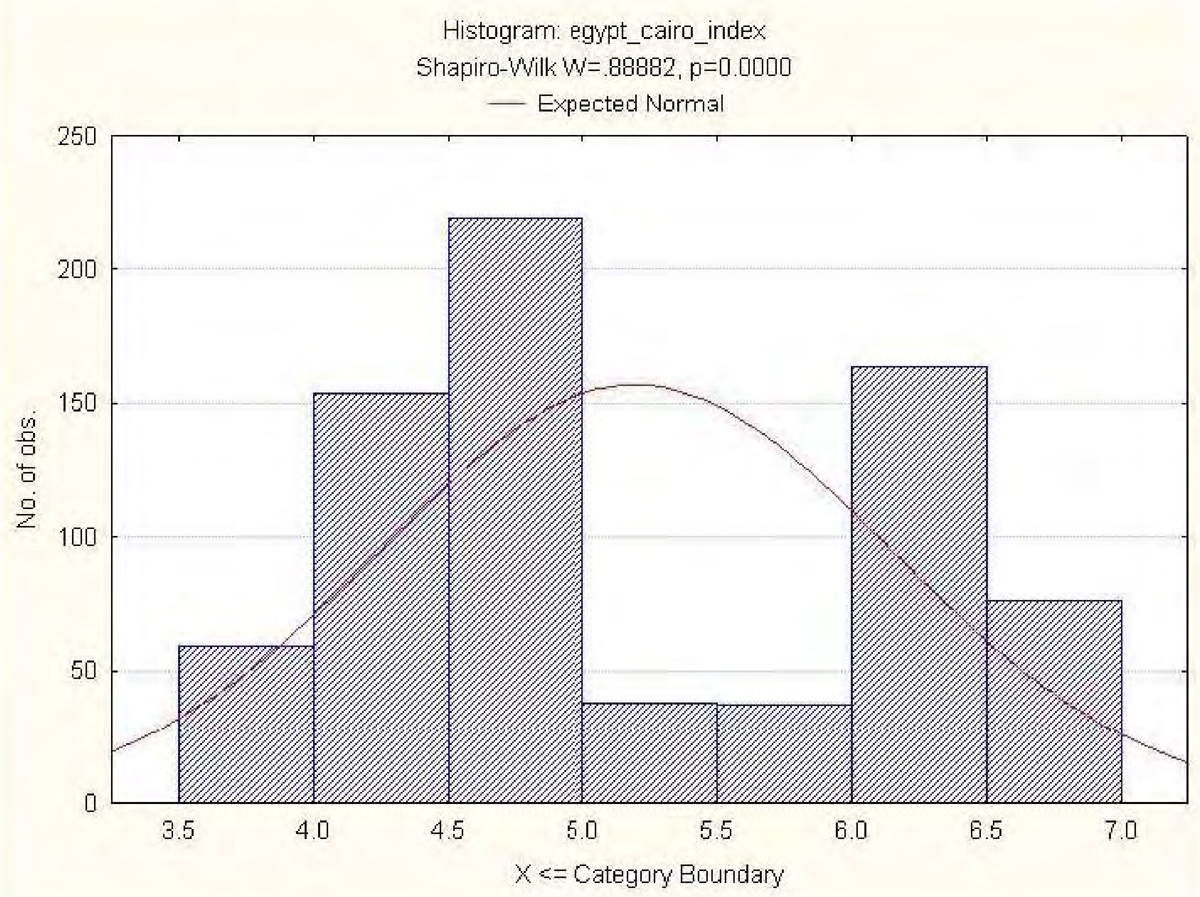


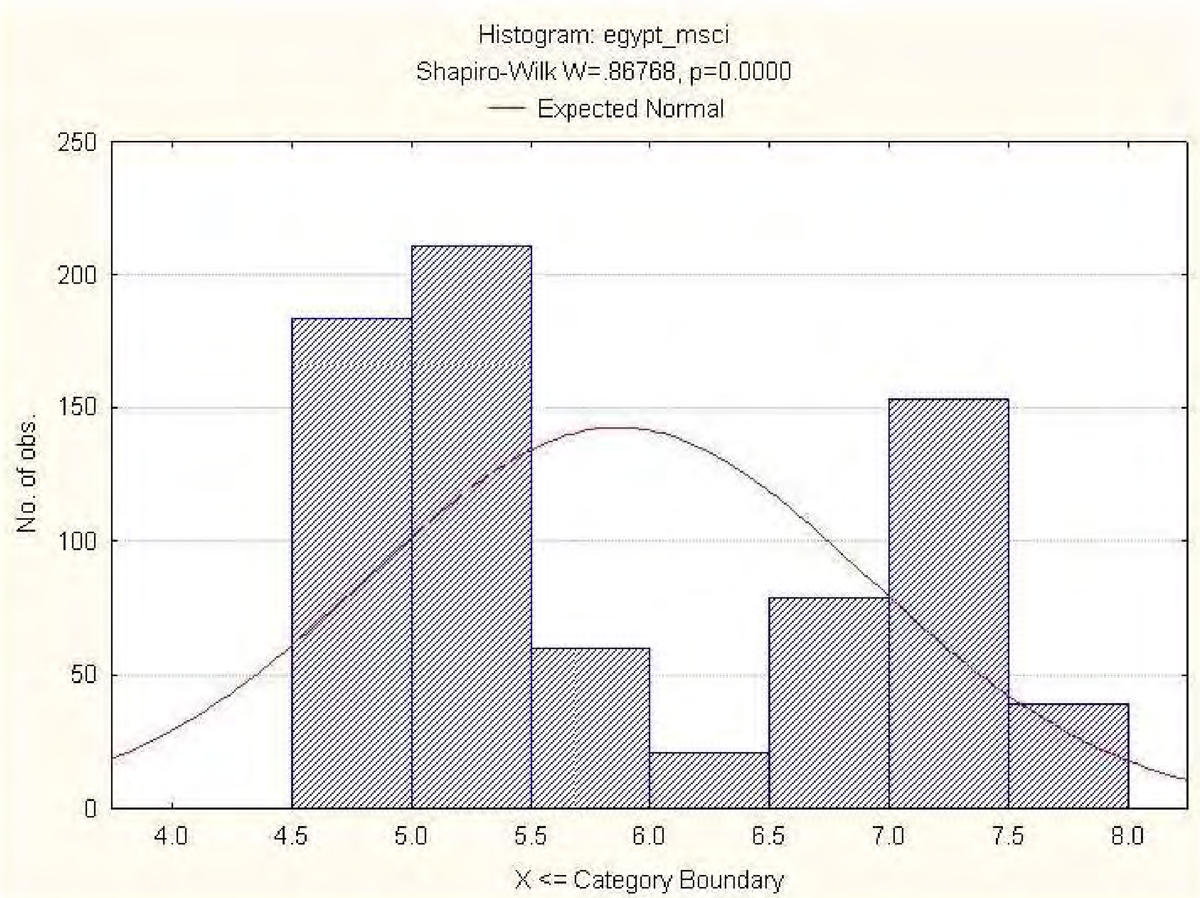
Histogram: china_shang_asi
Shapiro-Wilk W=.96128, p=.00000
Expected Normal
No. of obs.
0
50
100
150
200
250
300
350
400
450
6.0
6.5
7.0
7.5
8.0
8.5
9.0
X <= Category Boundary

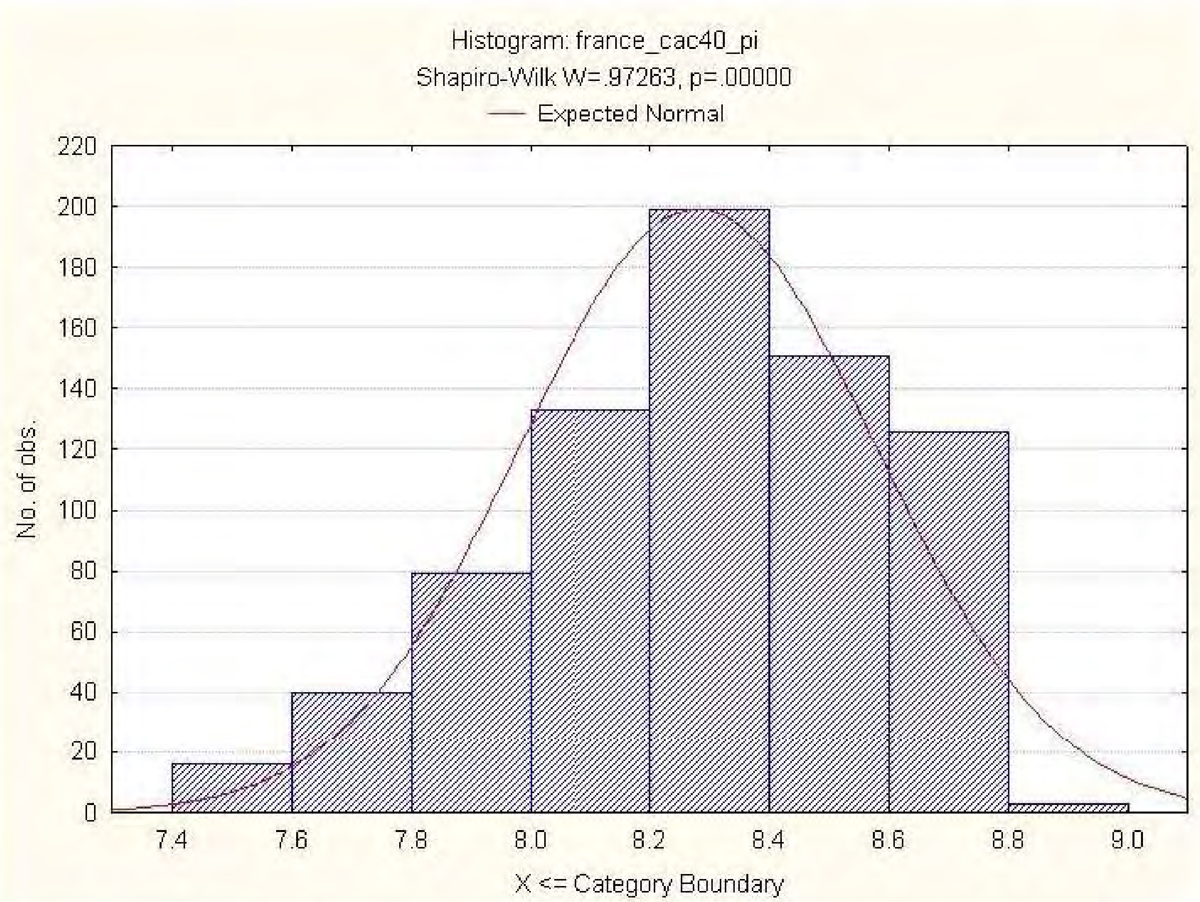


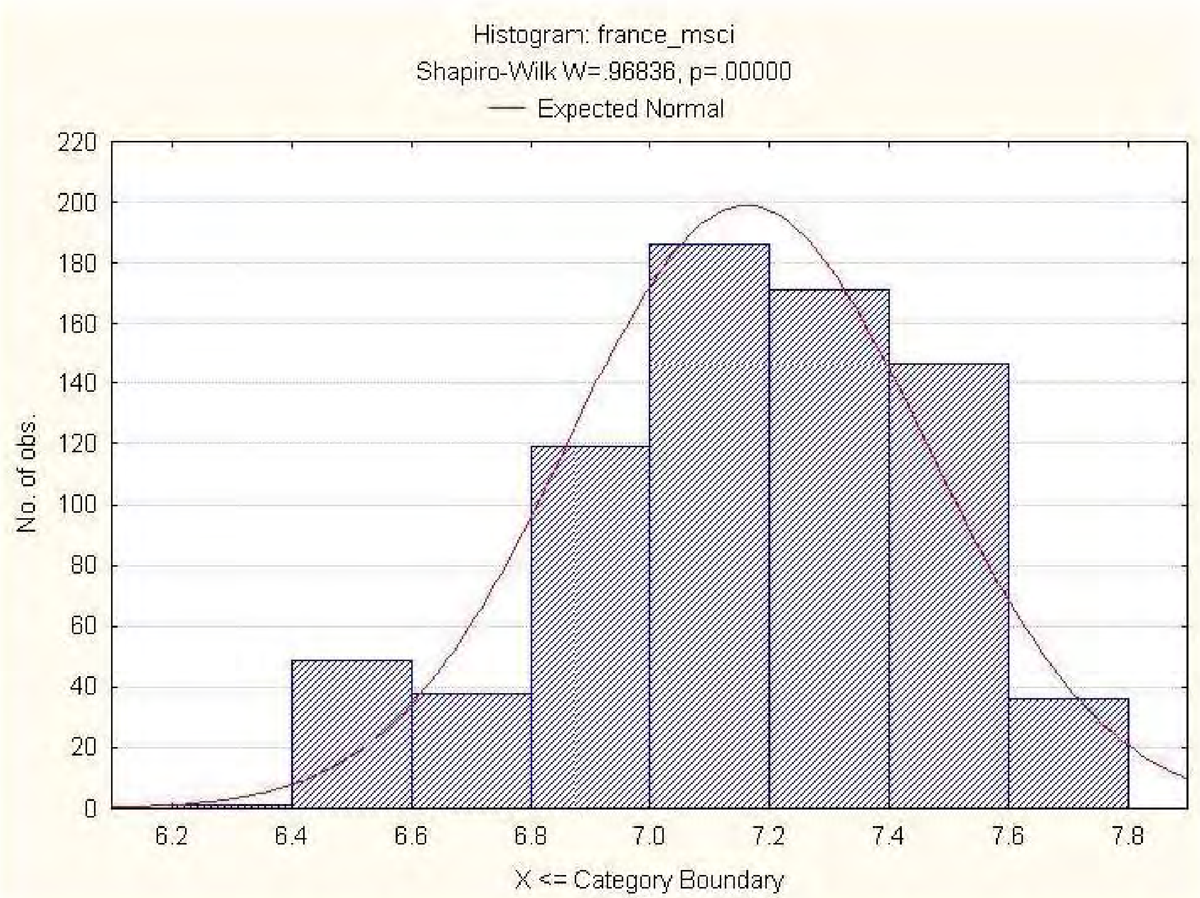
Histogram: china_shen_pi
Shapiro-Wilk W=.96788, p=.00000
Expected Normal
No. of obs.
0
50
100
150
200
250
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
X <= Category Boundary

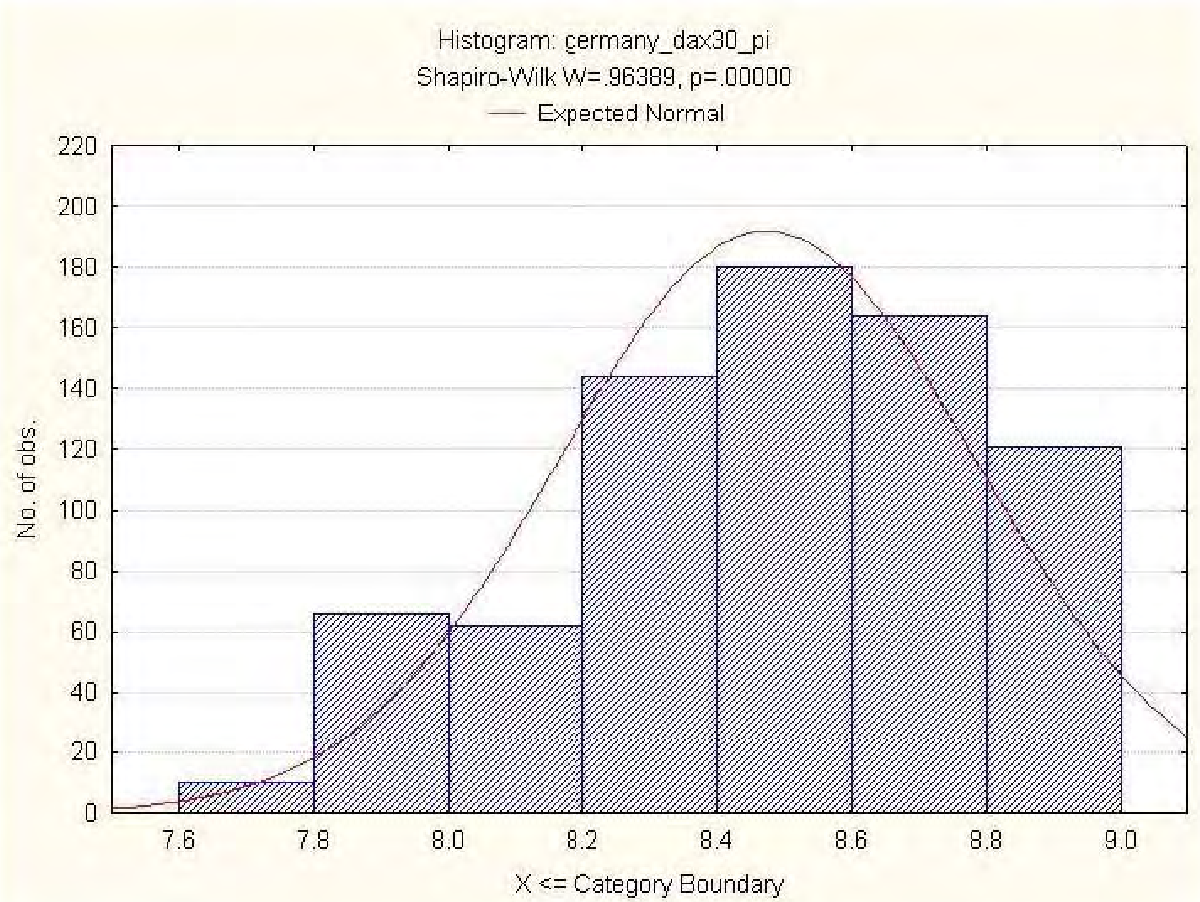

Histogram: col_msci
Shapiro-Wilk W=.84660, p=0.0000
Expected Normal
No. of obs.
X <= Category Boundary

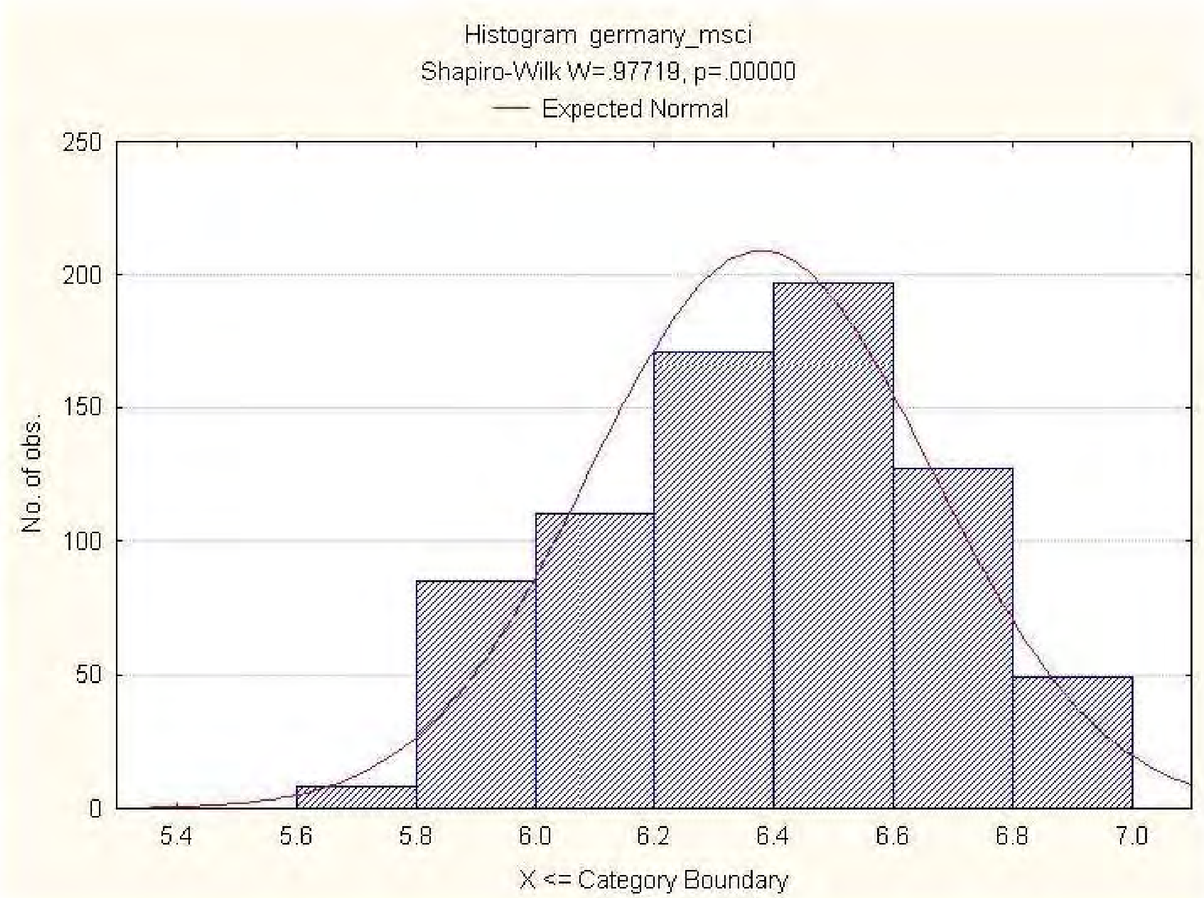

Histogram: egypt_cairo_index
Shapiro-Wilk W=.88882, p=0.0000
Expected Normal
No. of obs.
X <= Category Boundary


Histogram: egypt_msci
Shapiro-Wilk W=.86768, p=0.0000
Expected Normal
No. of obs.
250
200
150
100
50
0
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
X <= Category Boundary


Histogram: france_cac40_pi
Shapiro-Wilk W=.97263, p=.00000
Expected Normal
No. of obs.
220
200
180
160
140
120
100
80
60
40
20
0
7.4
7.6
7.8
8.0
8.2
8.4
8.6
8.8
9.0
X <= Category Boundary


Histogram: france_msci
Shapiro-Wilk W=.96836, p=.00000
Expected Normal
No. of obs.
X <= Category Boundary


Histogram: germany_dax30_pi
Shapiro-Wilk W=.96389, p=.00000
Expected Normal
No. of obs.
X <= Category Boundary


Histogram germany_msci
Shapiro-Wilk W=.97719, p=.00000
Expected Normal
No. of obs.
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200
150
100
50
0
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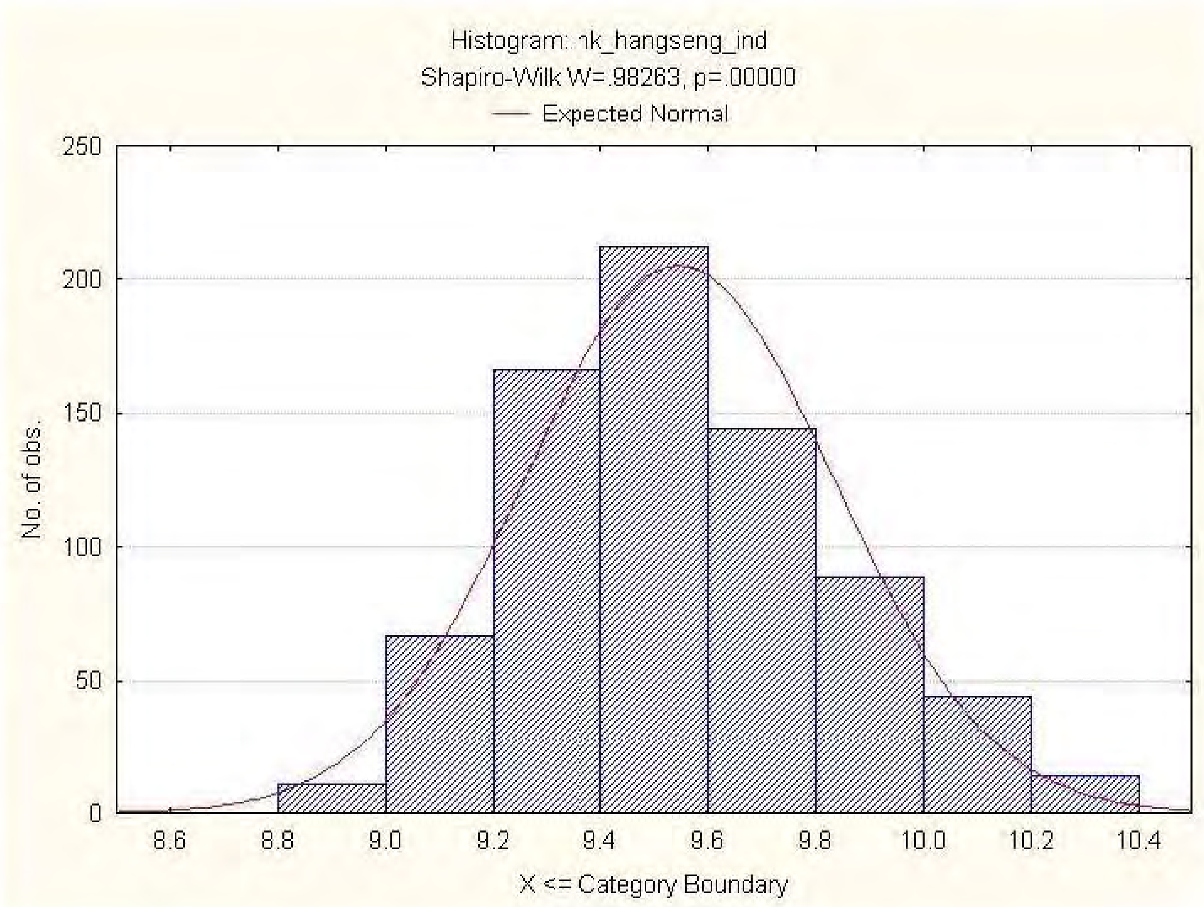
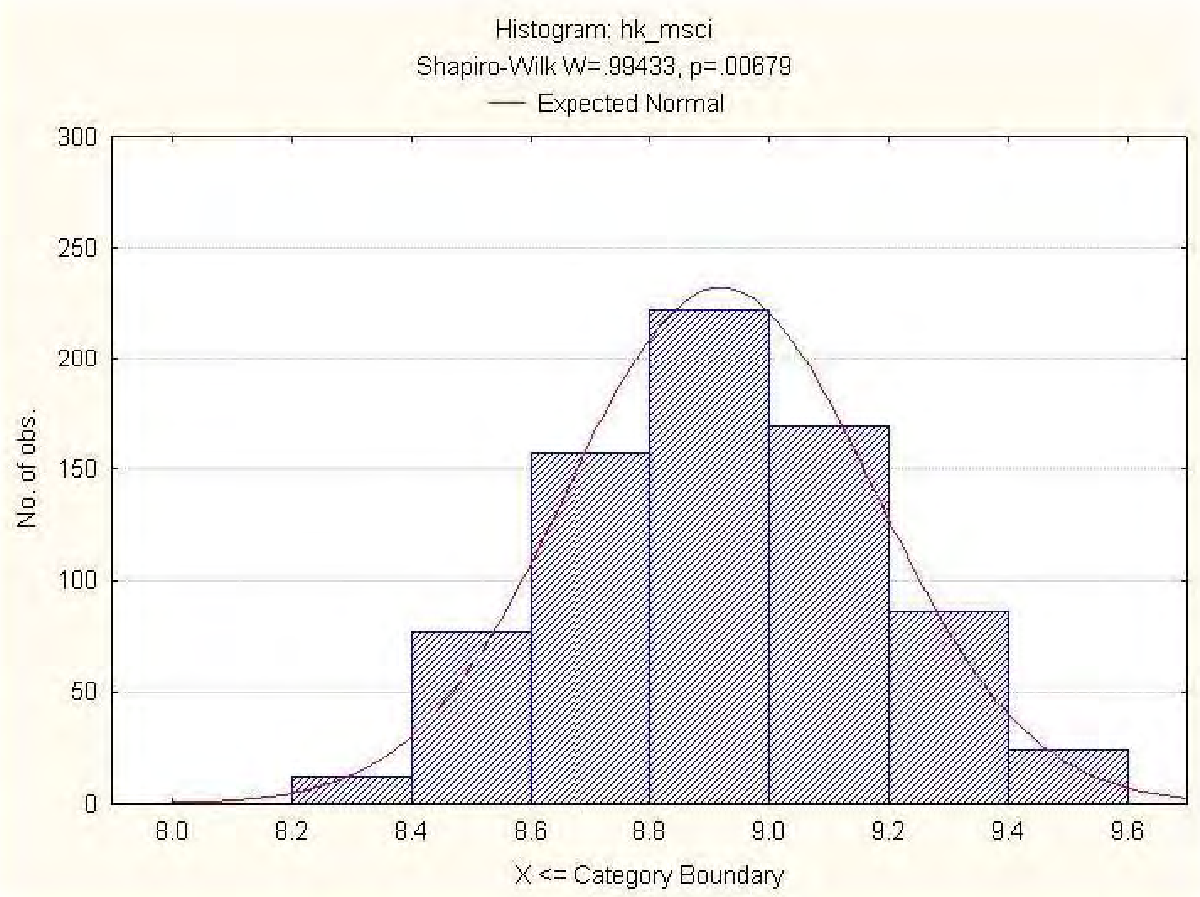
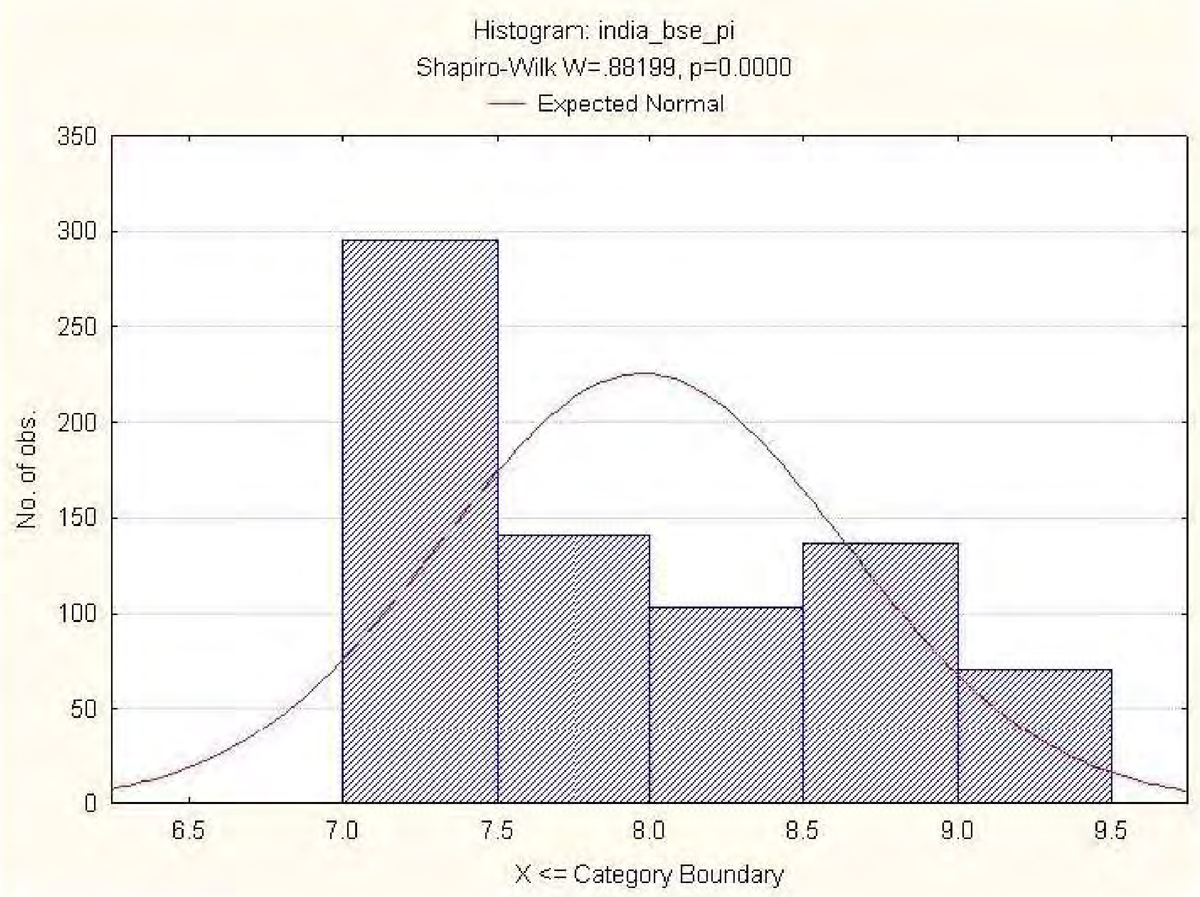
5.6
5.8
6.0
6.2
6.4
6.6
6.8
7.0
X <= Category Boundary


Histogram: hk_hangseng_ind
Shapiro-Wilk W=.98263, p=.00000
Expected Normal
No. of obs.
250
200
150
100
50
0
8.6
8.8
9.0
9.2
9.4
9.6
9.8
10.0
10.2
10.4
X <= Category Boundary


Histogram: hk_msci
Shapiro-Wilk W=.99433, p=.00679
Expected Normal
No. of obs.
X <= Category Boundary
300
250
200
150
100
50
0
8.0
8.2
8.4
8.6
8.8
9.0
9.2
9.4
9.6


Histogram: india_bse_pi
Shapiro-Wilk W=.88199, p=0.0000
Expected Normal
No. of obs.
X <= Category Boundary
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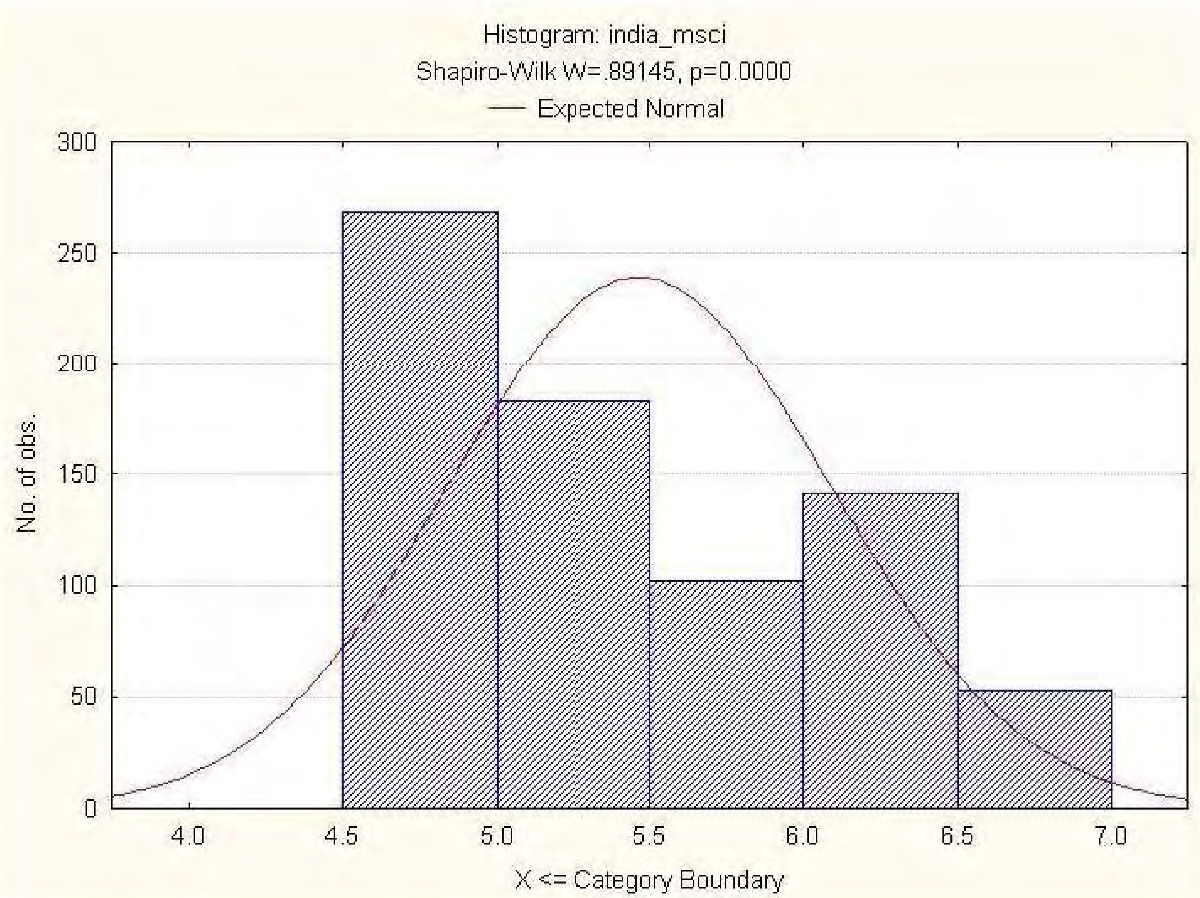
250
200
150
100
50
0
6.5
7.0
7.5
8.0
8.5
9.0
9.5


Histogram: india_msci
Shapiro-Wilk W=.89145, p=0.0000
Expected Normal
No. of obs.
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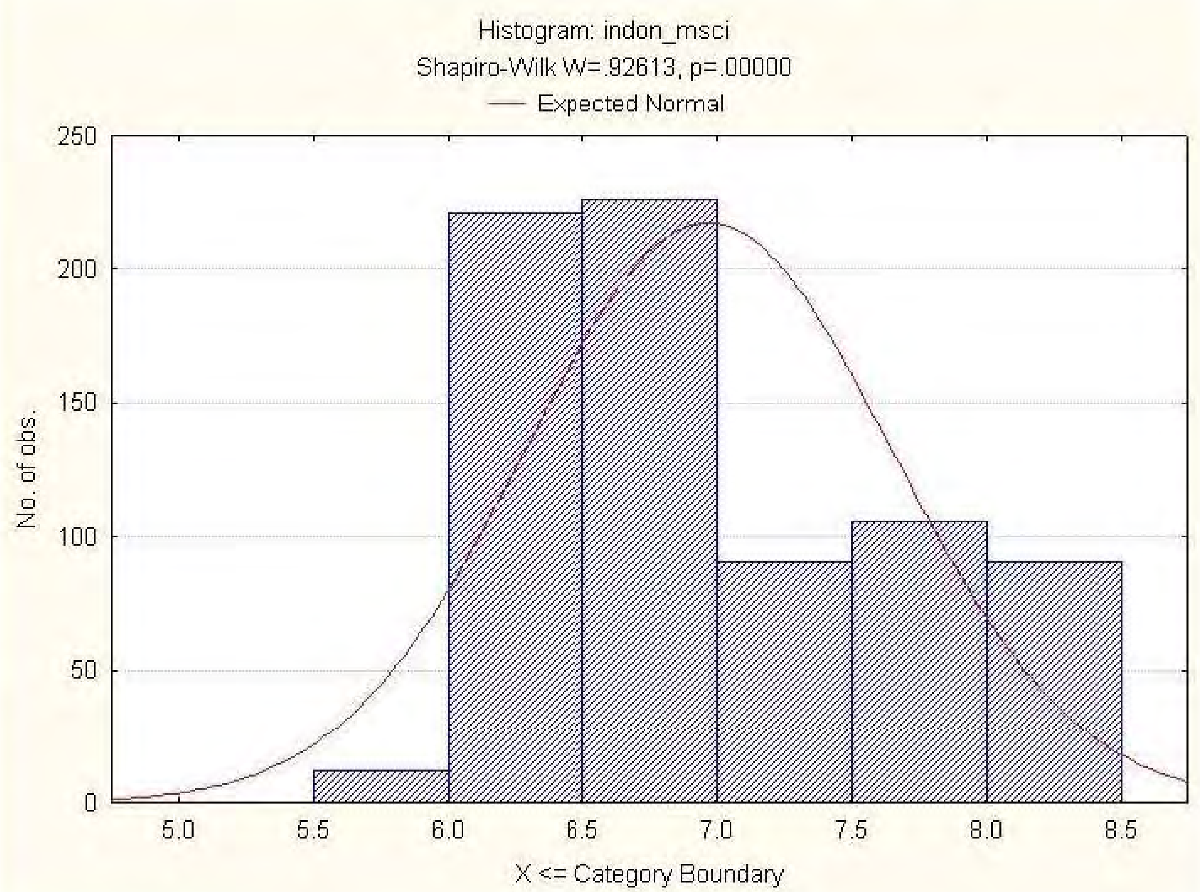
250
200
150
100
50
0
4.0
4.5
5.0
5.5
6.0
6.5
7.0
X <= Category Boundary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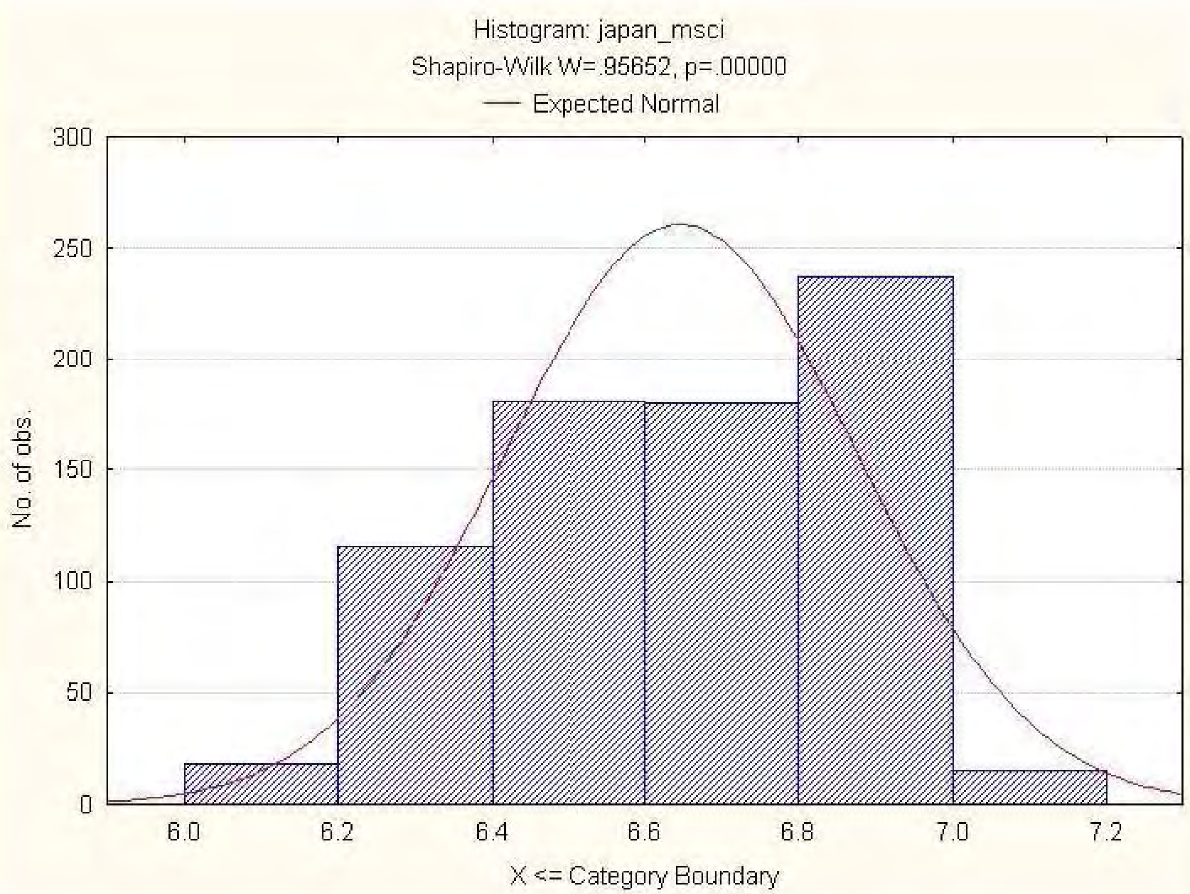
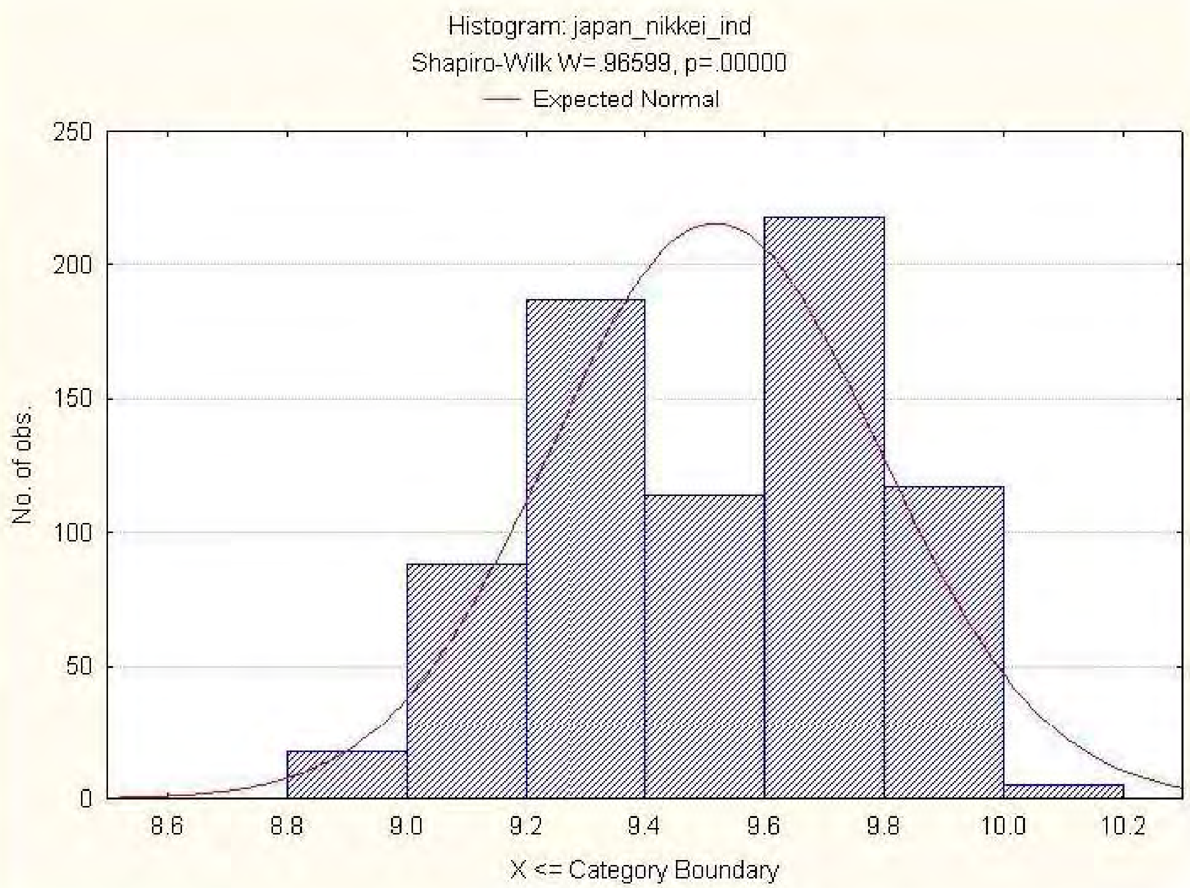
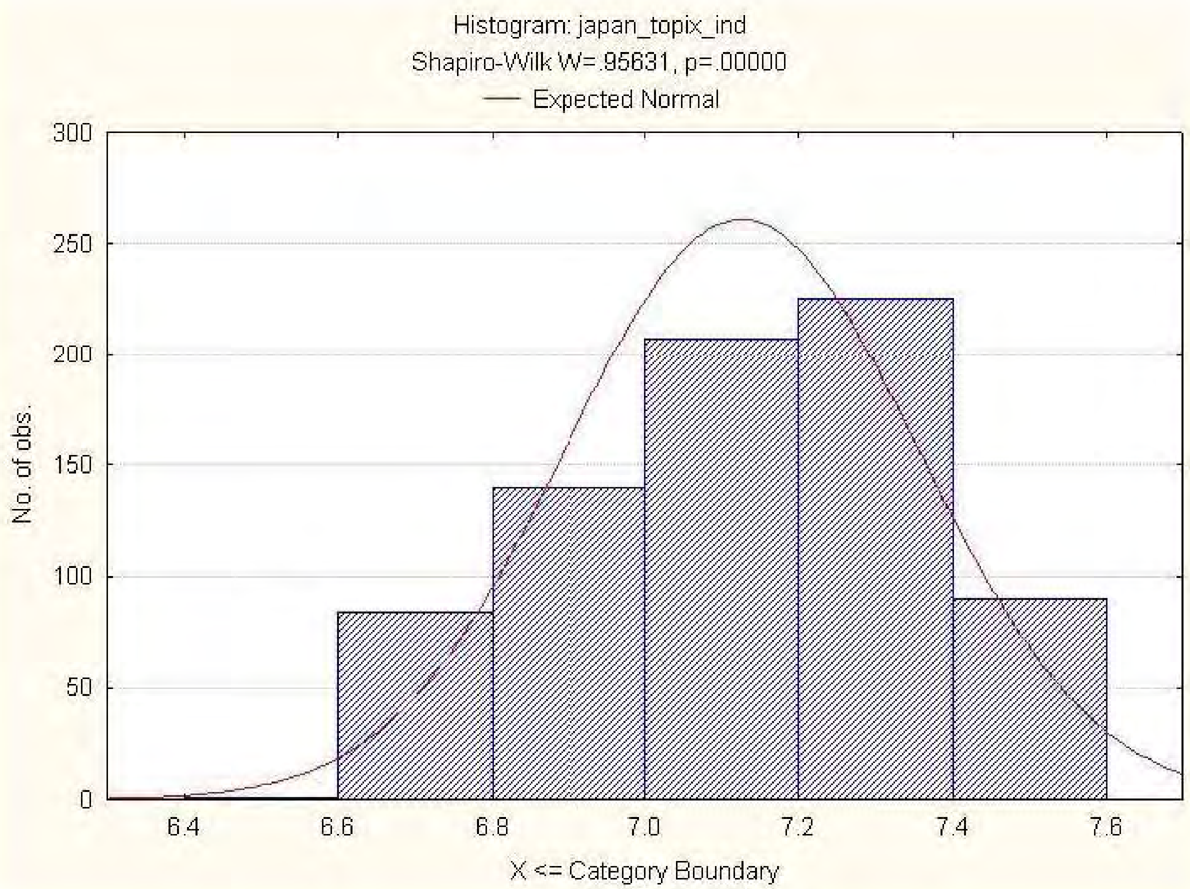
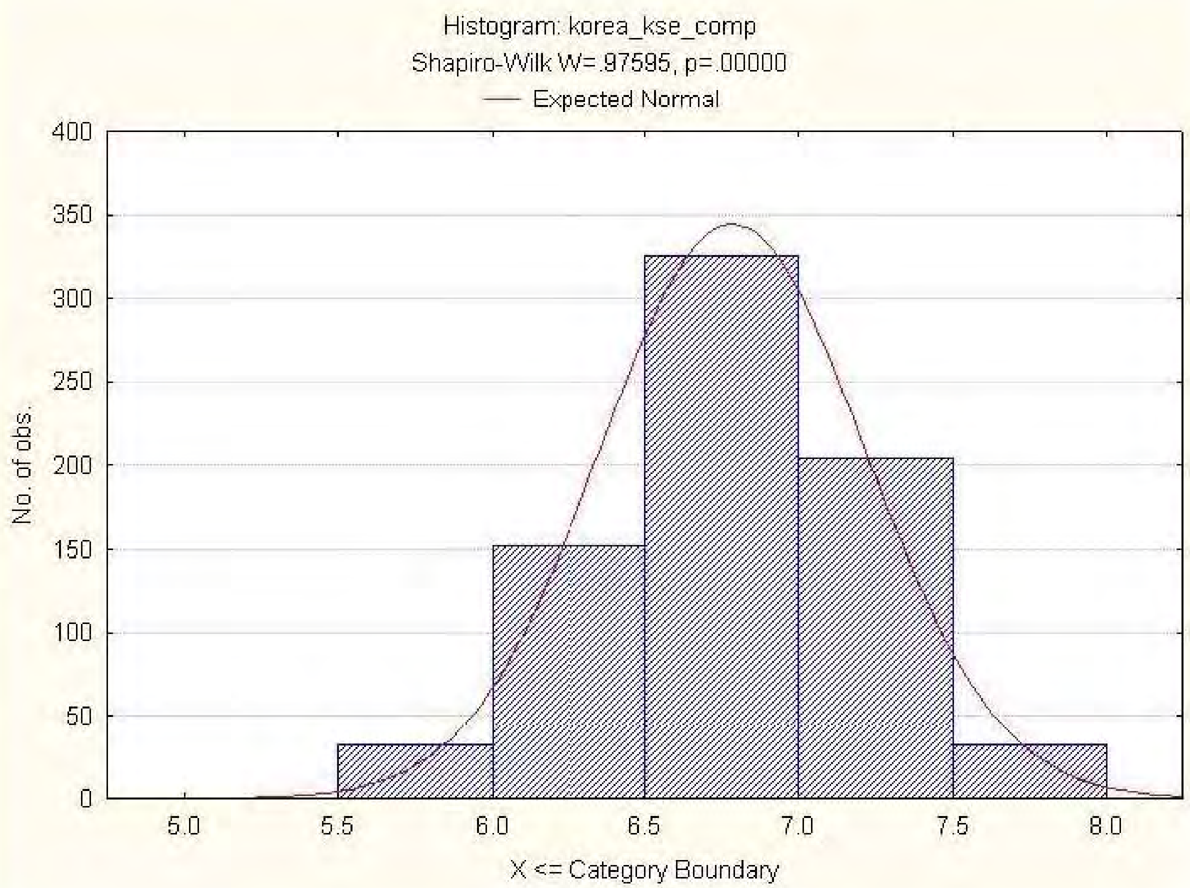
Shapiro-Wilk W=.92613, p=.00000
Expected Normal
No. of obs.
250
200
150
100
50
0
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
X <= Category Boundary


Histogram: japan_msci
Shapiro-Wilk W=.95652, p=.00000
Expected Normal
No. of obs.
300
250
200
150
100
50
0
6.0
6.2
6.4
6.6
6.8
7.0
7.2
X <= Category Boundary


Histogram: japan_nikkei_ind
Shapiro-Wilk W=.96599, p=.00000
Expected Normal
No. of obs.
250
200
150
100
50
0
8.6
8.8
9.0
9.2
9.4
9.6
9.8
10.0
10.2
X <= Category Boundary


Histogram: japan_topix_ind
Shapiro-Wilk W=.95631, p=.00000
Expected Normal
No. of obs.
300
250
200
150
100
50
0
6.4
6.6
6.8
7.0
7.2
7.4
7.6
X <= Category Boundary


Histogram: korea_kse_comp
Shapiro-Wilk W=.97595, p=.00000
Expected Normal
No. of obs.
400
350
300
250
200
150
100
50
0
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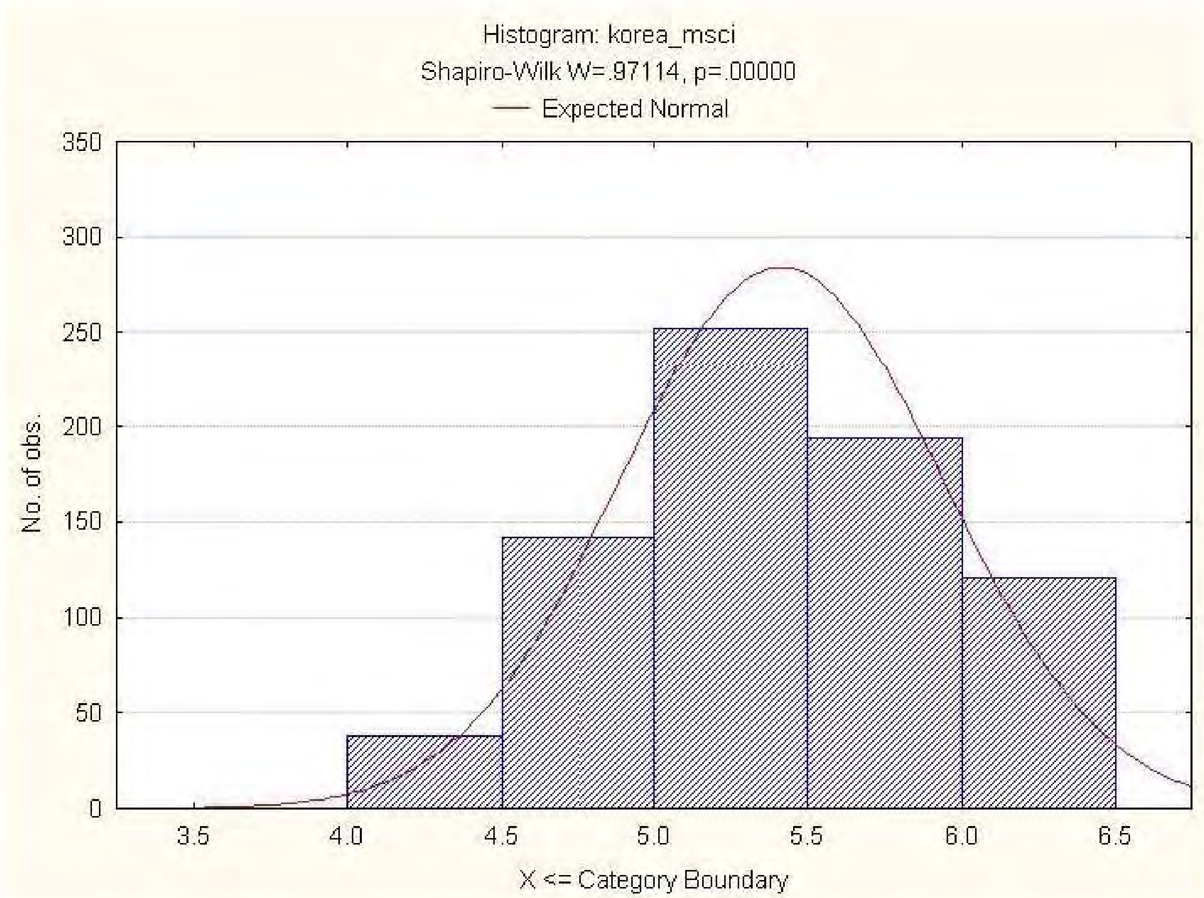
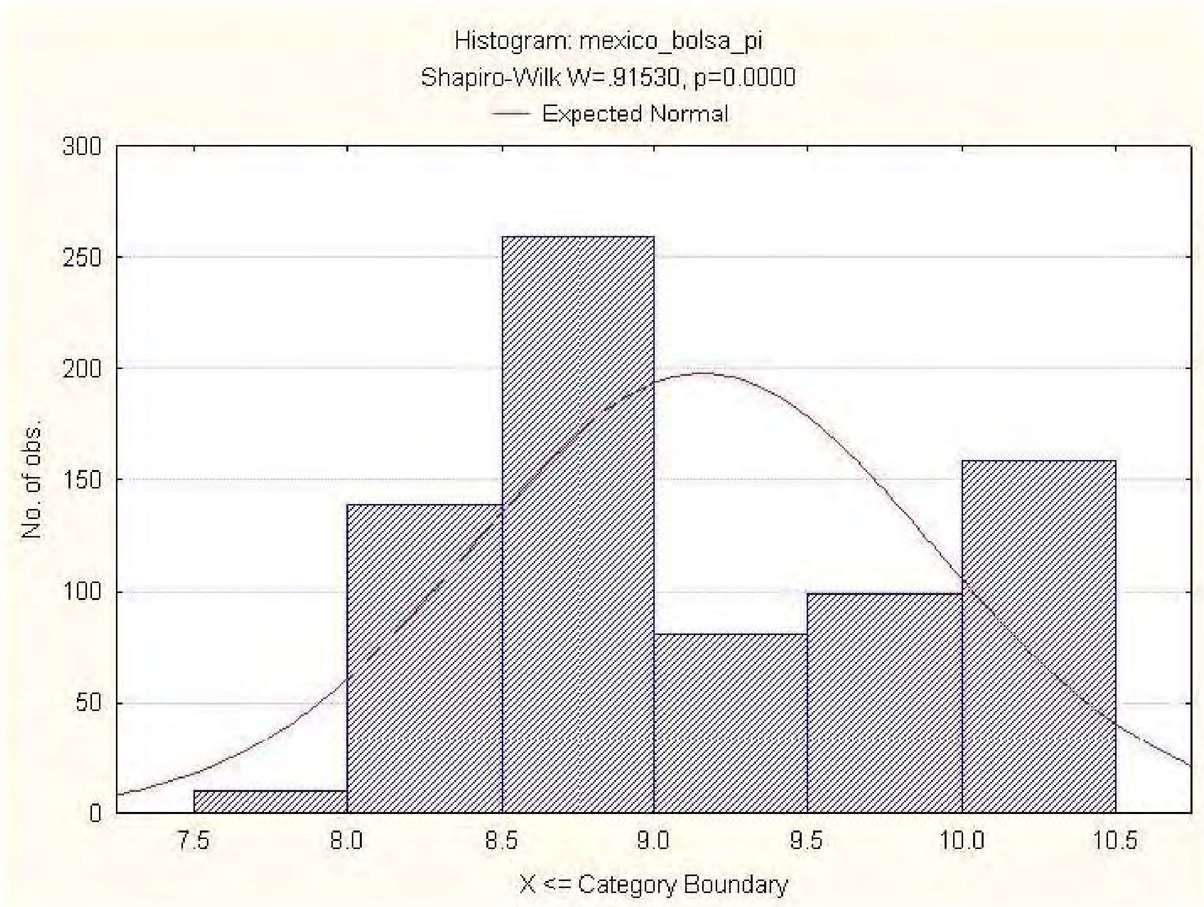
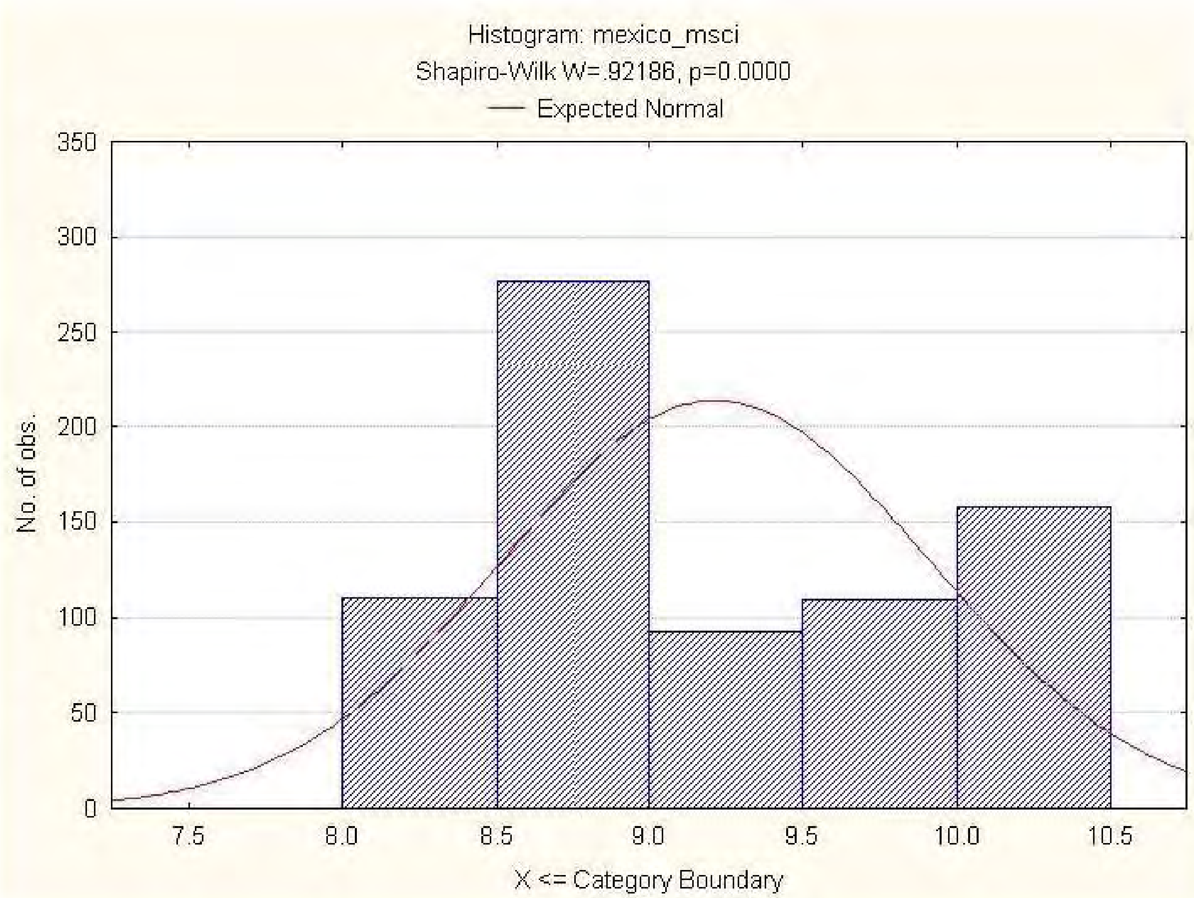
5.5
6.0
6.5
7.0
7.5
8.0
X <= Category Boundary

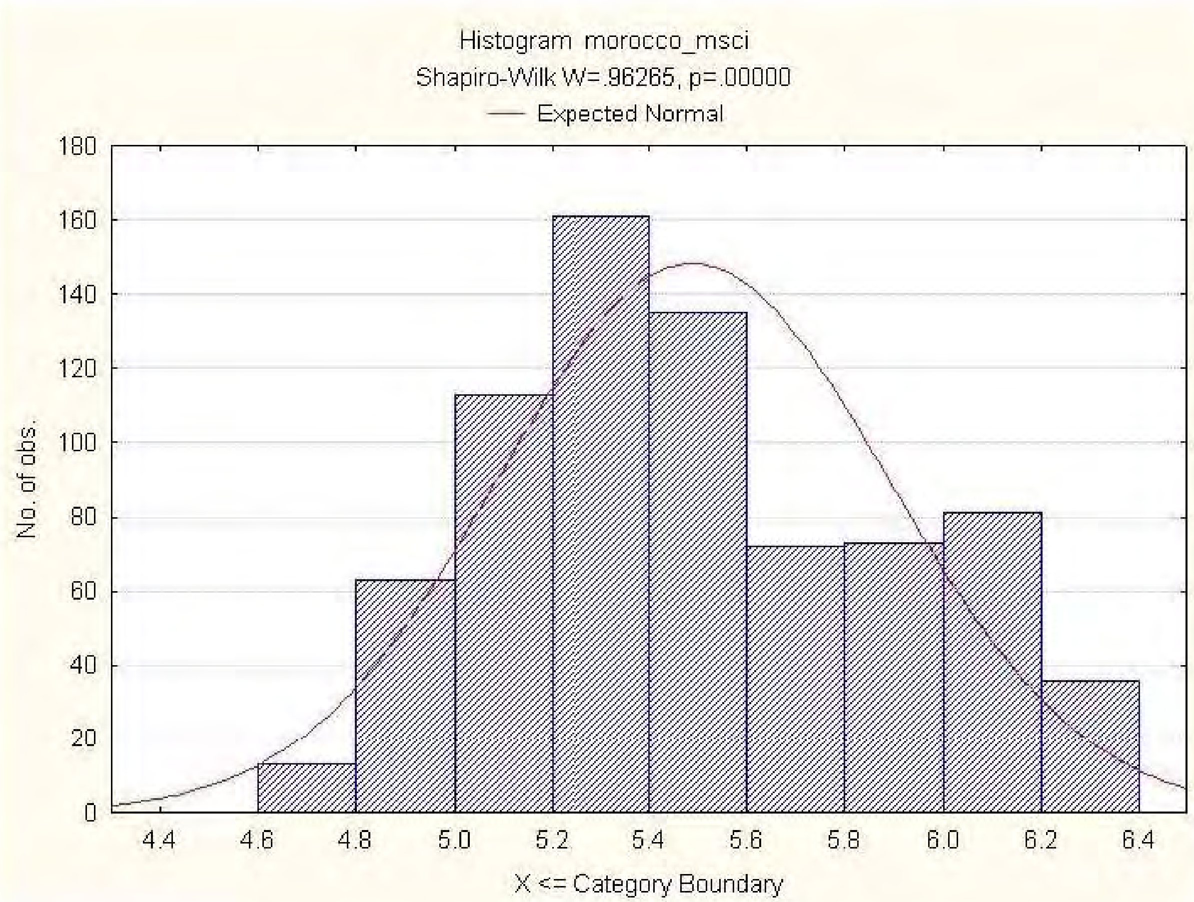


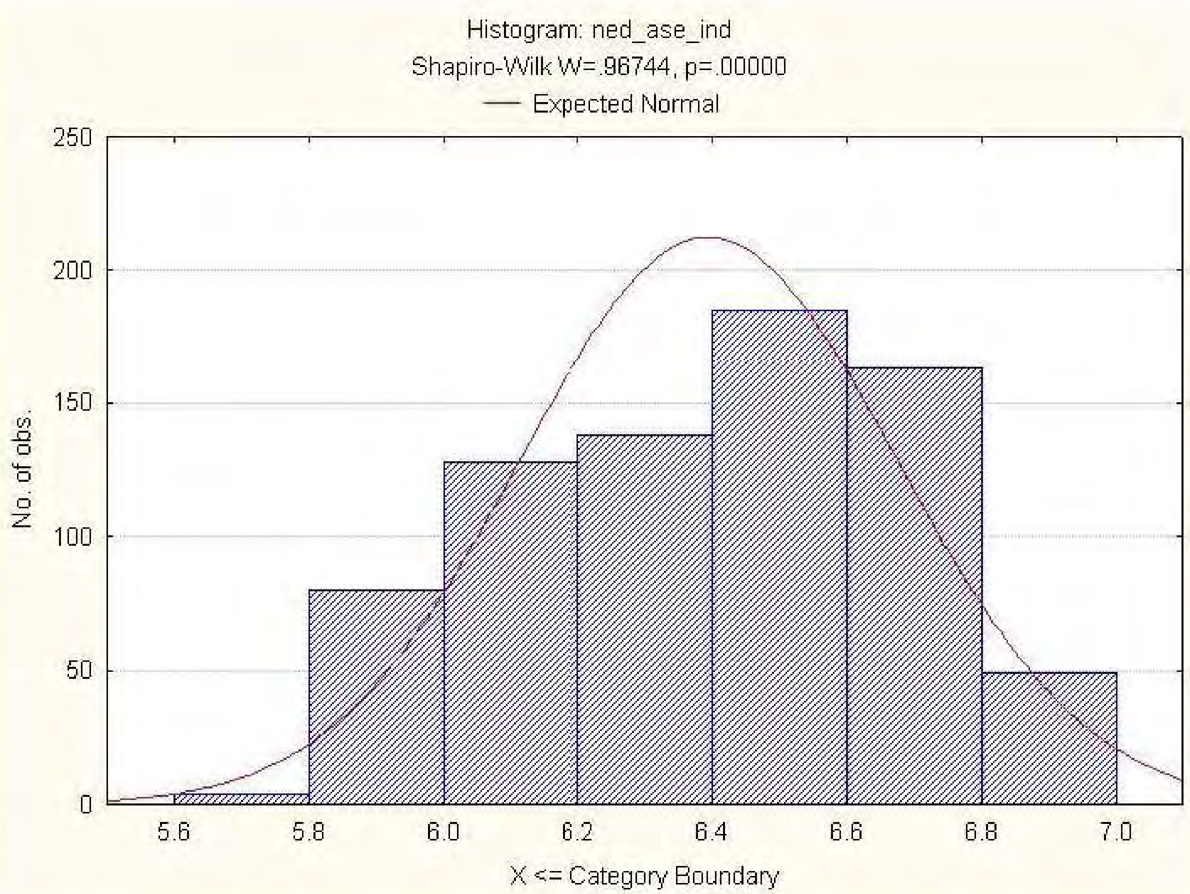
Histogram: korea_msci
Shapiro-Wilk W=.97114, p=.00000
Expected Normal
No. of obs.
0
50
100
150
200
250
300
350
3.5
4.0
4.5
5.0
5.5
6.0
6.5
X <= Category Boundary



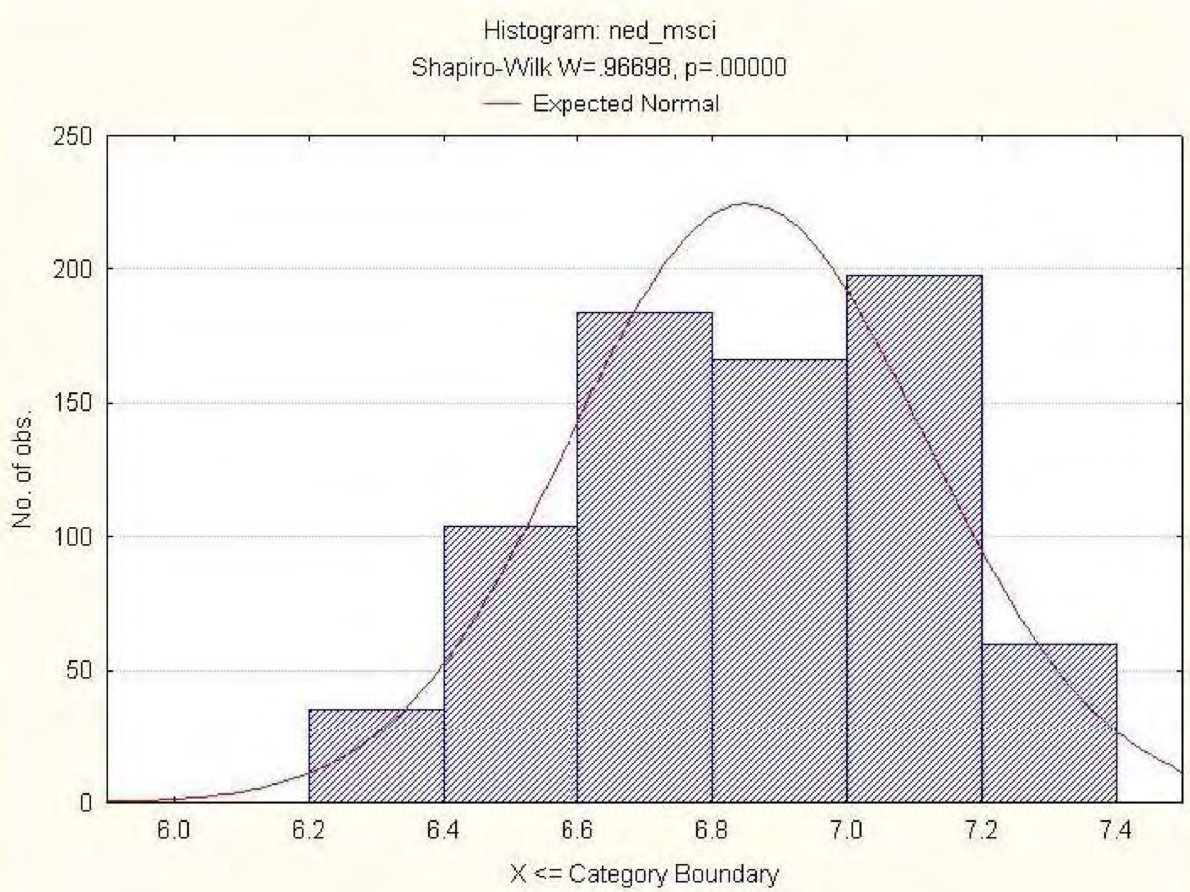
Histogram: mexico_bolsa_pi
Shapiro-Wilk W=.91530, p=0.0000
Expected Normal
No. of obs.
0
50
100
150
200
250
300
7.5
8.0
8.5
9.0
9.5
10.0
10.5
X <= Category Boundary


Histogram: mexico_msci
Shapiro-Wilk W=.92186, p=0.0000
Expected Normal
No. of obs.
X <= Category Boundary
0
50
100
150
200
250
300
350
7.5
8.0
8.5
9.0
9.5
10.0
10.5

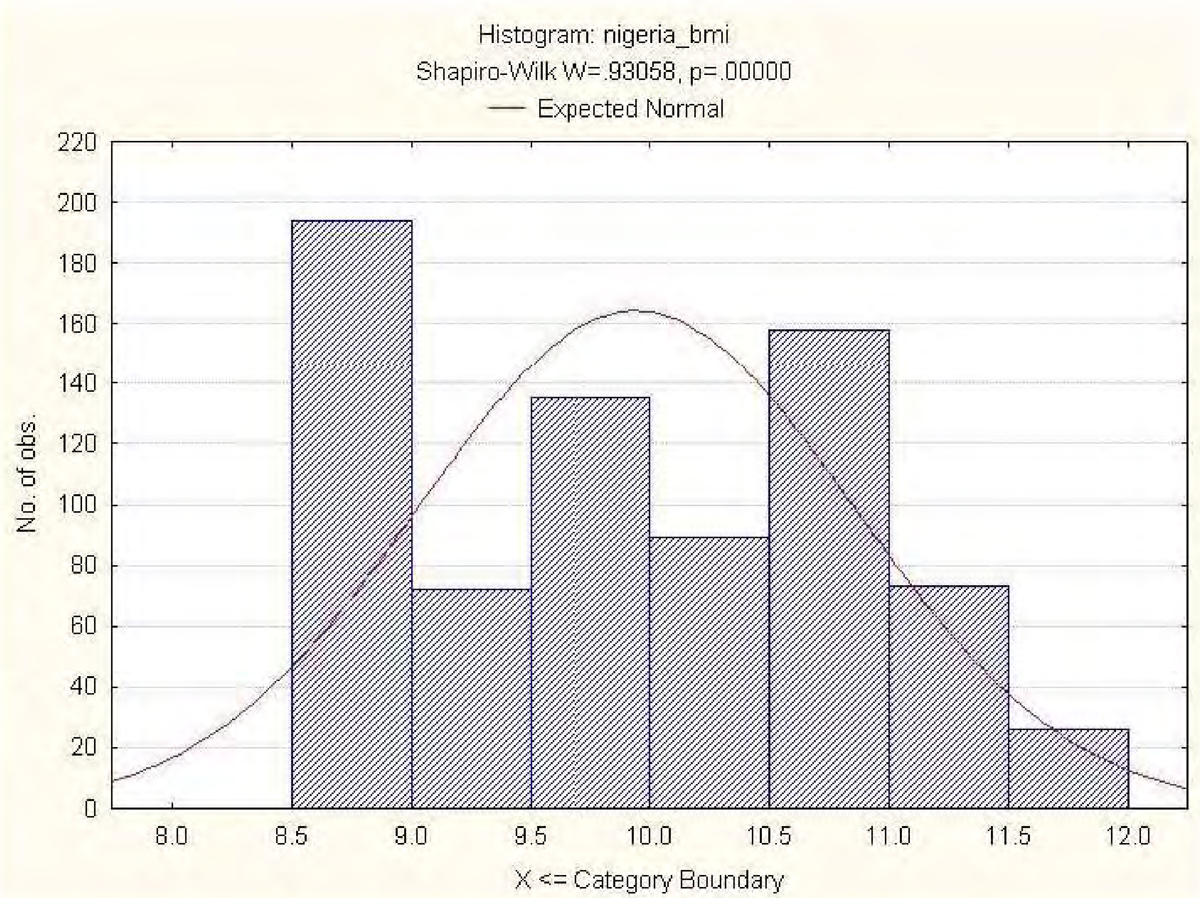

Histogram: morocco_msci
Shapiro-Wilk W=.96265, p=.00000
Expected Normal
No. of obs.
X <= Category Boundary
0
20
40
60
80
100
120
140
160
180
4.4
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
6.2
6.4



Histogram: ned_ase_ind
Shapiro-Wilk W=.96744, p=.00000
Expected Normal
250
200
150
100
50
0
No. of obs.
5.6
5.8
6.0
6.2
6.4
6.6
6.8
7.0
X <= Category Boundary



Histogram: ned_msci
Shapiro-Wilk W=.96698, p=.00000
Expected Normal
250
200
150
100
50
0
No. of obs.
6.0
6.2
6.4
6.6
6.8
7.0
7.2
7.4
X <= Category Boundary


Histogram: nigeria_bmi
Shapiro-Wilk W=.93058, p=.00000
Expected Normal
No. of obs.
X <= Category Boundary
0
20
40
60
80
100
120
140
160
180
200
220
8.0
8.5
9.0
9.5
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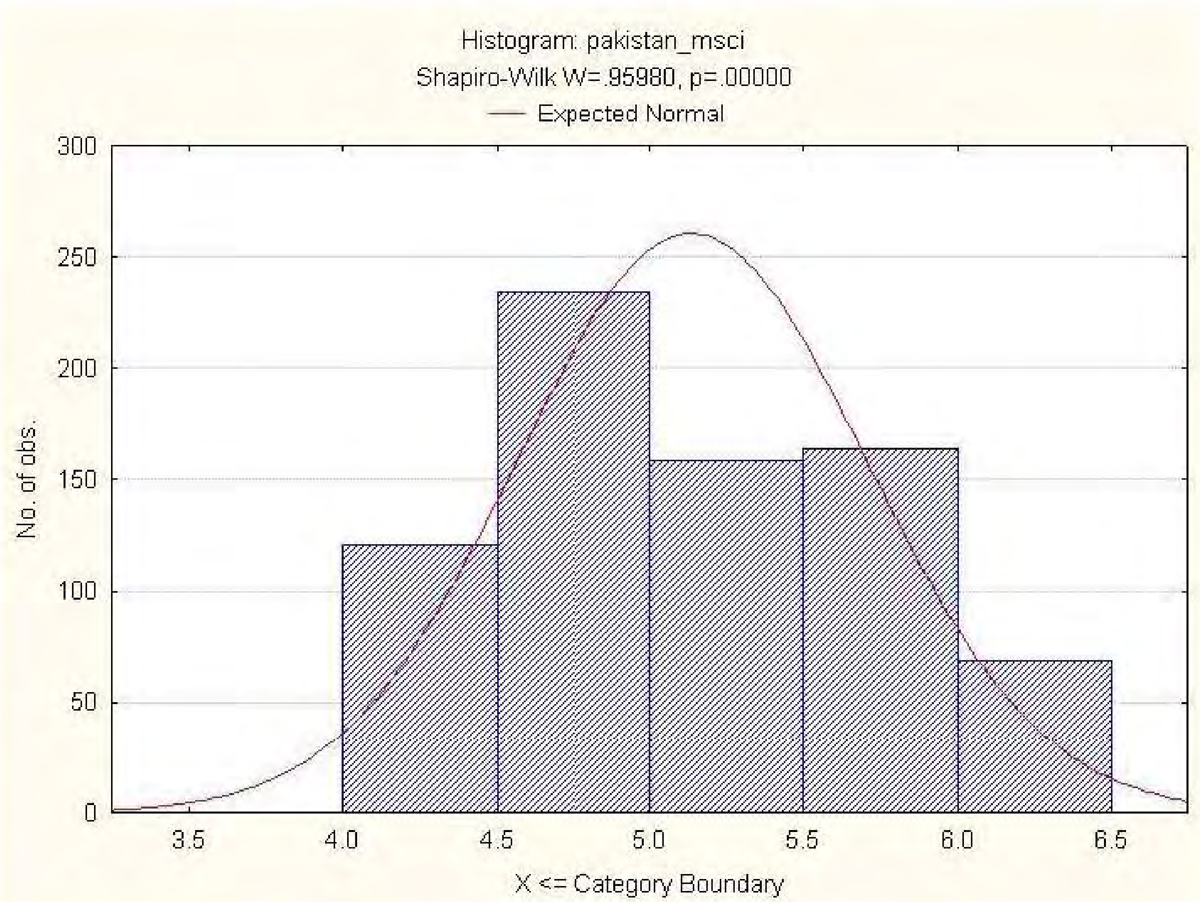
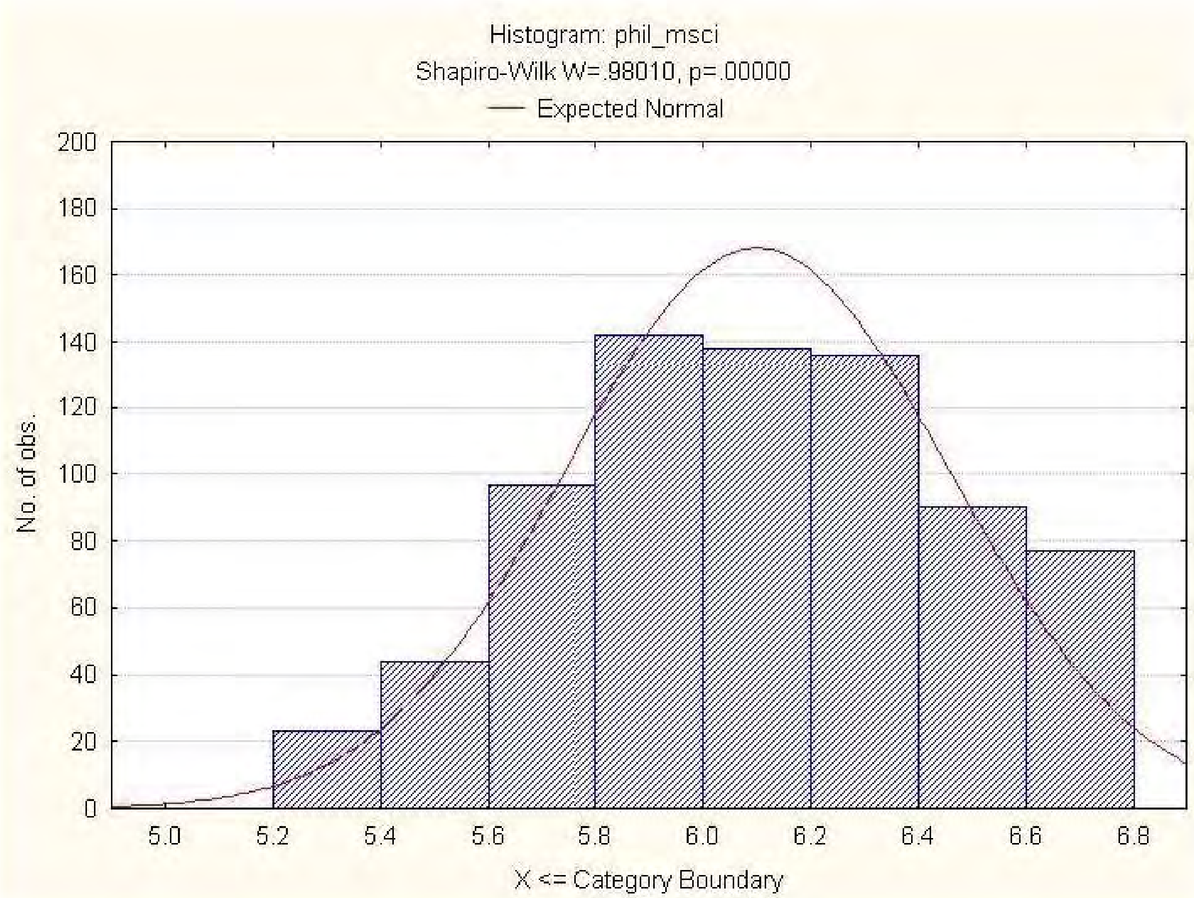
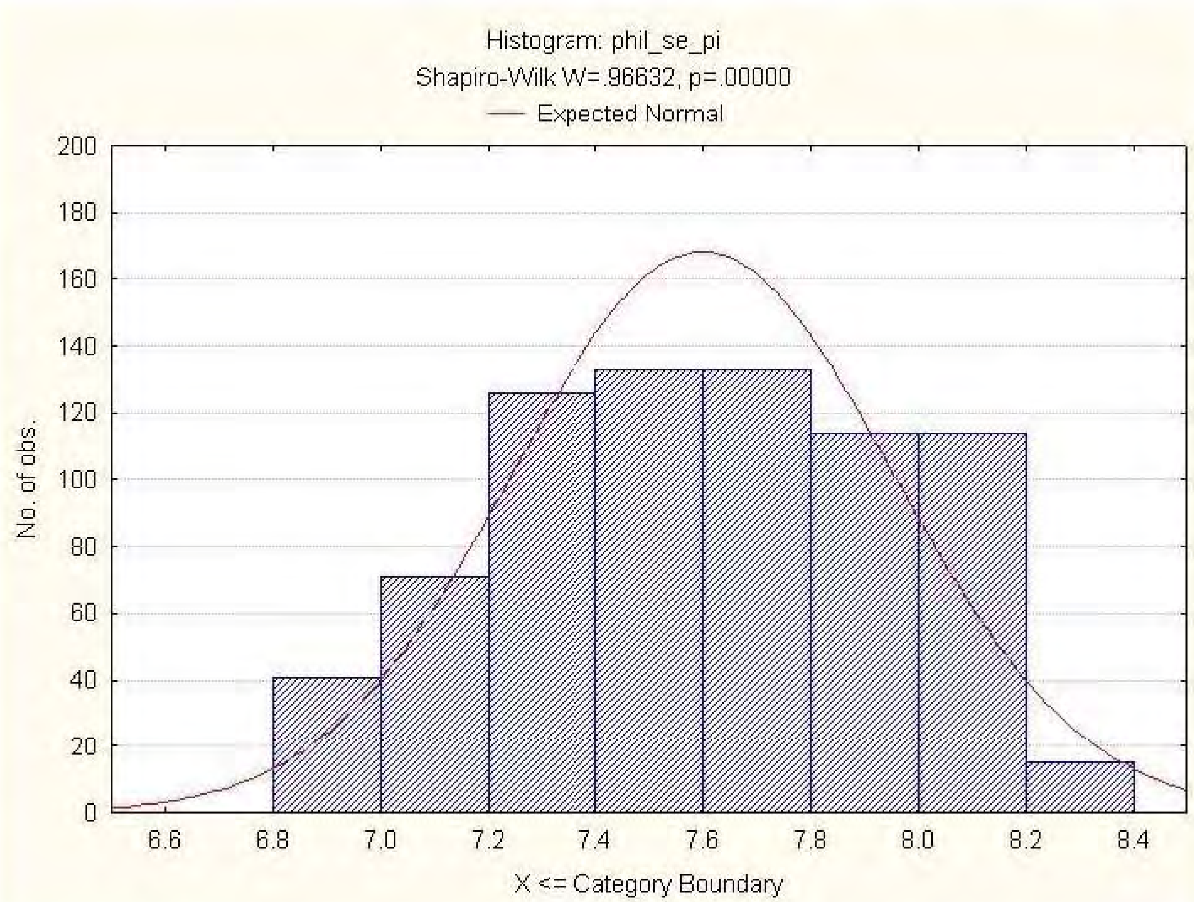
11.0
11.5
12.0

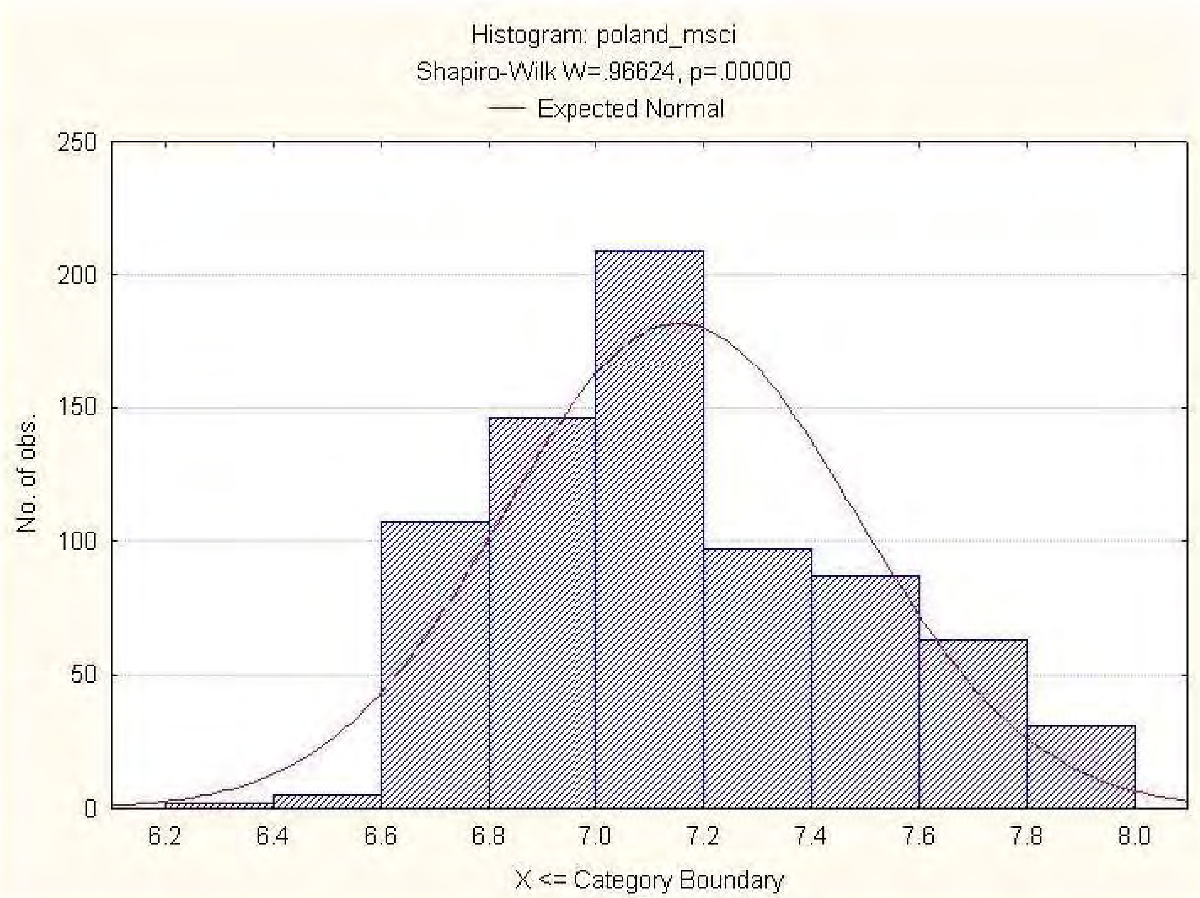

Histogram: pakistan_msci
Shapiro-Wilk W=.95980, p=.00000
Expected Normal
No. of obs.
X <= Category Boundary
0
50
100
150
200
250
300
3.5
4.0
4.5
5.0
5.5
6.0
6.5

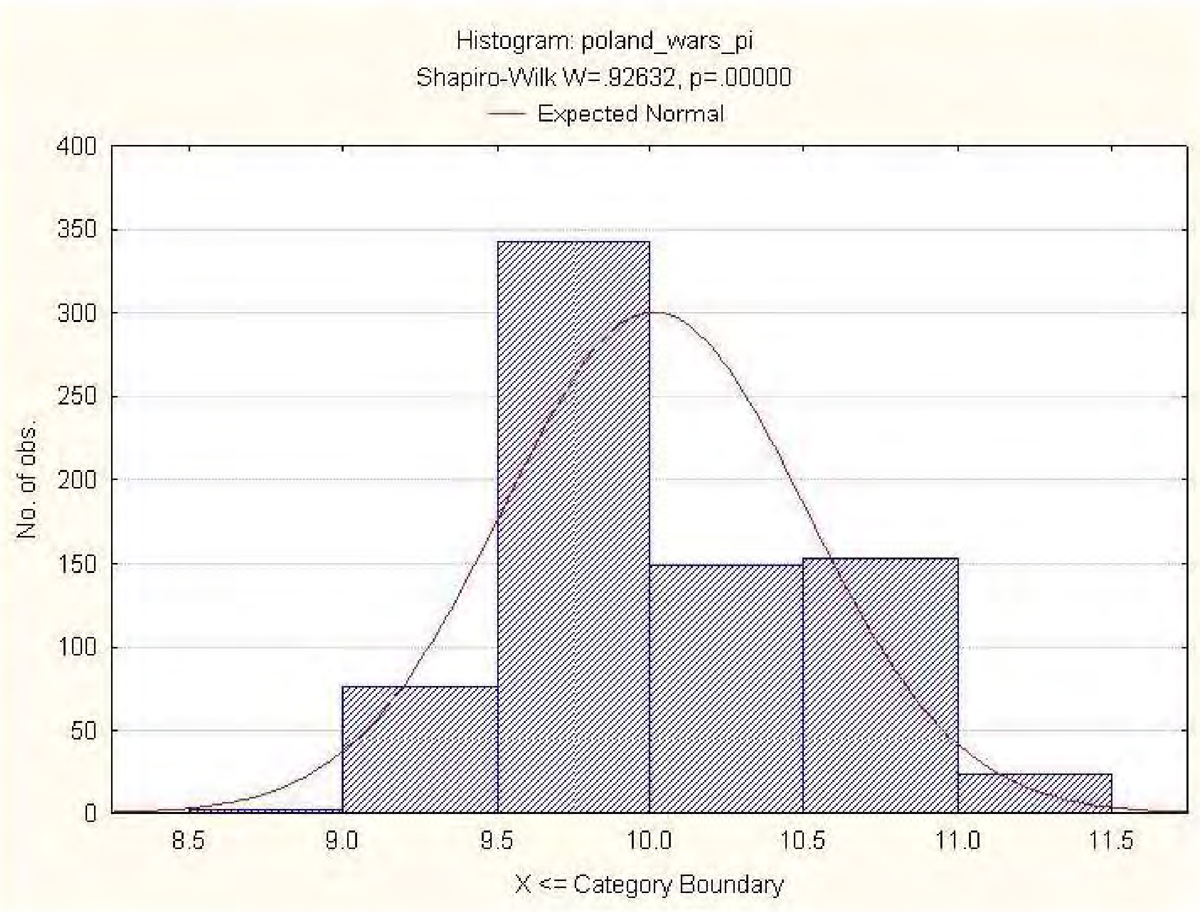


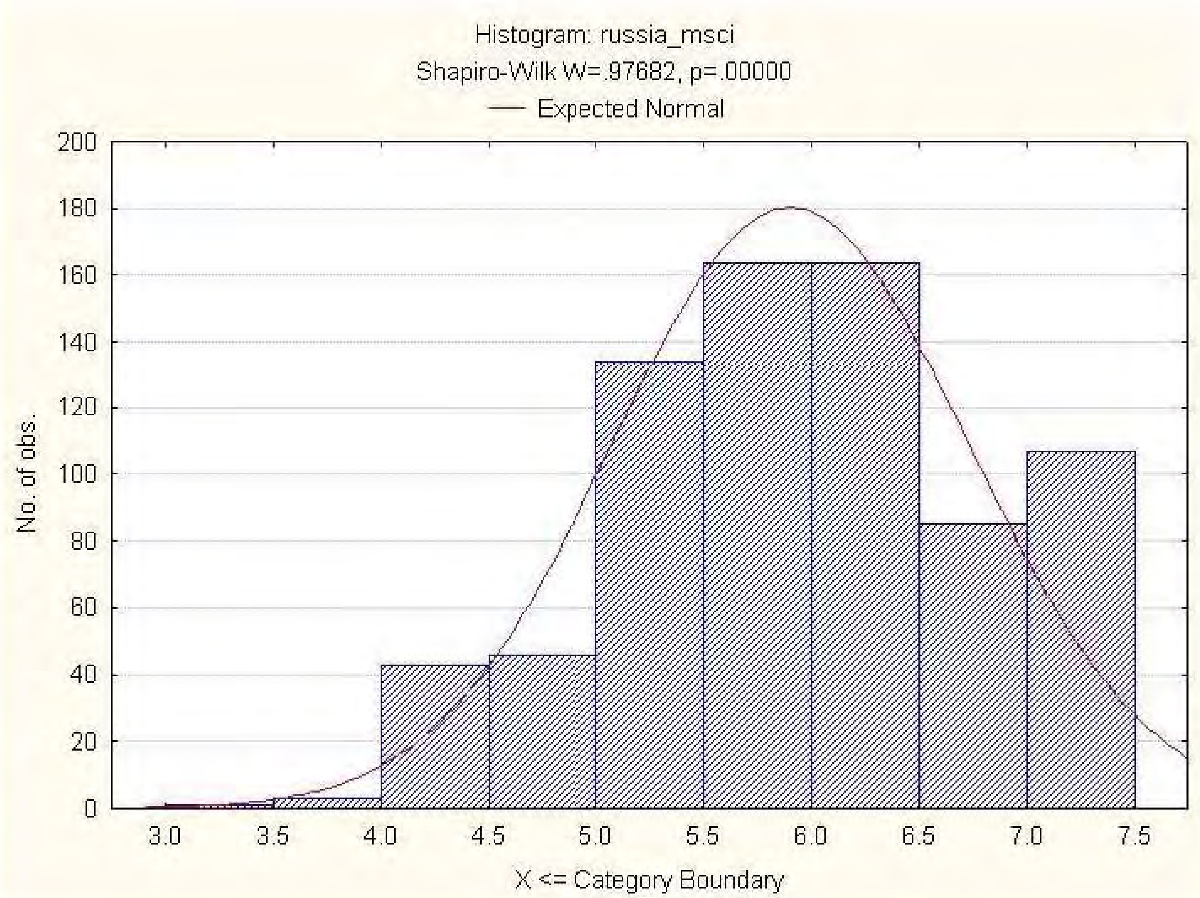
Histogram: phil_msci
Shapiro-Wilk W=.98010, p=.00000
Expected Normal
No. of obs.
0
20
40
60
80
100
120
140
160
180
200
5.0
5.2
5.4
5.6
5.8
6.0
6.2
6.4
6.6
6.8
X <= Category Boundary

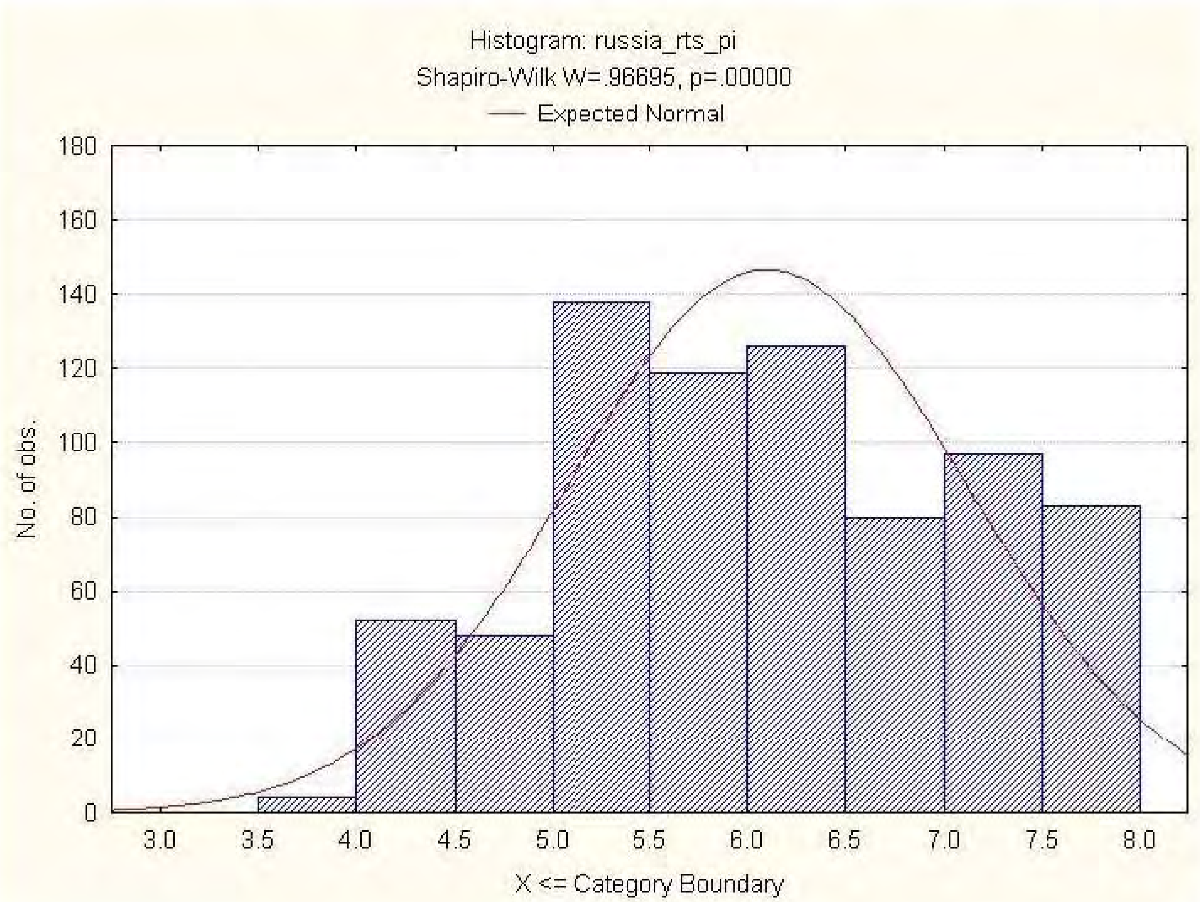


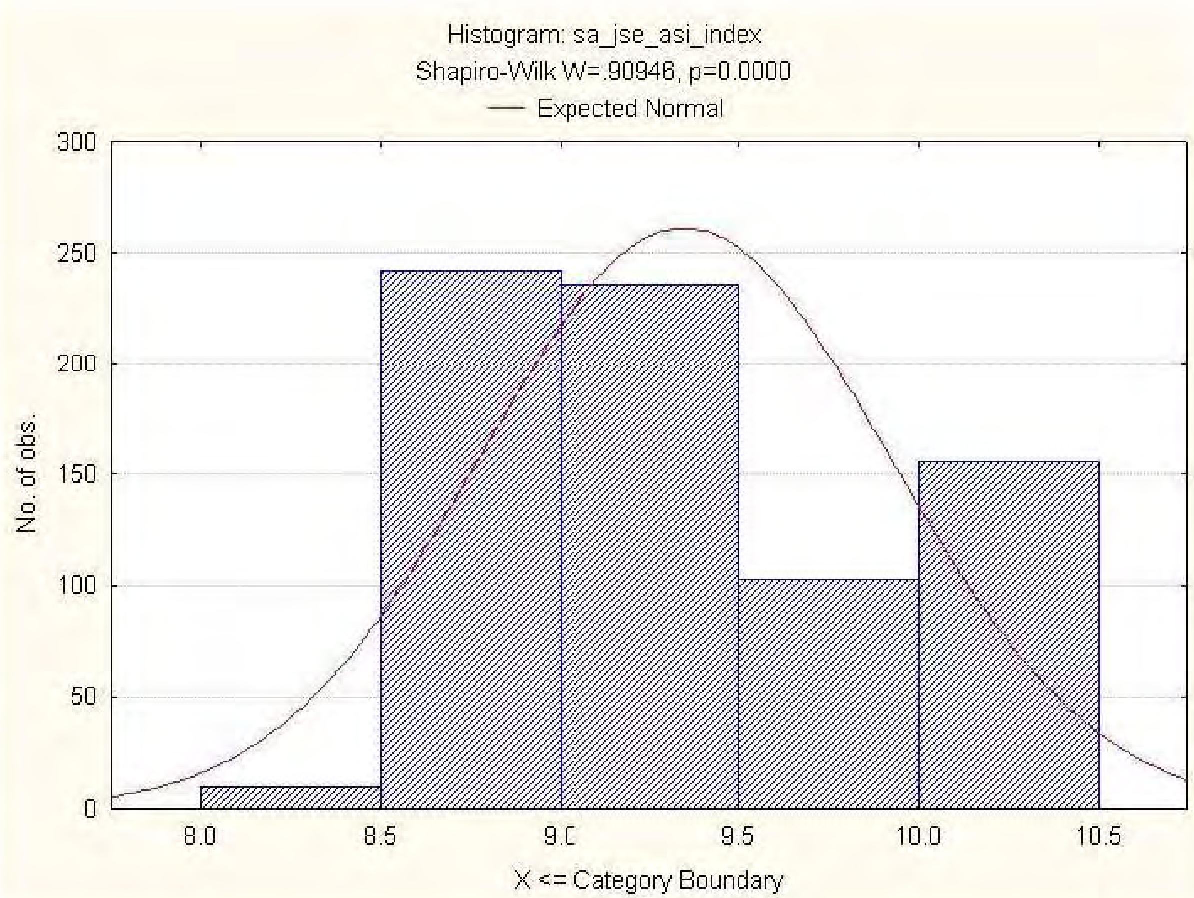
Histogram: phil_se_pi
Shapiro-Wilk W=.96632, p=.00000
Expected Normal
No. of obs.
0
20
40
60
80
100
120
140
160
180
200
6.6
6.8
7.0
7.2
7.4
7.6
7.8
8.0
8.2
8.4
X <= Category Boundary


Histogram: poland_msci
Shapiro-Wilk W=.96624, p=.00000
Expected Normal
250
200
150
100
50
0
No. of obs.
6.2
6.4
6.6
6.8
7.0
7.2
7.4
7.6
7.8
8.0
X <= Category Boundary

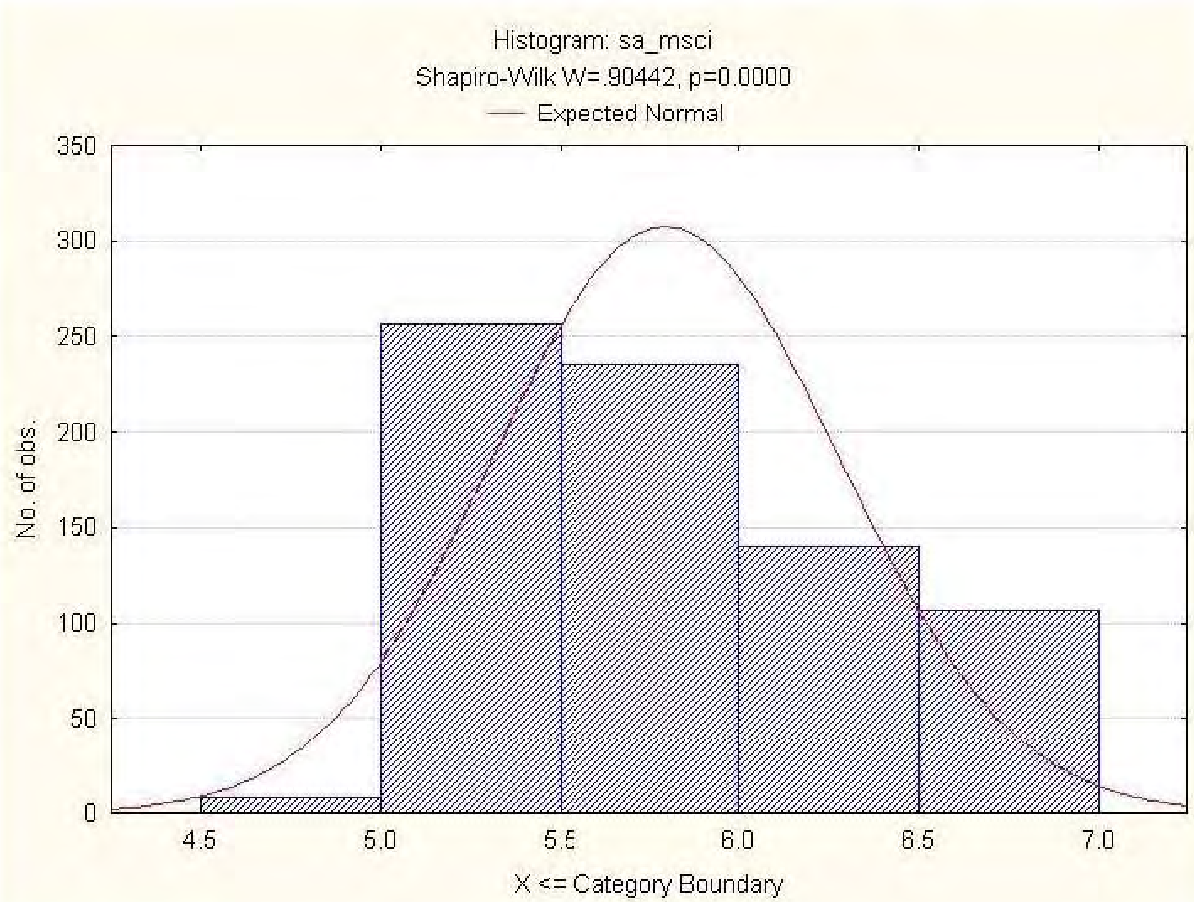

Histogram: poland_wars_pi
Shapiro-Wilk W=.92632, p=.00000
Expected Normal
400
350
300
250
200
150
100
50
0
No. of obs.
8.5
9.0
9.5
10.0
10.5
11.0
11.5
X <= Category Boundary


Histogram: russia_msci
Shapiro-Wilk W=.97682, p=.00000
Expected Normal
No. of obs.
200
180
160
140
120
100
80
60
40
20
0
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
X <= Category Boundary

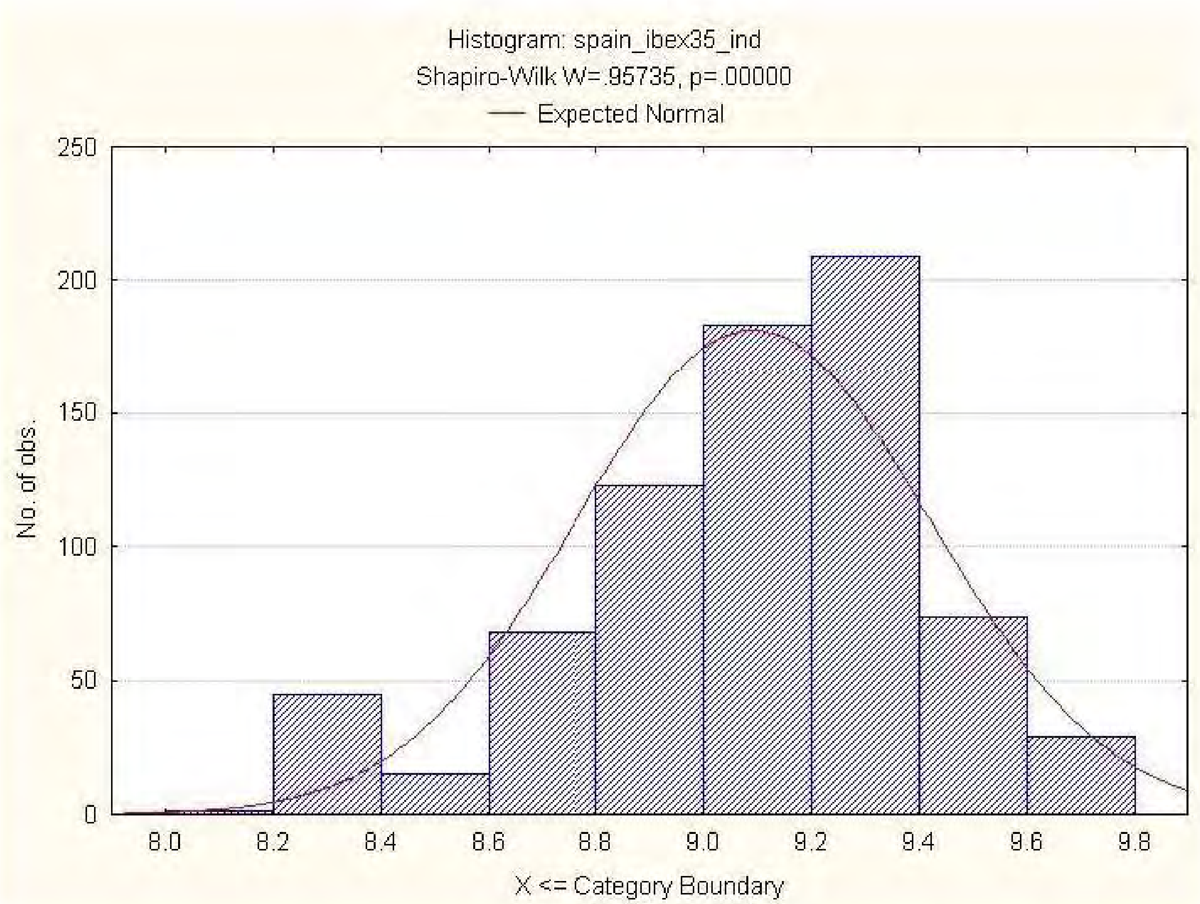

Histogram: russia_rts_pi
Shapiro-Wilk W=.96695, p=.00000
Expected Normal
No. of obs.
180
160
140
120
100
80
60
40
20
0
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
X <= Category Boundary

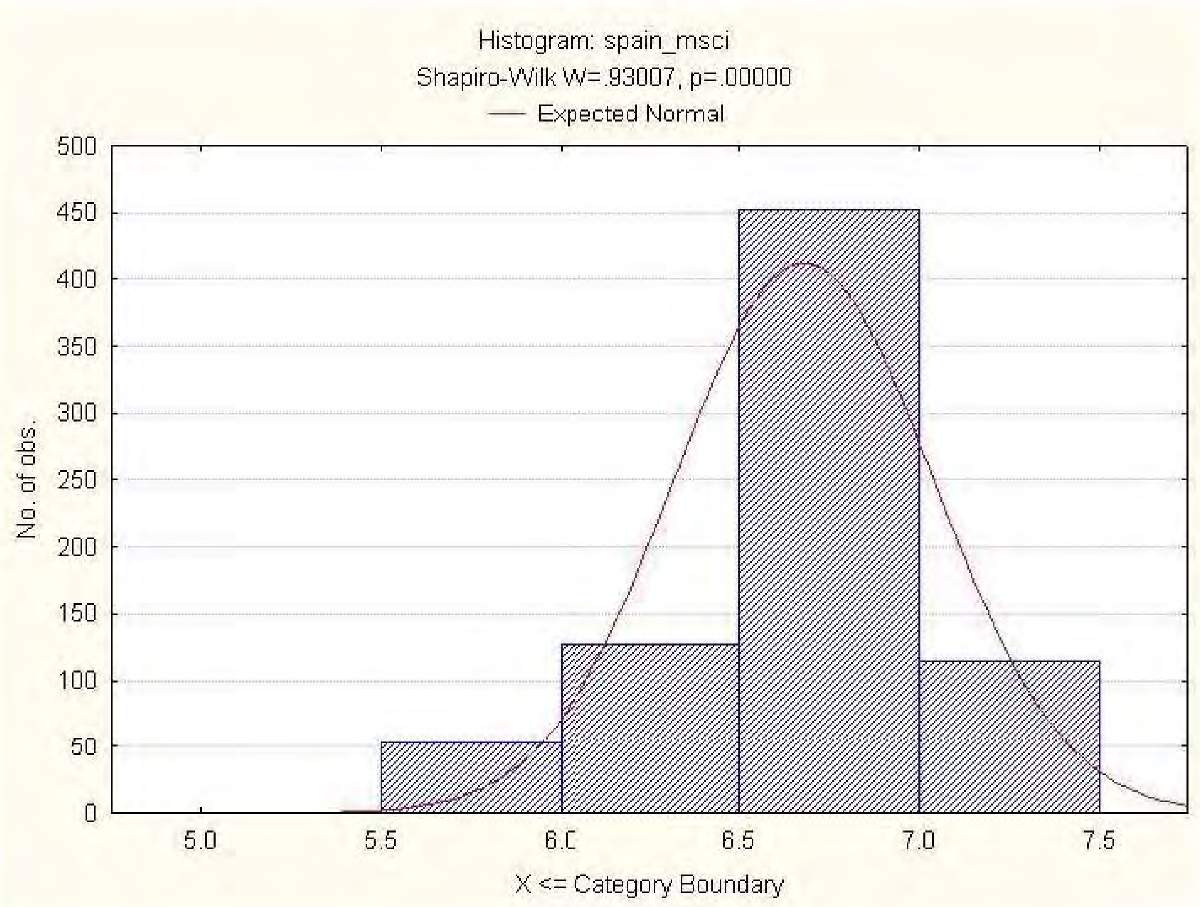


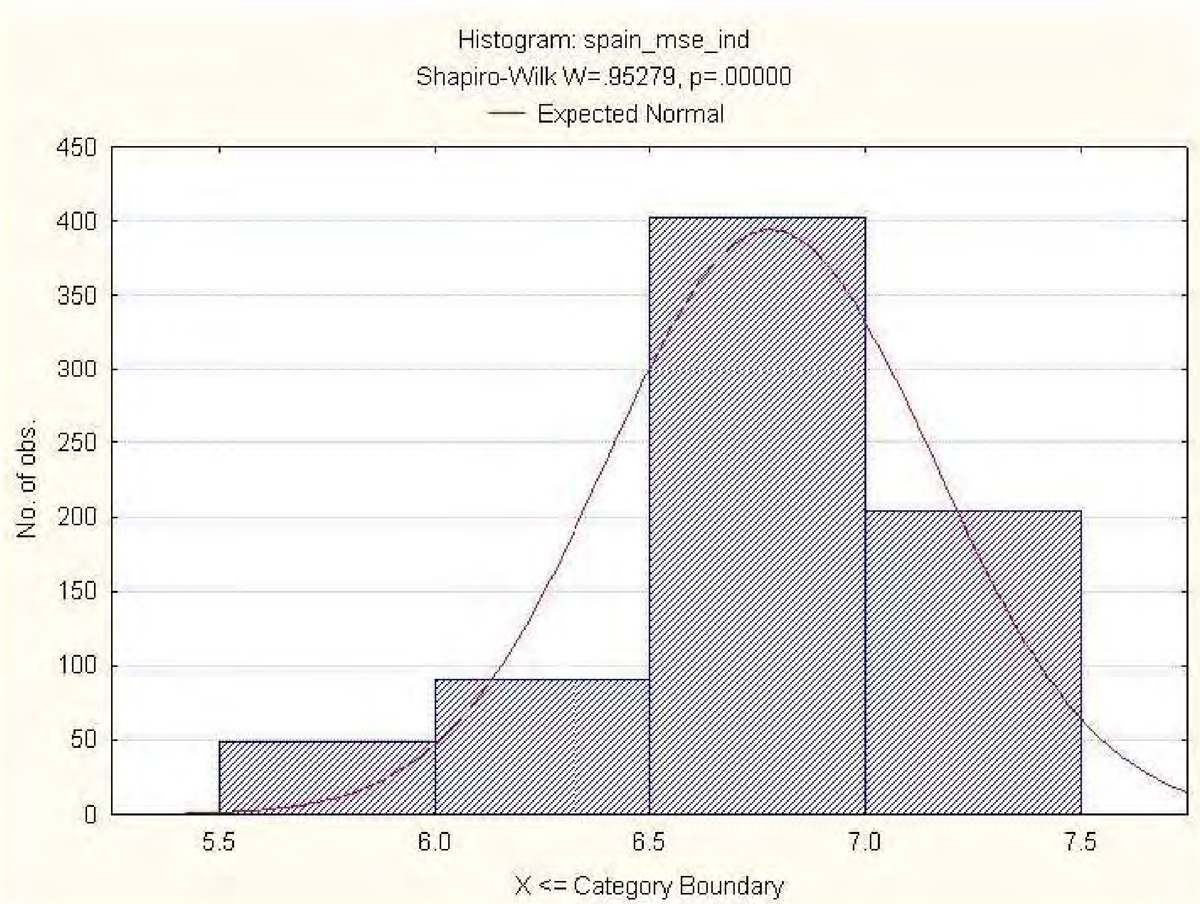
Histogram: sa_jse_asi_index
Shapiro-Wilk W=.90946, p=0.0000
Expected Normal
No. of obs.
300
250
200
150
100
50
0
8.0
8.5
9.0
9.5
10.0
10.5
X <= Category Boundary

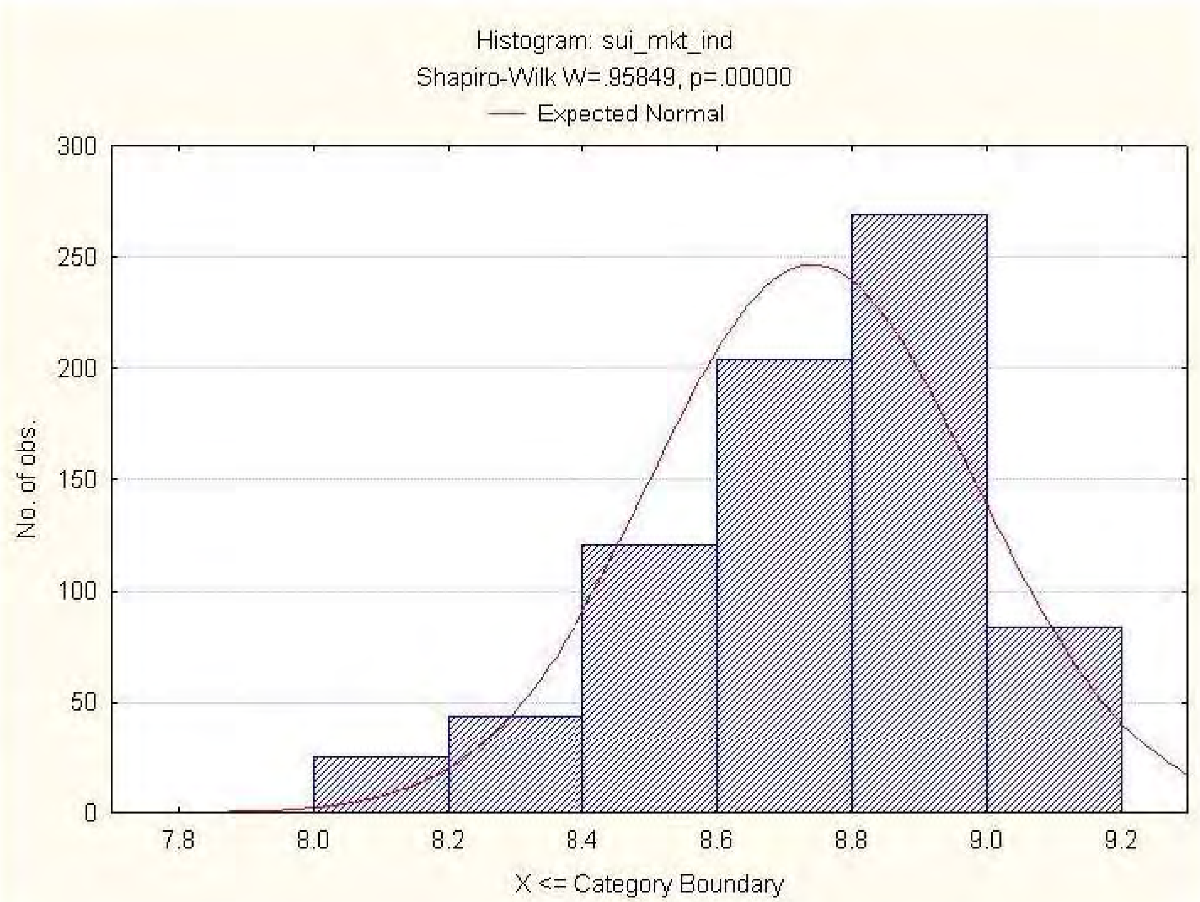


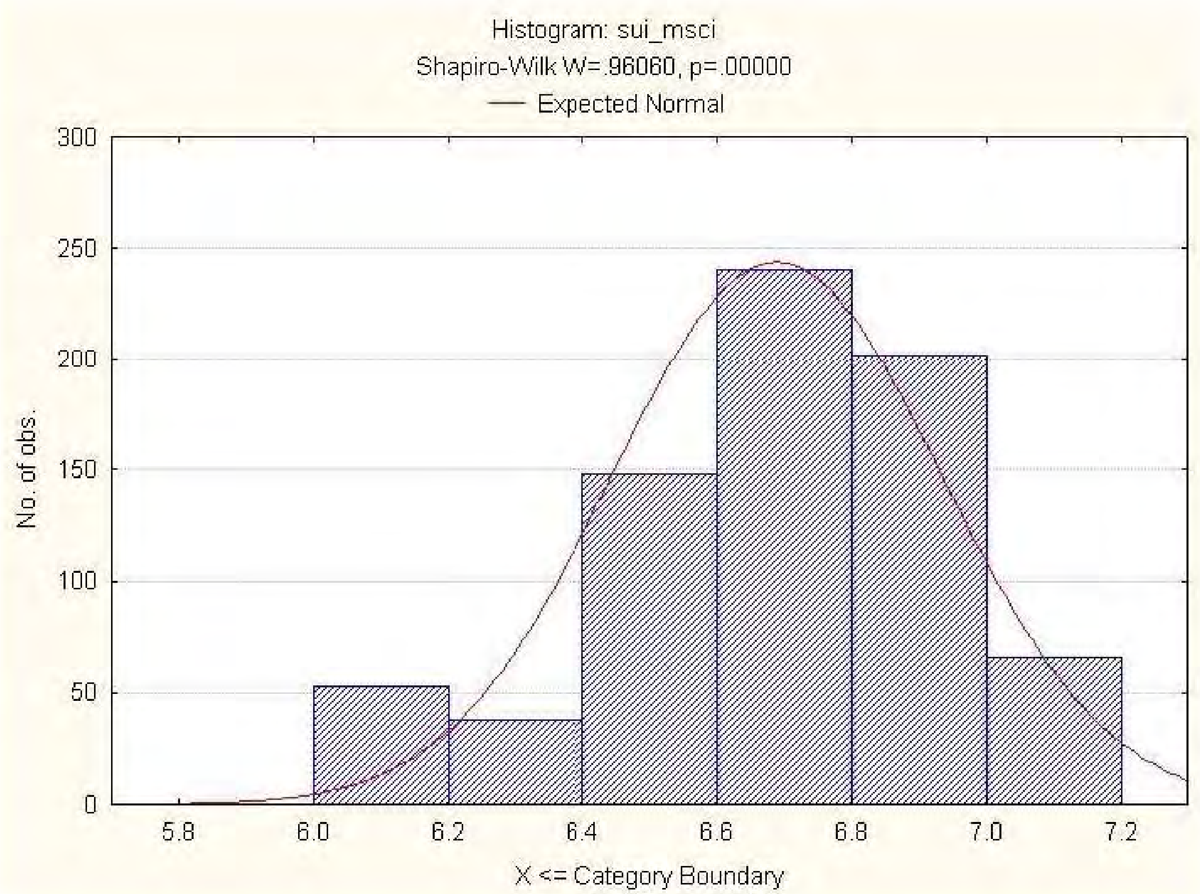
Histogram: sa_msci
Shapiro-Wilk W=.90442, p=0.0000
Expected Normal
No. of obs.
350
300
250
200
150
100
50
0
4.5
5.0
5.5
6.0
6.5
7.0
X <= Category Boundary

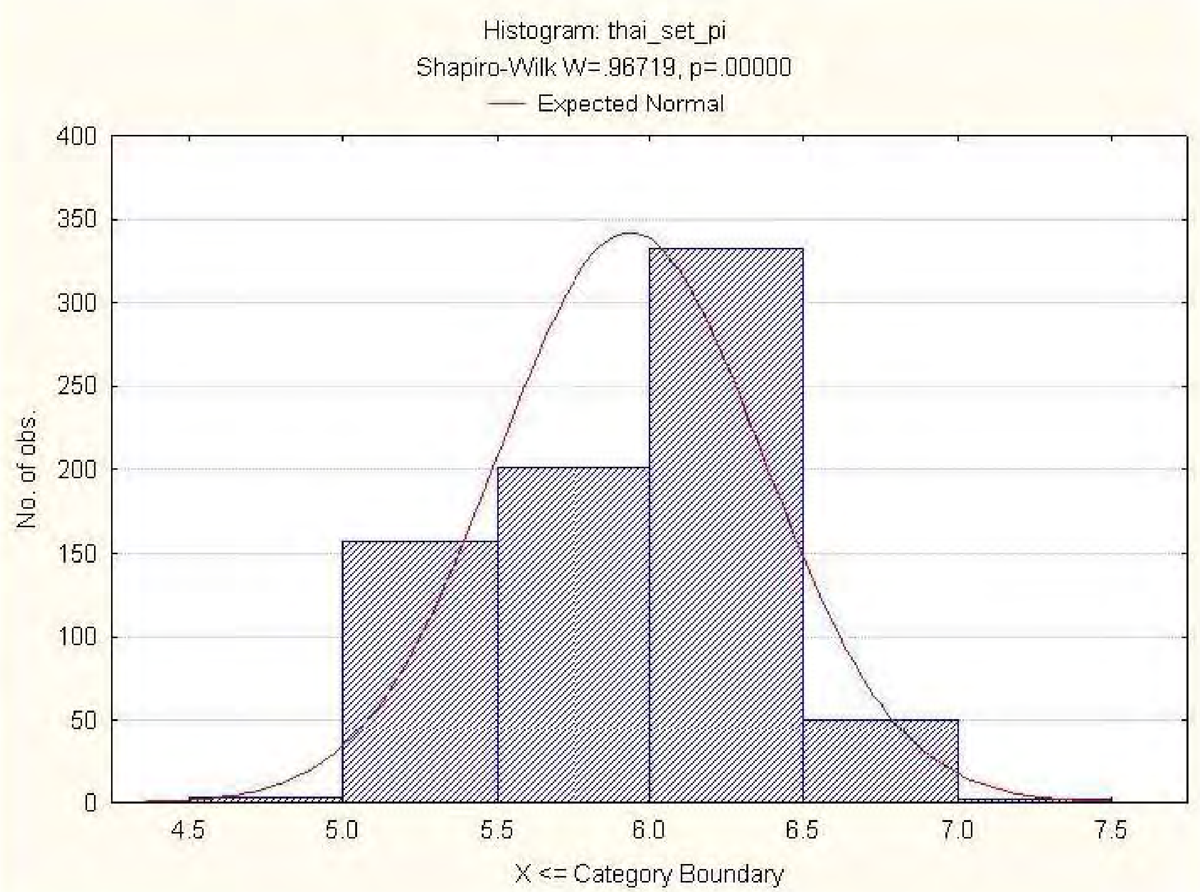

Histogram: spain_ibex35_ind
Shapiro-Wilk W=.95735, p=.00000
Expected Normal
No. of obs.
0
50
100
150
200
250
8.0
8.2
8.4
8.6
8.8
9.0
9.2
9.4
9.6
9.8
X <= Category Boundary

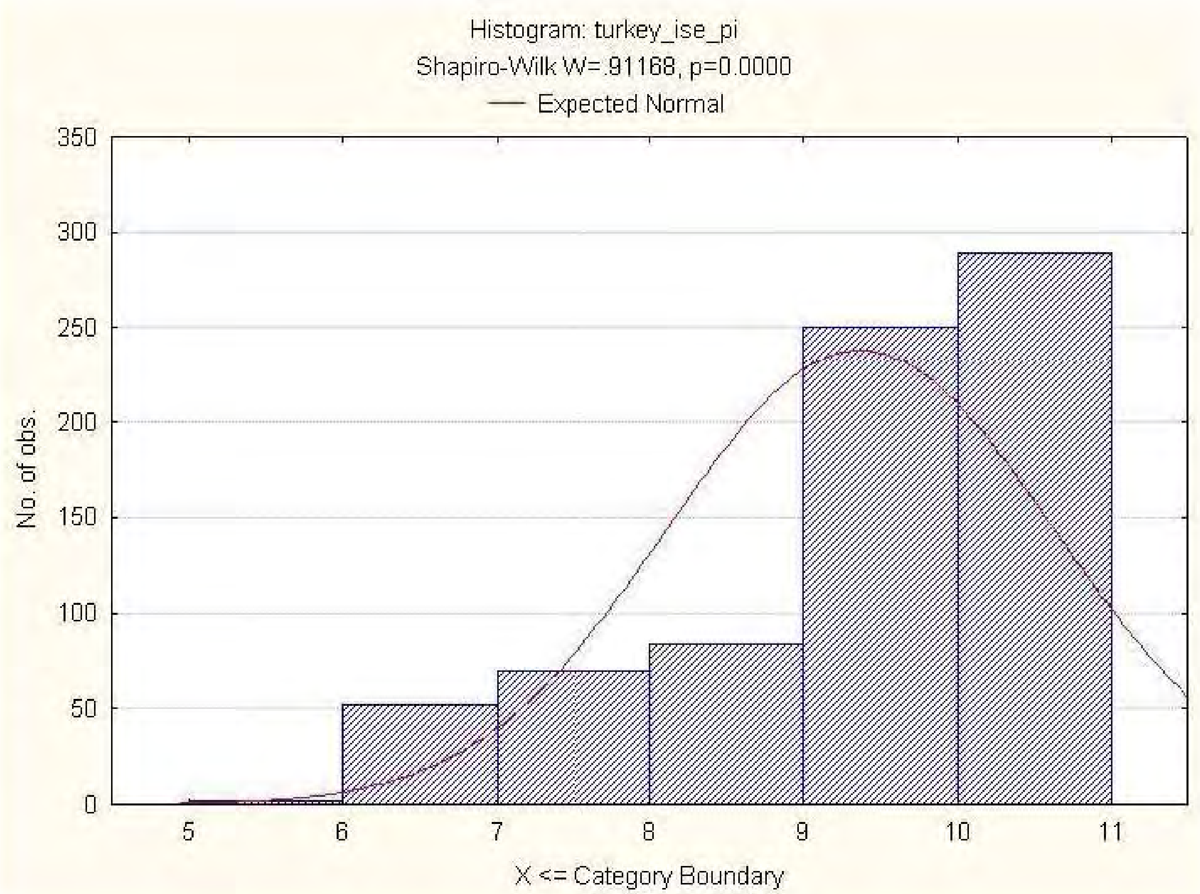

Histogram: spain_msci
Shapiro-Wilk W=.93007, p=.00000
Expected Normal
No. of obs.
0
50
100
150
200
250
300
350
400
450
500
5.0
5.5
6.0
6.5
7.0
7.5
X <= Category Boundary

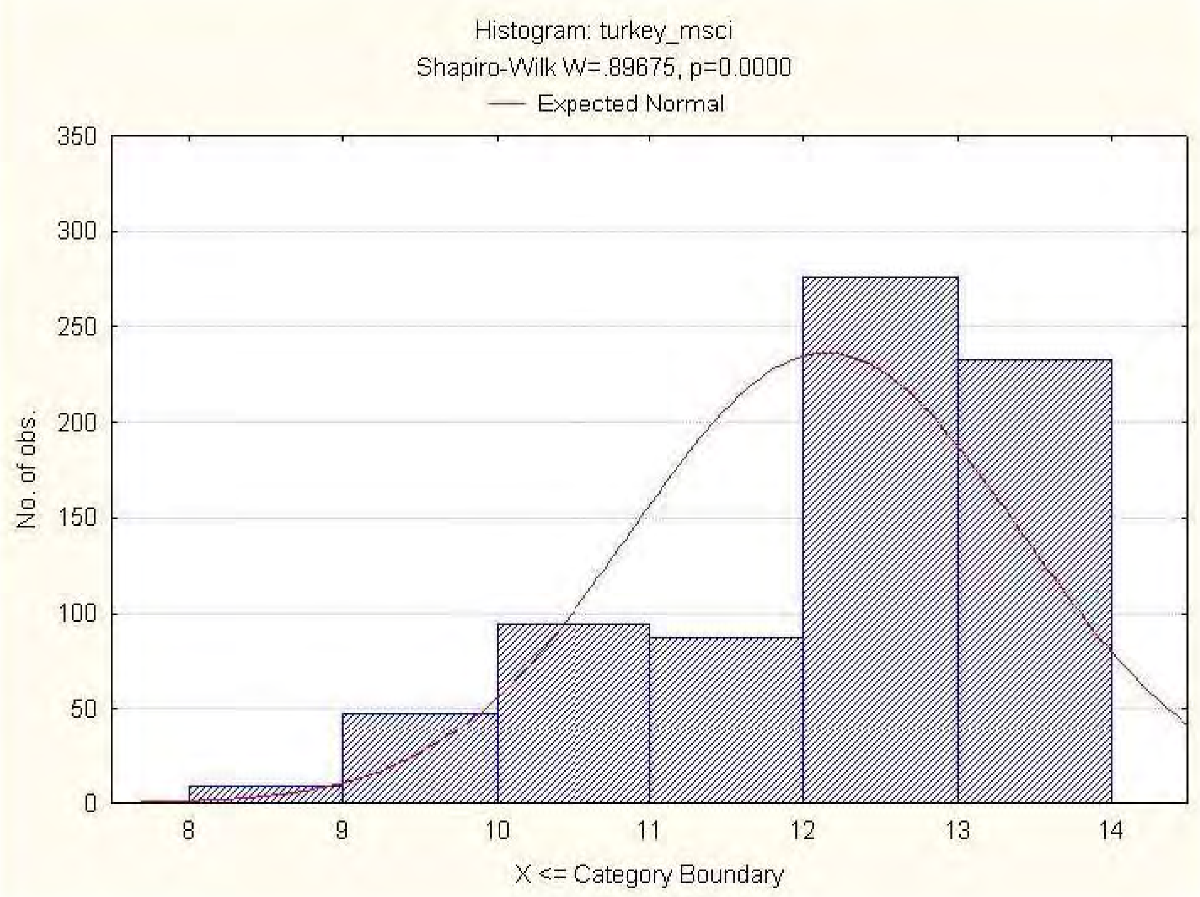

Histogram: spain_mse_ind
Shapiro-Wilk W=.95279, p=.00000
Expected Normal
No. of obs.
X <= Category Boundary
450
400
350
300
250
200
150
100
50
0
5.5
6.0
6.5
7.0
7.5

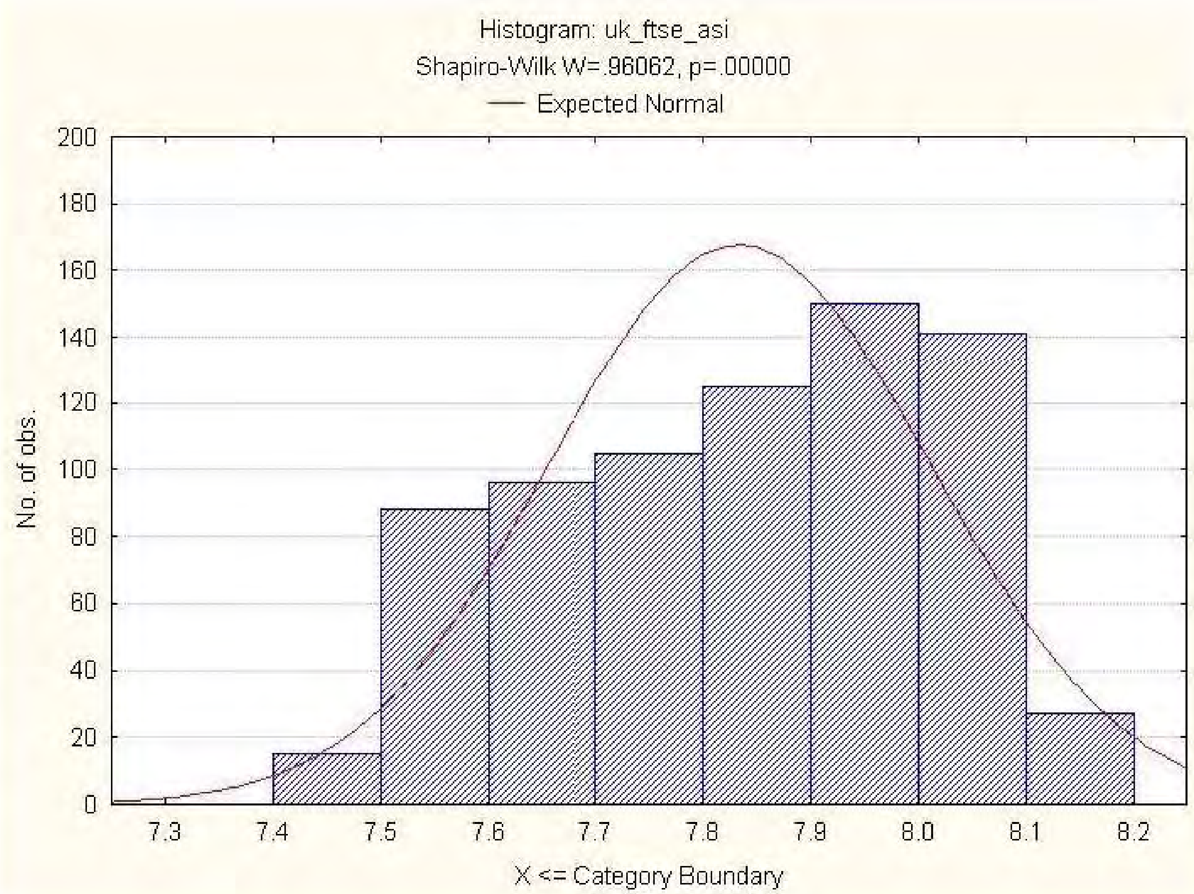

Histogram: sui_mkt_ind
Shapiro-Wilk W=.95849, p=.00000
Expected Normal
No. of obs.
X <= Category Boundary
300
250
200
150
100
50
0
7.8
8.0
8.2
8.4
8.6
8.8
9.0
9.2

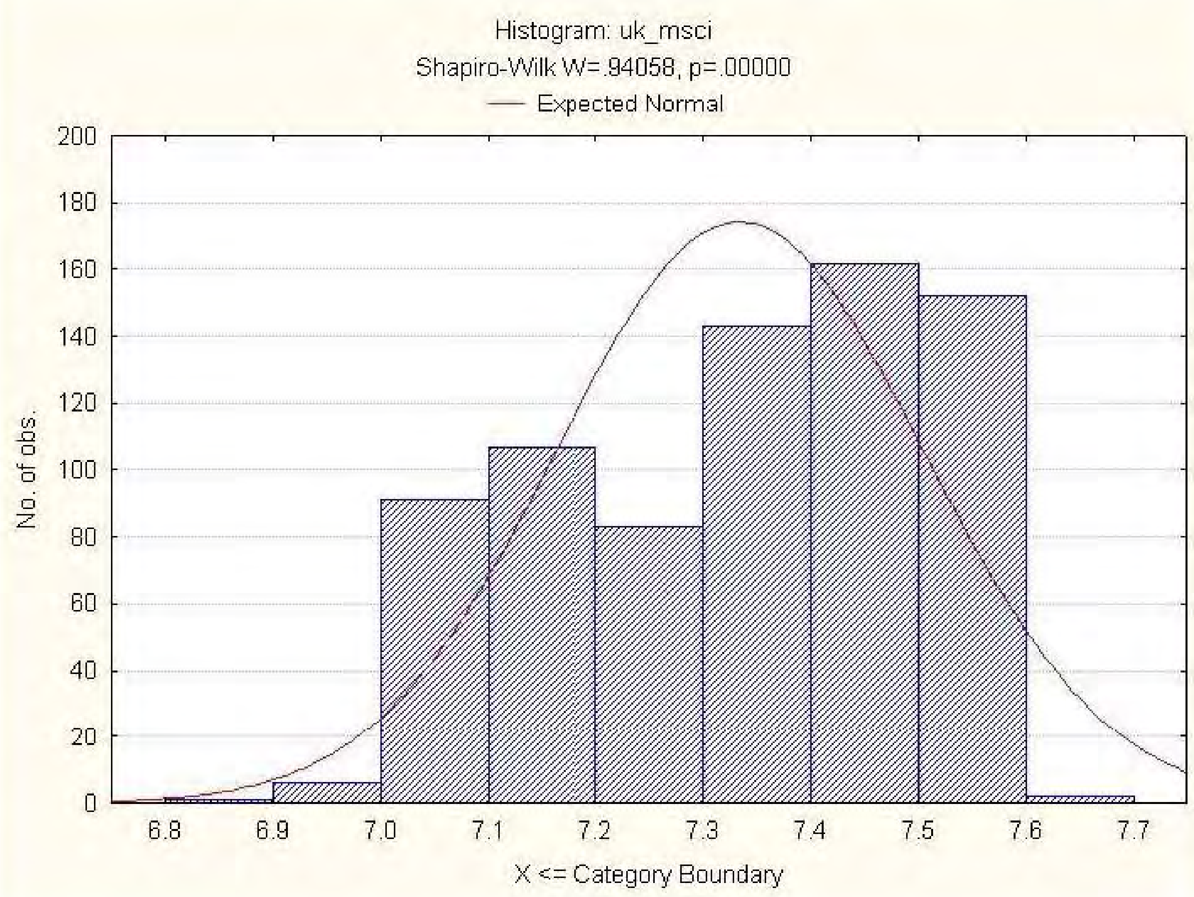

Histogram: sui_msci
Shapiro-Wilk W=.96060, p=.00000
Expected Normal
No. of obs.
X <= Category Boundary

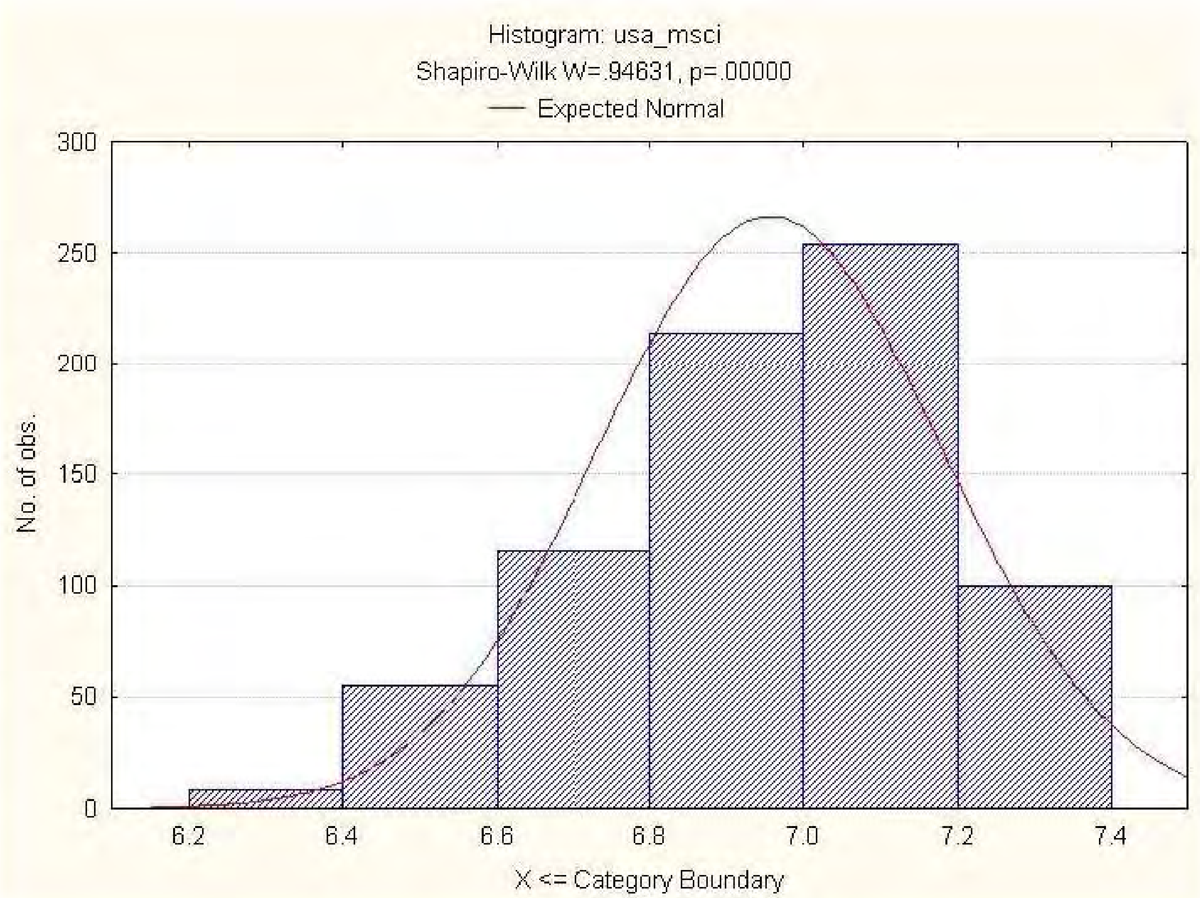

Histogram: thai_set_pi
Shapiro-Wilk W=.96719, p=.00000
Expected Normal
No. of obs.
X <= Category Boundary

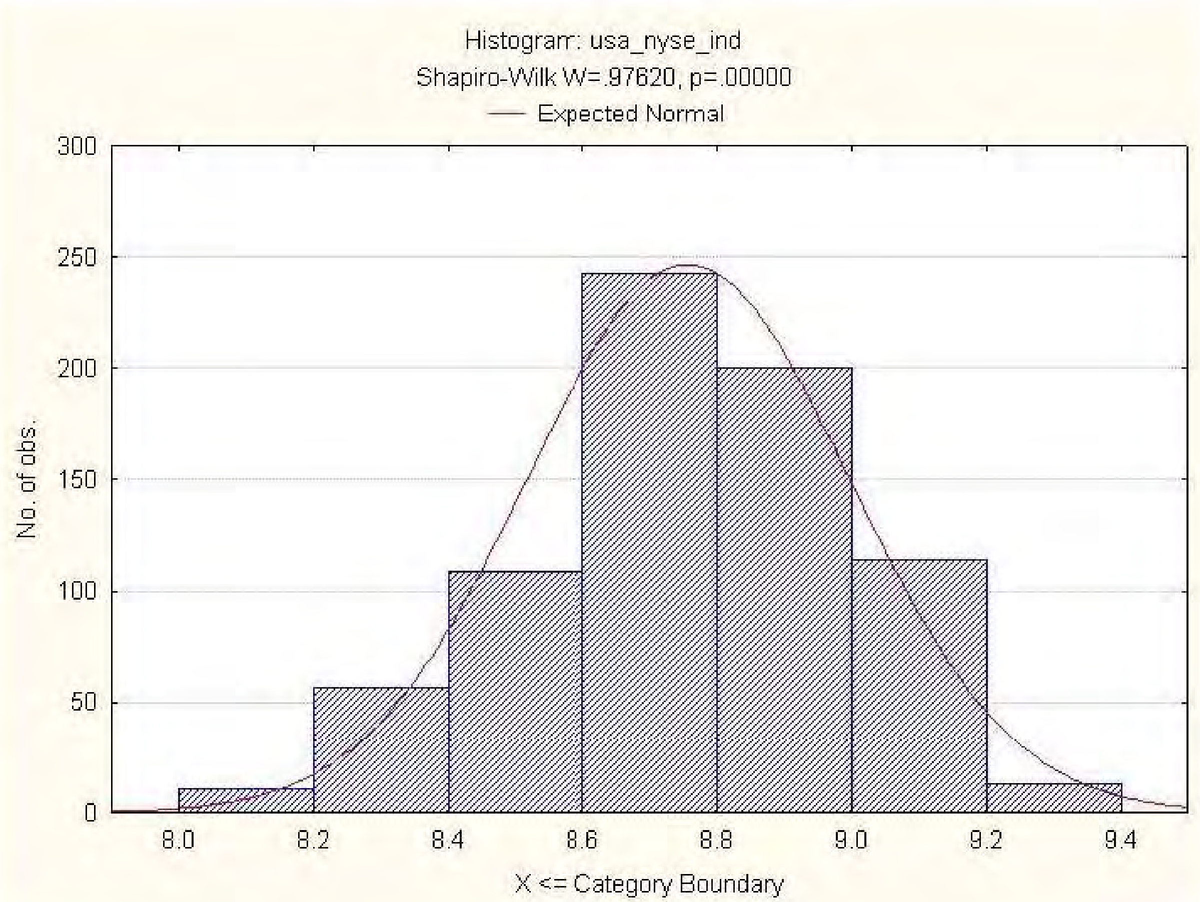

Histogram: turkey_ise_pi
Shapiro-Wilk W=.91168, p=0.0000
Expected Normal
No. of obs.
X <= Category Boundary


Histogram: turkey_msci
Shapiro-Wilk W=.89675, p=0.0000
Expected Normal
No. of obs.
X <= Category Boundary


Histogram: uk_ftse_asi
Shapiro-Wilk W=.96062, p=.00000
Expected Normal
No. of obs.
0
20
40
60
80
100
120
140
160
180
200
7.3
7.4
7.5
7.6
7.7
7.8
7.9
8.0
8.1
8.2
X <= Category Boundary


Histogram: uk_msci
Shapiro-Wilk W=.94058, p=.00000
Expected Normal
No. of obs.
0
20
40
60
80
100
120
140
160
180
200
6.8
6.9
7.0
7.1
7.2
7.3
7.4
7.5
7.6
7.7
X <= Category Boundary


Histogram: usa_msci
Shapiro-Wilk W=.94631, p=.00000
Expected Normal
No. of obs.
0
50
100
150
200
250
300
6.2
6.4
6.6
6.8
7.0
7.2
7.4
X <= Category Boundary


Histogram: usa_nyse_ind
Shapiro-Wilk W=.97620, p=.00000
Expected Normal
No. of obs.
0
50
100
150
200
250
300
8.0
8.2
8.4
8.6
8.8
9.0
9.2
9.4
X <= Category Boundary

Appendix B – Unit root test for stationarity of series using Augmented Dickey Fuller test

MSCI

	ADF Stat	
	level	1st difference
Argentina	0.8740	0.0000
Australia	0.6813	0.0000
Brazil	0.7474	0.0000
Canada	0.3896	0.0000
China	0.5640	0.0000
Colombia	0.9453	0.0000
Egypt	0.8610	0.0002
France	0.1242	0.0000
Germany	0.2083	0.0000
Hong Kong	0.1901	0.0000
India	0.8556	0.0000
Indonesia	0.9463	0.0000
Japan	0.4129	0.0000
Korea	0.7691	0.0000
Mexico	0.8293	0.0000
Morocco	0.5957	0.0000
Netherland	0.1510	0.0000
Nigeria	0.7237	0.0000
Pakistan	0.6906	0.0000
Philippines	0.3706	0.0000
Poland	0.1975	0.0000
Russia	0.2382	0.0000
SA	0.9257	0.0000
Spain	0.0662	0.0000
Switzerland	0.1055	0.0000
Turkey	0.1053	0.0000
UK	0.2243	0.0000
USA	0.1235	0.0000

Price Indices

	ADF Stat	
	level	1^{st} difference
Argentina, Merval	0.8242	0.0000
Australia, ASI	0.6360	0.0000
Bangladesh, Dhaka	0.9052	0.0000
Brazil, Bovespa	0.7602	0.0000
Canada, TSI	0.3682	0.0000
China, Shanghai	0.1827	0.0004
China, Shenzhen	0.5847	0.0000
Egypt, Cairo	0.8662	0.0002
France, CAC40	0.1181	0.0000
Germany, DAX30	0.1710	0.0000
Hong Kong, Hangseng	0.4920	0.0000
India, BSE	0.9063	0.0000
Japan, Nikkei	0.3698	0.0000
Japan, Topix	0.4641	0.0000
Korea, KSE	0.7325	0.0000
Mexico, Bolsa	0.8904	0.0000
Netherlands, ASE	0.1626	0.0000
Philippines, SE	0.5323	0.0000
Poland, Warsaw	0.6912	0.0000
Russia, RTS	0.4937	0.0000
SA, JSE	0.9209	0.0000
Spain, IBEX35	0.0925	0.0000
Spain, MSE	0.1065	0.0000
Switzerland, SE	0.0570	0.0000
Thailand, SET	0.1080	0.0000
Turkey, ISE	0.1313	0.0000
UK, FTSE100	0.2313	0.0000
USA, NYSE	0.1649	0.0000

Appendix C – Engle Granger test at 1 lag

Country pairs (MSCI) – dependent variable 1st	p-value for unit root tests on residuals with 1 lag		
	Intercept only	No trend/intercept	Trend and Intercept
SA – Argentina	0.2187	0.0291	0.3829
SA – Australia	0.2984	0.0462	0.3962
SA – Brazil	0.0099	0.0006	0.0416
SA – Canada	0.4457	0.0895	0.3212
SA – China	0.8147	0.3632	0.2837
SA – Colombia	0.2131	0.0280	0.4480
SA – Egypt	0.4143	0.0786	0.5519
SA – France	0.9782	0.7708	0.3319
SA – Germany	0.9762	0.7597	0.2600
SA – Hong Kong	0.5985	0.1585	0.2712
SA – India	0.0551	0.0046	0.1431
SA – Indonesia	0.2062	0.0267	0.4659
SA – Japan	0.9213	0.5730	0.3953
SA – Korea	0.1037	0.0104	0.2737
SA – Mexico	0.0366	0.0028	0.1322
SA – Morocco	0.6565	0.1958	0.3248
SA – Netherlands	0.9268	0.5871	0.3669
SA – Nigeria	0.3162	0.0504	0.4919
SA – Pakistan	0.2482	0.0349	0.2333
SA – Philippines	0.8770	0.4742	0.1592
SA – Poland	0.4812	0.1027	0.0319
SA – Russia	0.3312	0.0544	0.1635
SA – Spain	0.8288	0.3860	0.2062
SA – Switzerland	0.9529	0.6658	0.2125
SA – Turkey	0.3445	0.0581	0.3445
SA – UK	0.9636	0.7040	0.2723
SA – USA	0.9765	0.7616	0.3027

Country pairs (MSCI) - dependent variable 1st	p-value for unit root tests on residuals with 1 lag		
	Intercept only	No trend/intercept	Trend and Intercept
Argentina – SA	0.1899	0.0238	0.4621
Australia – SA	0.1702	0.0204	0.4515
Brazil – SA	0.0054	0.0003	0.0373
Canada – SA	0.1028	0.0104	0.3690
China – SA	0.4653	0.0968	0.8904
Colombia – SA	0.2376	0.0328	0.5290
Egypt – SA	0.3924	0.0718	0.7146
France – SA	0.2000	0.0258	0.5129
Germany – SA	0.2849	0.0432	0.5487
Hong Kong – SA	0.2048	0.0265	0.4984
India – SA	0.0505	0.0041	0.1766
Indonesia – SA	0.2612	0.0377	0.6050
Japan – SA	0.4411	0.0877	0.7295
Korea – SA	0.0869	0.0083	0.2535
Mexico – SA	0.0251	0.0018	0.1292
Morocco – SA	0.3226	0.0524	0.6310
Netherlands – SA	0.1940	0.0246	0.4022
Nigeria – SA	0.2208	0.0295	0.5971
Pakistan – SA	0.1314	0.0143	0.3500
Philippines – SA	0.3920	0.0718	0.8441
Poland – SA	0.0436	0.0035	0.1083
Russia – SA	0.0749	0.0068	0.2254
Spain – SA	0.0522	0.0044	0.2579
Switzerland – SA	0.1480	0.0169	0.3887
Turkey – SA	0.0142	0.0009	0.1950
UK – SA	0.2278	0.0309	0.4855
USA – SA	0.1324	0.0146	0.3914

Country pairs (Price index) – dependent variable 1st	p-value for unit root tests on residuals with 1 lag		
	Intercept only	No trend/intercept	Trend and Intercept
SA – Argentina, Merval	0.4057	0.0760	0.6770
SA – Australia, ASX	0.4221	0.0812	0.4587
SA – Bangladesh, Dhaka	0.3354	0.0556	0.7239
SA – Brazil, Bovespa	0.0527	0.0044	0.1278
SA – Canada, TSI	0.4224	0.0814	0.2725
SA – China, Shanghai	0.4952	0.1084	0.2048
SA – China, Shenzhen	0.1140	0.0118	0.1573
SA – Egypt, Cairo	0.5712	0.1436	0.7439
SA – France, CAC 40	0.9903	0.8480	0.3584
SA – Germany, DAX 30	0.9494	0.6541	0.2570
SA – Hong Kong, Hangseng	0.3694	0.0649	0.2751
SA – India, BSE	0.1222	0.0130	0.3046
SA – Japan, Nikkei	0.8522	0.4261	0.6088
SA – Japan, Topix	0.9227	0.5766	0.4968
SA – Korea, KSE	0.0379	0.0029	0.0956
SA – Mexico, Bolsa	0.0103	0.0006	0.0473
SA – Netherlands, ASE	0.9515	0.6594	0.4165
SA – Philippines, PSE	0.6655	0.2036	0.5695
SA – Poland, Warsaw	0.1188	0.0125	0.0457
SA – Russia, RTS	0.4224	0.0813	0.4275
SA – Spain, IBEX 35	0.8742	0.4692	0.2205
SA – Spain, MSE	0.7982	0.3391	0.2598
SA – Switzerland, SE	0.9727	0.7435	0.1962
SA – Thailand, SET	0.4767	0.1030	0.4143
SA – Turkey, ISE	0.2671	0.0392	0.2032
SA – UK, FTSE 100	0.9530	0.6658	0.2862
SA – USA, NYSE	0.8468	0.4169	0.2799

Country pairs (Price index) – dependent variable 1st	p-value for unit root tests on residuals with 1 lag		
	Intercept only	No trend/intercept	Trend and Intercept
Argentina, Merval – SA	0.3747	0.0665	0.7086
Australia, ASX – SA	0.2345	0.0322	0.5105
Bangladesh, Dhaka – SA	0.5792	0.1476	0.8938
Brazil, Bovespa – SA	0.0265	0.0019	0.1249
Canada, TSI – SA	0.1213	0.0129	0.3254
China, Shanghai – SA	0.0991	0.0099	0.3034
China, Shenzhen – SA	0.0448	0.0036	0.1674
Egypt, Cairo – SA	0.5695	0.1428	0.8525
France, CAC 40 – SA	0.2655	0.0389	0.5554
Germany, DAX 30 – SA	0.2210	0.0297	0.4687
Hong Kong, Hangseng – SA	0.1348	0.0148	0.3571
India, BSE – SA	0.1245	0.0133	0.3500
Japan, Nikkei – SA	0.3154	0.0504	0.6586
Japan, Topix – SA	0.4549	0.0927	0.7604
Korea, KSE – SA	0.0268	0.0019	0.1260
Mexico, Bolsa – SA	0.0083	0.0005	0.0429
Netherlands, ASE – SA	0.2129	0.0281	0.4084
Philippines, PSE – SA	0.4431	0.0886	0.8657
Poland, Warsaw – SA	0.0301	0.0022	0.0862
Russia, RTS – SA	0.2195	0.0293	0.4977
Spain, IBEX 35 – SA	0.1119	0.0116	0.3239
Spain, MSE – SA	0.0971	0.0097	0.3367
Switzerland, SE – SA	0.1582	0.0185	0.3695
Thailand, SET – SA	0.0408	0.0032	0.2472
Turkey, ISE – SA	0.0140	0.0009	0.1580
UK, FTSE 100 – SA	0.2660	0.0389	0.5237
USA, NYSE – SA	0.1387	0.0155	0.3653

Appendix D – Engle-Granger test at the number of lags selected to be optimal by the modified AIC

Country pairs (MSCI) – dependent variable 1st	p-value for unit root tests on residuals with 1 lag		
	Intercept only	No trend/intercept	Trend and Intercept
SA – Argentina (2)	0.2872	0.0435	0.4604
SA – Australia (3)	0.2197	0.0292	0.2757
SA – Brazil (4)	0.0236	0.0017	0.0808
SA – Canada (15)	0.2834	0.0428	0.1891
SA – China	0.8166 (19)	0.3753 (3)	0.2837 (1)
SA – Colombia (1)	0.2131	0.0280	0.4480
SA – Egypt (1)	0.4143	0.0786	0.5519
SA – France (2)	0.9719	0.7390	0.2613
SA – Germany (4)	0.9704	0.7294	0.1542
SA – Hong Kong (6)	0.5220	0.1198	0.2166
SA – India (1)	0.0551	0.0046	0.1431
SA – Indonesia (1)	0.2062	0.0267	0.4659
SA – Japan (12)	0.9167	0.5539	0.3444
SA – Korea (1)	0.1037	0.0104	0.2737
SA – Mexico (4)	0.0439	0.0035	0.1474
SA – Morocco (7)	0.6765	0.2104	0.3067
SA – Netherlands (12)	0.9248	0.5734	0.3259
SA – Nigeria (1)	0.3162	0.0504	0.4919
SA – Pakistan (10)	0.4071	0.0757	0.4617
SA – Philippines (7)	0.8837	0.4851	0.1278
SA – Poland (3)	0.5669	0.1412	0.0588
SA – Russia	0.3312 (1)	0.0544 (1)	0.1792 (3)
SA – Spain (2)	0.7895	0.3271	0.1539
SA – Switzerland (8)	0.9535	0.6643	0.0929
SA – Turkey (1)	0.3445	0.0581	0.3445
SA – UK (1)	0.9636	0.7040	0.2723
SA – USA (4)	0.9715	0.7353	0.1738

Country pairs (MSCI) - dependent variable 1st	p-value for unit root tests on residuals with 1 lag		
	Intercept only	No trend/intercept	Trend and Intercept
Argentina – SA (2)	0.2461	0.0346	0.5448
Australia – SA (3)	0.1160	0.0121	0.3509
Brazil – SA (4)	0.0114	0.0007	0.0779
Canada – SA (1)	0.1028	0.0104	0.3690
China – SA (0)	0.5469	0.1315	0.9134
Colombia – SA (1)	0.2376	0.0328	0.5290
Egypt – SA (1)	0.3924	0.0718	0.7146
France – SA (3)	0.1930	0.0248	0.4889
Germany – SA	0.2452 (3)	0.0346 (3)	0.5487 (1)
Hong Kong – SA (6)	0.1110	0.0114	0.3395
India – SA (1)	0.0505	0.0041	0.1766
Indonesia – SA (19)	0.3179	0.0515	0.6989
Japan – SA (3)	0.4035	0.0752	0.6992
Korea – SA (1)	0.0869	0.0083	0.2535
Mexico – SA (4)	0.0259	0.0019	0.1530
Morocco – SA (7)	0.3430	0.0587	0.6443
Netherlands – SA (3)	0.1504	0.0174	0.3356
Nigeria – SA (1)	0.2208	0.0295	0.5971
Pakistan – SA (5)	0.1067	0.0108	0.3037
Philippines – SA (3)	0.3118	0.0497 *	0.7590
Poland – SA (3)	0.0695 *	0.0063	0.1645
Russia – SA (10)	0.0164 *	0.0011	0.0604
Spain – SA (2)	0.0414 *	0.0033	0.2124
Switzerland – SA (1)	0.1480	0.0169	0.3887
Turkey – SA	0.0233 (0)	0.0016 (0)	0.1719 (4)
UK – SA	0.2278	0.0309	0.4855
USA – SA (7)	0.1757	0.0222	0.4475

Country pairs (Price index) – dependent variable 1st	p-value for unit root tests on residuals with 1 lag		
	Intercept only	No trend/intercept	Trend and Intercept
SA – Argentina, Merval (1)	0.4057	0.0760	0.6770
SA – Australia, ASX (1)	0.4221	0.0812	0.4587
SA – Bangladesh, Dhaka (2)	0.2984	0.0463 *	0.5951
SA – Brazil, Bovespa (7)	0.1192	0.0128	0.2266
SA – Canada, TSI (1)	0.4224	0.0814	0.2725
SA – China, Shanghai (0)	0.4952	0.1084	0.2307
SA – China, Shenzhen (0)	0.1224	0.0130	0.1752
SA – Egypt, Cairo (1)	0.5712	0.1436	0.7439
SA – France, CAC 40	0.9882 (2)	0.8307 (2)	0.3584 (1)
SA – Germany, DAX 30 (2)	0.9393	0.6225	0.2067
SA – Hong Kong, Hangseng (2)	0.2966	0.0458 *	0.1752
SA – India, BSE (7)	0.1700	0.0204	0.4179
SA – Japan, Nikkei	0.8431 (0)	0.3897 (7)	0.6402 (0)
SA – Japan, Topix	0.9069 (9)	0.5330 (9)	0.3943 (7)
SA – Korea, KSE (1)	0.0379	0.0029	0.0956
SA – Mexico, Bolsa (7)	0.0544 *	0.0046	0.1763
SA – Netherlands, ASE (9)	0.9461	0.6330	0.3142
SA – Philippines, PSE (1)	0.6655	0.2036	0.5695
SA – Poland, Warsaw (12)	0.4875	0.1043 *	0.4880 *
SA – Russia, RTS (1)	0.4224	0.0813	0.4275
SA – Spain, IBEX 35 (1)	0.8742	0.4692	0.2205
SA – Spain, MSE (2)	0.7466	0.2757	0.1995
SA – Switzerland, SE (1)	0.9727	0.7435	0.1962
SA – Thailand, SET (1)	0.4767	0.1030	0.4143
SA – Turkey, ISE (1)	0.2671	0.0392	0.2032
SA – UK, FTSE 100 (8)	0.9801	0.7741	0.2163
SA – USA, NYSE	0.8468 (1)	0.4169 (1)	0.1828 (4)

Country pairs (Price index) – dependent variable 1st	p-value for unit root tests on residuals with 1 lag		
	Intercept only	No trend/intercept	Trend and Intercept
Argentina, Merval – SA (1)	0.3747	0.0665	0.7086
Australia, ASX – SA (1)	0.2345	0.0322	0.5105
Bangladesh, Dhaka – SA (6)	0.4543	0.0916	0.8183
Brazil, Bovespa – SA (7)	0.0592 *	0.0053	0.2306
Canada, TSI – SA (1)	0.1213	0.0129	0.3254
China, Shanghai – SA (0)	0.1119	0.0115	0.3319
China, Shenzhen – SA (0)	0.0566 *	0.0048	0.2000
Egypt, Cairo – SA (1)	0.5695	0.1428	0.8525
France, CAC 40 – SA (1)	0.2655	0.0389	0.5554
Germany, DAX 30 – SA (0)	0.2152	0.0285	0.4621
Hong Kong, Hangseng – SA (2)	0.0820	0.0077	0.2445
India, BSE – SA (2)	0.0775	0.0071	0.2465
Japan, Nikkei – SA (1)	0.3154	0.0504	0.6586
Japan, Topix – SA (1)	0.4549	0.0927	0.7604
Korea, KSE – SA (1)	0.0268	0.0019	0.1260
Mexico, Bolsa – SA (7)	0.0412	0.0033	0.1789 *
Netherlands, ASE – SA (2)	0.1800	0.0222	0.3614
Philippines, PSE – SA (3)	0.3440	0.0580	0.7796
Poland, Warsaw – SA (12)	0.3042 *	0.0479	0.5731
Russia, RTS – SA (3)	0.2046	0.0265	0.4729
Spain, IBEX 35 – SA	0.0924 (3)	0.0091 (3)	0.3239 (1)
Spain, MSE – SA (2)	0.0775	0.0073	0.2806
Switzerland, SE – SA (7)	0.0932	0.0094	0.2244
Thailand, SET – SA (4)	0.0280	0.0021	0.1766
Turkey, ISE – SA (1)	0.0140	0.0009	0.1580
UK, FTSE 100 – SA (1)	0.2660	0.0389	0.5237
USA, NYSE – SA (7)	0.1612	0.0194	0.3869

Appendix E – Engle-Granger test for data from 2003 to 2010 at 1 lag

Country pairs (MSCI) – dependent variable 1st	p-value for unit root tests on residuals with 1 lag (since 2003)		
	Intercept only	No trend/intercept	Intercept and Trend
SA – Argentina	0.2440	0.0340	0.2131
SA – Australia	0.6174	0.1695	0.5547
SA – Brazil	0.0501	0.0041	0.1742
SA – Canada	0.4939	0.1074	0.2857
SA – China	0.2580	0.0370	0.5362
SA – Colombia	0.3110	0.0492	0.6032
SA – Egypt	0.4253	0.0821	0.4569
SA – France	0.8464	0.4155	0.2298
SA – Germany	0.8476	0.4169	0.3406
SA – Hong Kong	0.5298	0.1232	0.3885
SA – India	0.0607	0.0052	0.1614
SA – Indonesia	0.1438	0.0161	0.3940
SA – Japan	0.8335	0.3935	0.0572
SA – Korea	0.0690	0.0061	0.1156
SA – Mexico	0.0089	0.0005	0.0310
SA – Morocco	0.0772	0.0071	0.2520
SA – Netherlands	0.6626	0.2030	0.1429
SA – Nigeria	0.6968	0.2258	0.5378
SA – Pakistan	0.6082	0.1634	0.0674
SA – Philippines	0.2463	0.0345	0.2494
SA – Poland	0.8280	0.3836	0.1877
SA – Russia	0.7193	0.2464	0.2129
SA – Spain	0.6811	0.2132	0.3770
SA – Switzerland	0.8483	0.4184	0.4324
SA – Turkey	0.3217	0.0519	0.4255
SA – UK	0.6809	0.2149	0.4791
SA – USA	0.6755	0.2144	0.5692

Country pairs (MSCI) - dependent variable 1st	p-value for unit root tests on residuals with 1 lag (since 2003)		
	Intercept only	No trend/intercept	Trend and Intercept
Argentina – SA	0.2212	0.0295	0.3796
Australia – SA	0.6154	0.1684	0.7997
Brazil – SA	0.0464	0.0037	0.1610
Canada – SA	0.3227	0.0521	0.4223
China – SA	0.2286	0.0310	0.5228
Colombia – SA	0.2676	0.0391	0.5846
Egypt – SA	0.3100	0.0490	0.5416
France – SA	0.7648	0.2959	0.7857
Germany – SA	0.6696	0.2053	0.6894
Hong Kong – SA	0.2688	0.0394	0.4261
India – SA	0.0477	0.0039	0.1646
Indonesia – SA	0.1583	0.0183	0.3724
Japan – SA	0.7844	0.3204	0.6482
Korea – SA	0.0427	0.0034	0.1290
Mexico – SA	0.0093	0.0005	0.0411
Morocco – SA	0.1168	0.0122	0.2956
Netherlands – SA	0.7007	0.2308	0.8195
Nigeria – SA	0.5992	0.1585	0.7868
Pakistan – SA	0.3789	0.0675	0.4671
Philippines – SA	0.1511	0.0173	0.3158
Poland – SA	0.5351	0.1259	0.5238
Russia – SA	0.5160	0.1169	0.6065
Spain – SA	0.5518	0.1333	0.6691
Switzerland – SA	0.7623	0.2931	0.8009
Turkey – SA	0.2155	0.0284	0.4556
UK – SA	0.5214	0.1196	0.6972
USA – SA	0.5750	0.1457	0.6669

Country pairs (Price index) – dependent variable 1st	p-value for unit root tests on residuals with 1 lag (since 2003)		
	Intercept only	No trend/intercept	Trend and Intercept
SA – Argentina, Merval	0.3437	0.0577	0.4153
SA – Australia, ASX	0.7566	0.2857	0.6337
SA – Bangladesh, Dhaka	0.1443	0.0163	0.4371
SA – Brazil, Bovespa	0.1069	0.0108	0.3027
SA – Canada, TSI	0.5583	0.1366	0.1766
SA – China, Shanghai	0.0917	0.0092	0.5084
SA – China, Shenzhen	0.2120	0.0281	0.7099
SA – Egypt, Cairo	0.4105	0.0772	0.4763
SA – France, CAC 40	0.8649	0.4492	0.1360
SA – Germany, DAX 30	0.4669	0.0968	0.1694
SA – Hong Kong, Hangseng	0.2930	0.0448	0.3649
SA – India, BSE	0.0514	0.0042	0.1565
SA – Japan, Nikkei	0.8708	0.4613	0.1250
SA – Japan, Topix	0.7974	0.3416	0.4814
SA – Korea, KSE	0.0036	0.0002	0.0076
SA – Mexico, Bolsa	0.0005	0.0000	0.0031
SA – Netherlands, ASE	0.7260	0.2600	0.0606
SA – Philippines, PSE	0.1729	0.0208	0.2828
SA – Poland, Warsaw	0.5964	0.1569	0.1929
SA – Russia, RTS	0.3456	0.0582	0.2887
SA – Spain, IBEX 35	0.6636	0.1999	0.2801
SA – Spain, MSE	0.8120	0.3570	0.4538
SA – Switzerland, SE	0.8624	0.4447	0.4160
SA – Thailand, SET	0.7977	0.3384	0.4084
SA – Turkey, ISE	0.3056	0.0478	0.5556
SA – UK, FTSE 100	0.6858	0.2183	0.4095
SA – USA, NYSE	0.8280	0.3838	0.1854

Country pairs (Price index) – dependent variable 1st	p-value for unit root tests on residuals with 1 lag (since 2003)		
	Intercept only	No trend/intercept	Trend and Intercept
Argentina, Merval – SA	0.1786	0.0218	0.3870
Australia, ASX – SA	0.6881	0.2199	0.8047
Bangladesh, Dhaka – SA	0.3978	0.0730	0.3197
Brazil, Bovespa – SA	0.1033	0.0103	0.2318
Canada, TSI – SA	0.3358	0.0555	0.3563
China, Shanghai – SA	0.3769	0.0674	0.6785
China, Shenzhen – SA	0.4321	0.0847	0.7522
Egypt, Cairo – SA	0.2947	0.0453	0.5339
France, CAC 40 – SA	0.7481	0.2768	0.7371
Germany, DAX 30 – SA	0.2961	0.0456	0.3352
Hong Kong, Hangseng – SA	0.1698	0.0203	0.3654
India, BSE – SA	0.0332	0.0025	0.1312
Japan, Nikkei – SA	0.6431	0.1865	0.4930
Japan, Topix – SA	0.7984	0.3395	0.6236
Korea, KSE – SA	0.0023	0.0001	0.0107
Mexico, Bolsa – SA	0.0006	0.0000	0.0022
Netherlands, ASE – SA	0.7440	0.2724	0.7964
Philippines, PSE – SA	0.1289	0.0139	0.3202
Poland, Warsaw – SA	0.4012	0.0745	0.4158
Russia, RTS – SA	0.3065	0.0481	0.5213
Spain, IBEX 35 – SA	0.5314	0.1236	0.5982
Spain, MSE – SA	0.7116	0.2397	0.7480
Switzerland, SE – SA	0.7511	0.2803	0.7585
Thailand, SET – SA	0.1042	0.0106	0.1251
Turkey, ISE – SA	0.2588	0.0371	0.5579
UK, FTSE 100 – SA	0.5251	0.1212	0.6706
USA, NYSE – SA	0.6002	0.1595	0.6240

Appendix F – Johansen test using the number of lags at which autocorrelation first disappears (number of lags in parenthesis)

	p-values (MSCI) 1 lag											
Trend/int.	no trend/intercept in the C.E. or VAR				intercept in C.E. and VAR				intercept and trend in C.E., no trend in VAR			
Test method	Trace		Max Eigenvalue		Trace		Max Eigenvalue		Trace		Max Eigenvalue	
Hypothesized no. of CE's	None	At most one	None	At most one	None	At most one	None	At most one	None	At most one	None	At most one
SA – Arg. (3)	0.7170	0.2845	0.8477	0.2845	0.8524	0.7825	0.8036	0.7825	0.8038	0.7870	0.7811	0.7870
SA – Aus. (1)	0.6715	0.5176	0.6740	0.5176	0.4874	0.4704	0.5536	0.4704	0.6694	0.7364	0.6384	0.7364
SA – Brazil (3)	0.3747	0.1556	0.5879	0.1556	0.1052	0.5099	0.0830	0.5099	0.2460	0.3841	0.3297	0.3841
SA – Canada (1)	0.7307	0.5581	0.7254	0.5581	0.4929	0.6218	0.4629	0.6218	0.5995	0.6106	0.6403	0.6106
SA – China (1)	0.5008	0.1467	0.7679	0.1467	0.9349	0.7015	0.9598	0.7015	0.7638	0.8677	0.6623	0.8677
SA – Col. (1)	0.1944	0.4059	0.1930	0.4059	0.3302	0.2256	0.5655	0.2256	0.8825	0.8815	0.8293	0.8815
SA – Egypt (1)	0.2418	0.2882	0.2873	0.2882	0.5252	0.5358	0.5560	0.5358	0.7950	0.9959	0.5174	0.9959
SA – France (1)	0.8597	0.9016	0.8060	0.9016	0.5019	0.6366	0.4650	0.6366	0.5234	0.5176	0.6129	0.5176
SA – Ger. (1)	0.8962	0.8159	0.8603	0.8159	0.8200	0.7650	0.7892	0.7650	0.5369	0.6777	0.5119	0.6777
SA – HK (1)	0.7895	0.6123	0.7747	0.6123	0.7927	0.6847	0.7978	0.6847	0.2490	0.7181	0.1731	0.7181
SA – India (1)	0.1591	0.0687	0.4001	0.0687	0.2410	0.3772	0.2903	0.3772	0.4516	0.7690	0.3523	0.7690
SA – Indon. (1)	0.2041	0.0836	0.4529	0.0836	0.6451	0.5162	0.7192	0.5162	0.5685	0.7220	0.5201	0.7220
SA – Japan (1)	0.7176	0.7835	0.6537	0.7835	0.8860	0.5431	0.9589	0.5431	0.5407	0.8359	0.4074	0.8359
SA – Korea (1)	0.0171	0.3216	0.0169	0.3216	0.1812	0.8797	0.0847	0.8797	0.0770	0.0837	0.3143	0.0837
SA – Mexico (1)	0.0141	0.0308	0.0654	0.0308	0.0733	0.1641	0.1510	0.1641	0.3667	0.6007	0.3530	0.6007
SA – Moroc. (1)	0.0591	0.3013	0.0641	0.3013	0.3628	0.9029	0.2051	0.9029	0.1103	0.9435	0.0330	0.9435
SA – Ned. (1)	0.9028	0.9712	0.8581	0.9712	0.6935	0.7446	0.6347	0.7446	0.3647	0.6093	0.3456	0.6093
SA – Nigeria (4)	0.1156	0.0614	0.3178	0.0614	0.6480	0.5838	0.6001	0.5838	0.7924	0.9383	0.6326	0.9383
SA – Pakistan (1)	0.2230	0.1136	0.4215	0.1136	0.7423	0.6041	0.7813	0.6041	0.6604	0.8393	0.5479	0.8393
SA – Philpp. (1)	0.4725	0.3105	0.5548	0.3105	0.9147	0.7901	0.9072	0.7901	0.3578	0.8078	0.2370	0.8078
SA – Poland (1)	0.7911	0.4197	0.8461	0.4197	0.4144	0.6736	0.3462	0.6736	0.1703	0.6485	0.1221	0.6485
SA – Russia (1)	0.1066	0.1878	0.1551	0.1878	0.5249	0.7096	0.4512	0.7096	0.3936	0.6363	0.3643	0.6363
SA – Spain (1)	0.6885	0.4200	0.7357	0.4200	0.2553	0.6157	0.2039	0.6157	0.3643	0.5249	0.3975	0.5249
SA – Sui. (1)	0.8615	0.9702	0.8052	0.9702	0.5595	0.6633	0.5183	0.6633	0.5254	0.6046	0.5496	0.6046
SA – Turkey (1)	0.0049	0.0490	0.0165	0.0490	0.0242	0.3513	0.0224	0.3513	0.2329	0.3799	0.3128	0.3799
SA – UK (1)	0.8675	0.8445	0.8210	0.8445	0.6481	0.6227	0.6528	0.6227	0.6320	0.4897	0.7711	0.4897
SA – USA (1)	0.8457	0.7255	0.8126	0.7255	0.3944	0.6321	0.3440	0.6321	0.4514	0.4232	0.5952	0.4232

	p-values (price index)											
Trend/int.	no trend/intercept in the C.E. or VAR				intercept in C.E. and VAR				intercept and trend in C.E., no trend in VAR			
Test method	Trace		Max Eigenvalue		Trace		Max Eigenvalue		Trace		Max Eigenvalue	
Hypothesized no. of CE’s	None	At most one	None	At most one	None	At most one	None	At most one	None	At most one	None	At most one
SA – Arg. (1)	0.2064	0.1049	0.4080	0.1049	0.6652	0.5802	0.7013	0.5802	0.7894	0.7135	0.8104	0.7135
SA – Aus.(2)	0.5979	0.8732	0.5137	0.8732	0.4622	0.4849	0.5110	0.4849	0.6360	0.5765	0.7118	0.5765
SA – Bang. (1)	0.2042	0.3008	0.2356	0.3008	0.4464	0.5453	0.4518	0.5453	0.7581	0.7364	0.7547	0.7364
SA – Brazil (1)	0.0015	0.0164	0.0116	0.0164	0.0161	0.1481	0.0323	0.1481	0.1512	0.6452	0.1059	0.6452
SA – Canada (1)	0.5940	0.5512	0.5764	0.5512	0.3591	0.4563	0.3977	0.4563	0.5451	0.7107	0.4990	0.7107
SA – China 1 (1)	0.0519	0.1677	0.0637	0.1677	0.2579	0.7465	0.1682	0.7465	0.3873	0.6934	0.3246	0.6934
SA – China 2 (1)	0.1301	0.0699	0.3297	0.0699	0.3368	0.2563	0.5372	0.2563	0.7718	0.7401	0.7702	0.7401
SA – Egypt (1)	0.3174	0.4845	0.3025	0.4845	0.6887	0.7429	0.6295	0.7429	0.8483	0.9897	0.6287	0.9897
SA – France (1)	0.6591	0.7395	0.5973	0.7395	0.2651	0.3916	0.3143	0.3916	0.4876	0.5828	0.5167	0.5828
SA – Ger. (1)	0.6954	0.7363	0.6378	0.7363	0.6318	0.5023	0.7127	0.5023	0.6538	0.7158	0.6333	0.7158
SA – HK (1)	0.4972	0.5021	0.4882	0.5021	0.3938	0.5382	0.3920	0.5382	0.2690	0.5951	0.2415	0.5951
SA – India (1)	0.1613	0.0624	0.4256	0.0624	0.3477	0.3047	0.5016	0.3047	0.6253	0.7675	0.5585	0.7675
SA – Japan 1 (1)	0.3802	0.7480	0.3140	0.7480	0.5921	0.5823	0.6089	0.5823	0.1688	0.7247	0.1030	0.7247
SA – Japan 2 (1)	0.3361	0.8414	0.2645	0.8414	0.6354	0.6643	0.6109	0.6643	0.6176	0.8323	0.5000	0.8323
SA – Korea (1)	0.0060	0.1068	0.0116	0.1068	0.1097	0.5962	0.0750	0.5962	0.0693	0.3832	0.0769	0.3832
SA – Mexico (3)	0.0738	0.0251	0.3521	0.0251	0.1266	0.5550	0.0984	0.5550	0.3399	0.5205	0.3686	0.5205
SA – Ned. (1)	0.6532	0.9886	0.5660	0.9886	0.3837	0.3566	0.5052	0.3566	0.2890	0.6870	0.2232	0.6870
SA – Philipp. (1)	0.2809	0.1966	0.4027	0.1966	0.8318	0.7274	0.8252	0.7274	0.5303	0.8007	0.4200	0.8007
SA – Poland (1)	0.0843	0.0366	0.3197	0.0366	0.1081	0.3162	0.1352	0.3162	0.1171	0.8695	0.0454	0.8695
SA – Russia (3)	0.3615	0.1915	0.5208	0.1915	0.7411	0.8716	0.6671	0.8716	0.7037	0.6177	0.7665	0.6177
SA – Spain 1 (1)	0.5158	0.6580	0.4635	0.6580	0.2553	0.2731	0.3899	0.2731	0.5676	0.6262	0.5879	0.6262
SA – Spain 2 (1)	0.2828	0.1062	0.5401	0.1062	0.2127	0.3717	0.2546	0.3717	0.4999	0.6861	0.4606	0.6861
SA – Sui. (1)	0.6829	0.9279	0.5998	0.9279	0.3420	0.3860	0.4234	0.3860	0.5469	0.6286	0.5596	0.6286
SA – Thai. (1)	0.0178	0.1604	0.0271	0.1604	0.2151	0.7102	0.1412	0.7102	0.1997	0.2011	0.4281	0.2011
SA – Turkey (4)	0.0053	0.0628	0.0150	0.0628	0.0848	0.3259	0.0793	0.3259	0.1740	0.3283	0.2561	0.3283
SA – UK (1)	0.6824	0.8860	0.6021	0.8860	0.6159	0.3903	0.7774	0.3903	0.7332	0.7113	0.7395	0.7113
SA – USA (1)	0.6115	0.8119	0.5346	0.8119	0.2408	0.3465	0.3092	0.3465	0.4894	0.5093	0.5746	0.5093

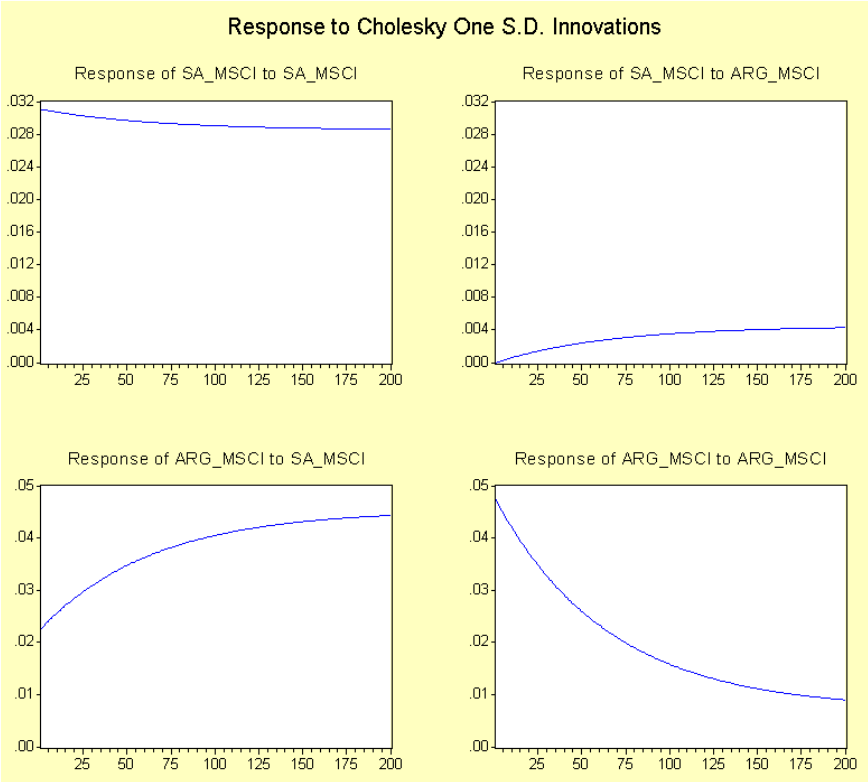
Appendix G – Johansen test using number of lags as selected by the various criteria

	p-values (MSCI) 1 lag											
Trend/int.	no trend/intercept in the C.E. or VAR				intercept in C.E. and VAR				intercept and trend in C.E., no trend in VAR			
Test method	Trace		Max Eigenvalue		Trace		Max Eigenvalue		Trace		Max Eigenvalue	
Hypothesized no. of CE's	None	At most one	None	At most one	None	At most one	None	At most one	None	At most one	None	At most one
SA – Arg. (1)	0.4909	0.1410	0.7659	0.1410	0.6791	0.5556	0.7344	0.5556	0.7219	0.7745	0.6793	0.7745
SA – Aus. (2)	0.7509	0.9158	0.6760	0.9158	0.6644	0.5370	0.7287	0.5370	0.7789	0.6987	0.8064	0.6987
SA – Brazil (3)	0.3747	0.1556	0.5879	0.1556	0.1052	0.5099	0.0830	0.5099	0.2460	0.3841	0.3297	0.3841
SA – Canada (2)	0.8151	0.7883	0.7646	0.7883	0.5327	0.6090	0.5184	0.6090	0.5961	0.5864	0.6539	0.5864
SA – China (2)	0.3519	0.1070	0.6487	0.1070	0.8459	0.5998	0.9026	0.5998	0.8168	0.7975	0.7920	0.7975
SA – Col. (4)	0.4437	0.2699	0.5506	0.2699	0.7681	0.9720	0.6945	0.9720	0.7970	0.8990	0.6816	0.8990
SA – Egypt (2)	0.3097	0.2402	0.4039	0.2402	0.6380	0.6938	0.5960	0.6938	0.7459	0.9911	0.4725	0.9911
SA – France (2)	0.8086	0.6176	0.7949	0.6176	0.3435	0.6033	0.3012	0.6033	0.3587	0.5530	0.3722	0.5530
SA – Ger. (2)	0.8742	0.9937	0.8208	0.9937	0.7935	0.6443	0.8209	0.6443	0.4705	0.7311	0.3967	0.7311
SA – HK (2)	0.7725	0.7917	0.7146	0.7917	0.6981	0.7158	0.6581	0.7158	0.3086	0.5185	0.3292	0.5185
SA – India (2)	0.2259	0.0851	0.4913	0.0851	0.4614	0.5089	0.4937	0.5089	0.5884	0.6528	0.5951	0.6528
SA – Indon. (4)	0.3535	0.1921	0.5091	0.1921	0.7510	0.8066	0.6826	0.8066	0.5344	0.5894	0.5722	0.5894
SA – Japan (4)	0.5779	0.9923	0.4878	0.9923	0.9319	0.9838	0.8973	0.9838	0.5332	0.8246	0.4069	0.8246
SA – Korea (1)	0.0171	0.3216	0.0169	0.3216	0.1812	0.8797	0.0847	0.8797	0.0770	0.0837	0.3143	0.0837
SA – Mexico (2)	0.0332	0.0378	0.1312	0.0378	0.1388	0.1841	0.2709	0.1841	0.5175	0.5946	0.5466	0.5946
SA – Moroc. (3)	0.1920	0.2685	0.2341	0.2685	0.7929	0.7484	0.7361	0.7484	0.2794	0.9412	0.1196	0.9412
SA – Ned. (2)	0.8634	0.8136	0.8196	0.8136	0.6458	0.6323	0.6439	0.6323	0.2420	0.6787	0.1801	0.6787
SA – Nigeria (4)	0.1156	0.0614	0.3178	0.0614	0.6480	0.5838	0.6001	0.5838	0.7924	0.9383	0.6326	0.9383
SA – Pakistan (2)	0.1913	0.1310	0.3387	0.1310	0.7305	0.6480	0.7404	0.6480	0.6559	0.7282	0.6269	0.7282
SA – Philpp. (3)	0.4090	0.3972	0.4324	0.3972	0.8903	0.7176	0.8564	0.7176	0.3167	0.7871	0.2086	0.7871
SA – Poland (3)	0.8591	0.6628	0.8419	0.6628	0.3240	0.7555	0.2567	0.7555	0.2282	0.5224	0.2267	0.5224
SA – Russia (1)	0.1066	0.1878	0.1551	0.1878	0.5249	0.7096	0.4512	0.7096	0.3936	0.6363	0.3643	0.6363
SA – Spain (2)	0.7337	0.6051	0.7136	0.6051	0.2029	0.5505	0.1712	0.5505	0.3208	0.5697	0.3150	0.5697
SA – Sui. (2)	0.8519	0.8137	0.8054	0.8137	0.4921	0.6287	0.4579	0.6287	0.4317	0.6354	0.4108	0.6354
SA – Turkey (1)	0.0049	0.0490	0.0165	0.0490	0.0242	0.3513	0.0224	0.3513	0.2329	0.3799	0.3128	0.3799
SA – UK (2)	0.8185	0.6477	0.7983	0.6477	0.5485	0.6181	0.5322	0.6181	0.5608	0.4683	0.7009	0.4683
SA – USA (2)	0.7825	0.5189	0.7970	0.5189	0.2106	0.5924	0.1668	0.5924	0.2884	0.4462	0.3477	0.4462

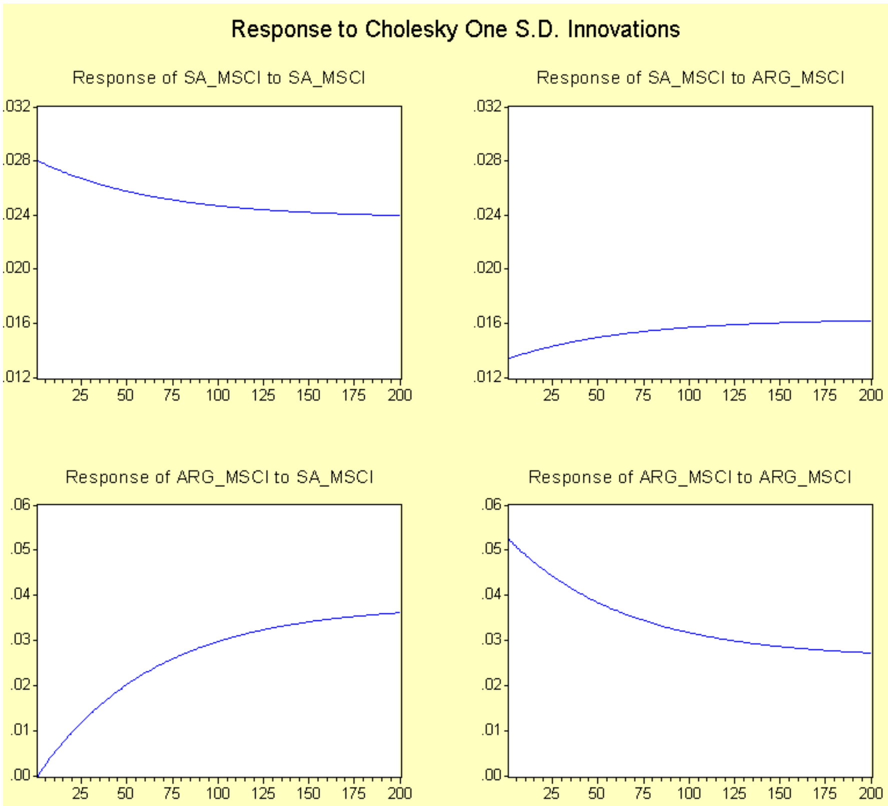
	p-values (price index) (1 lag)											
Trend/int.	no trend/intercept in the C.E. or VAR				intercept in C.E. and VAR				intercept and trend in C.E., no trend in VAR			
Test method	Trace		Max Eigenvalue		Trace		Max Eigenvalue		Trace		Max Eigenvalue	
Hypothesized no. of CE's	None	At most one	None	At most one	None	At most one	None	At most one	None	At most one	None	At most one
SA – Arg. (3)	0.3702	0.1347	0.6171	0.1347	0.9105	0.7844	0.8761	0.7844	0.8762	0.7704	0.8881	0.7704
SA – Aus. (2)	0.5979	0.8732	0.5137	0.8732	0.4622	0.4849	0.5110	0.4849	0.6360	0.5765	0.7118	0.5765
SA – Bang. (1)	0.2042	0.3008	0.2356	0.3008	0.4464	0.5453	0.4518	0.5453	0.7581	0.7364	0.7547	0.7364
SA – Brazil (2)	0.0150	0.0298	0.0708	0.0298	0.1455	0.2219	0.2487	0.2219	0.4669	0.5598	0.5066	0.5598
SA – Canada (2)	0.7164	0.9733	0.6347	0.9733	0.5136	0.4285	0.6196	0.4285	0.6629	0.6561	0.6882	0.6561
SA – China 1 (1)	0.0519	0.1677	0.0637	0.1677	0.2579	0.7465	0.1682	0.7465	0.3873	0.6934	0.3246	0.6934
SA – China 2 (1)	0.1301	0.0699	0.3297	0.0699	0.3368	0.2563	0.5372	0.2563	0.7718	0.7401	0.7702	0.7401
SA – Egypt (1)	0.3174	0.4845	0.3025	0.4845	0.6887	0.7429	0.6295	0.7429	0.8483	0.9897	0.6287	0.9897
SA – France (1)	0.6591	0.7395	0.5973	0.7395	0.2651	0.3916	0.3143	0.3916	0.4876	0.5828	0.5167	0.5828
SA – Ger. (1)	0.6954	0.7363	0.6378	0.7363	0.6318	0.5023	0.7127	0.5023	0.6538	0.7158	0.6333	0.7158
SA – HK (2)	0.5267	0.5584	0.5015	0.5584	0.4560	0.5217	0.4786	0.5217	0.4813	0.5043	0.5678	0.5043
SA – India (9)	0.3092	0.1271	0.5396	0.1271	0.6430	0.8282	0.5628	0.8282	0.6349	0.4397	0.8116	0.4397
SA – Japan 1 (2)	0.2202	0.7245	0.1720	0.7245	0.4557	0.5569	0.4562	0.5569	0.4412	0.7331	0.3620	0.7331
SA – Japan 2 (2)	0.2001	0.8676	0.1469	0.8676	0.4813	0.7159	0.3987	0.7159	0.6964	0.8390	0.5947	0.8390
SA – Korea (2)	0.0075	0.1870	0.0101	0.1870	0.1236	0.7603	0.0649	0.7603	0.0696	0.1560	0.1793	0.1560
SA – Mexico (2)	0.0470	0.0197	0.2733	0.0197	0.0408	0.1995	0.0682	0.1995	0.2411	0.5941	0.2109	0.5941
SA – Ned. (1)	0.6532	0.9886	0.5660	0.9886	0.3837	0.3566	0.5052	0.3566	0.2890	0.6870	0.2232	0.6870
SA – Phil. (2)	0.2098	0.2295	0.2779	0.2295	0.7380	0.7529	0.6868	0.7529	0.5444	0.7858	0.4465	0.7858
SA – Poland (2)	0.2534	0.1031	0.4966	0.1031	0.2226	0.3116	0.3068	0.3116	0.2470	0.8154	0.1403	0.8154
SA – Russia (8)	0.2039	0.1012	0.4110	0.1012	0.5236	0.9331	0.4359	0.9331	0.5449	0.5162	0.6420	0.5162
SA – Spain 1 (2)	0.6710	0.8822	0.5901	0.8822	0.2580	0.3784	0.3129	0.3784	0.4733	0.6383	0.4600	0.6383
SA – Spain 2 (2)	0.3580	0.1749	0.5366	0.1749	0.1680	0.3327	0.2130	0.3327	0.4187	0.6593	0.3803	0.6593
SA – Sui. (2)	0.6715	0.7571	0.6075	0.7571	0.3259	0.3939	0.3955	0.3939	0.4688	0.6656	0.4364	0.6656
SA – Thai. (2)	0.0040	0.1847	0.0054	0.1847	0.0693	0.7404	0.0332	0.7404	0.0875	0.2766	0.1393	0.2766
SA – Turkey (8)	0.0012	0.0478	0.0042	0.0478	0.0421	0.2973	0.0396	0.2973	0.1286	0.4118	0.1465	0.4118
SA – UK (2)	0.6326	0.8052	0.5579	0.8052	0.4440	0.4568	0.5074	0.4568	0.6295	0.5250	0.7419	0.5250
SA – USA (2)	0.6146	0.6169	0.5784	0.6169	0.1928	0.3877	0.2200	0.3877	0.4145	0.5542	0.4428	0.5542

Appendix H – bivariate IRFs at 1 lag, using intercept in CE specification, MSCI indices

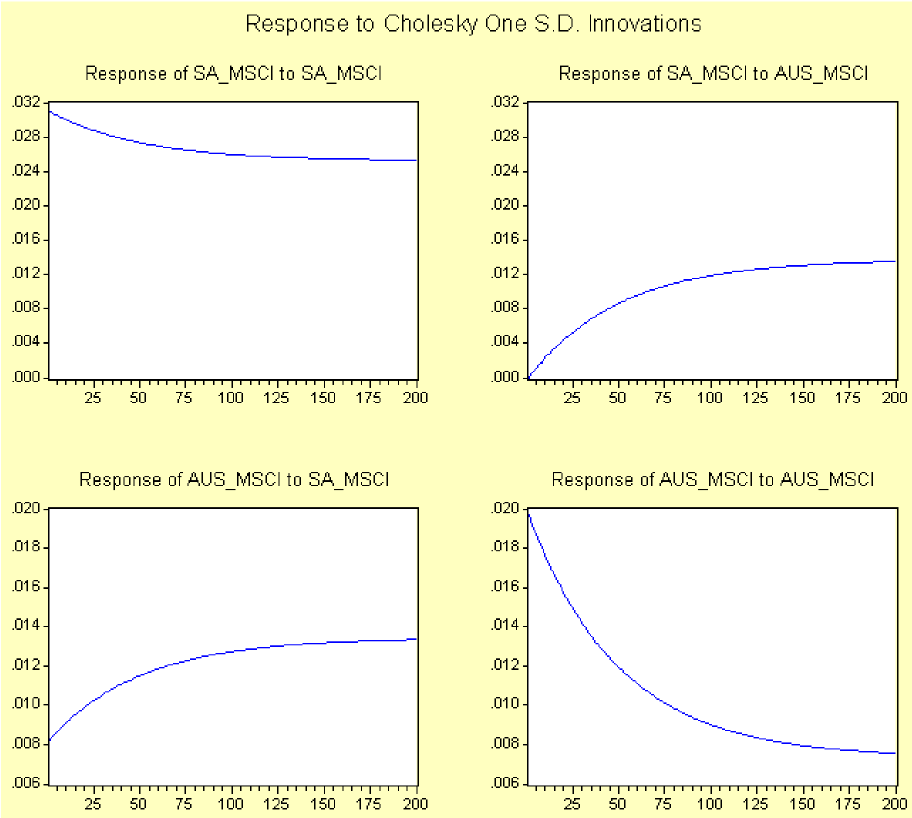
SA – Argentina, Cholesky ordering, SA – ARG



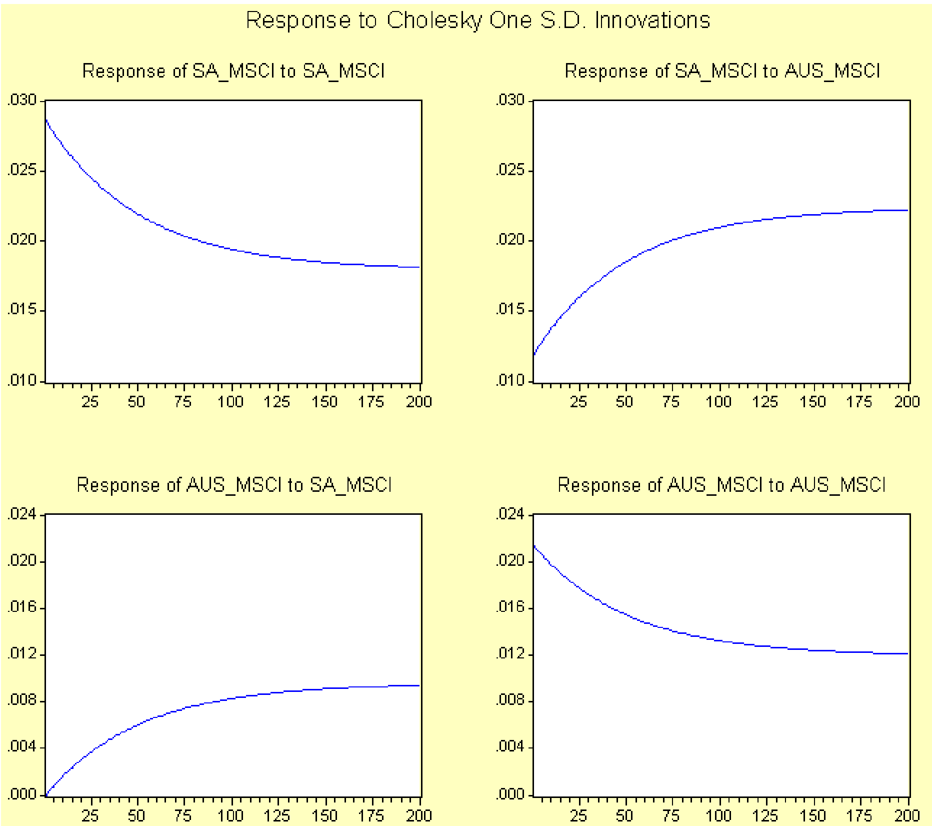
SA – Argentina, Cholesky ordering, ARG – SA



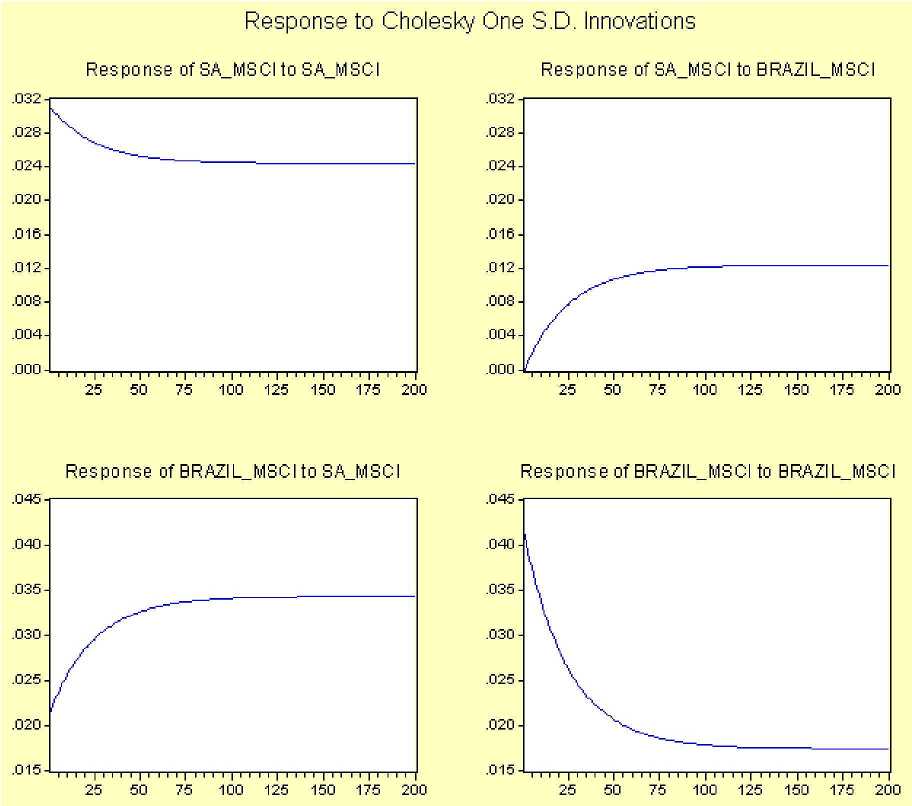
SA – Australia, Cholesky ordering, SA – Aus



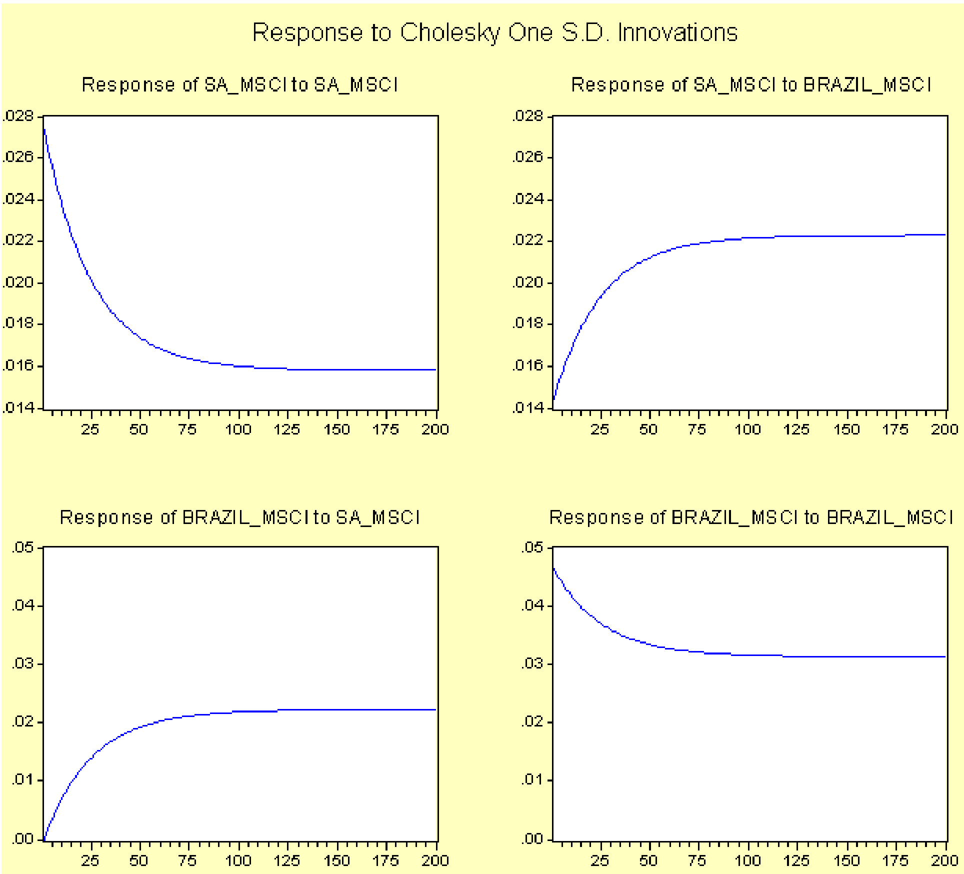
Cholesky ordering, Aus – SA



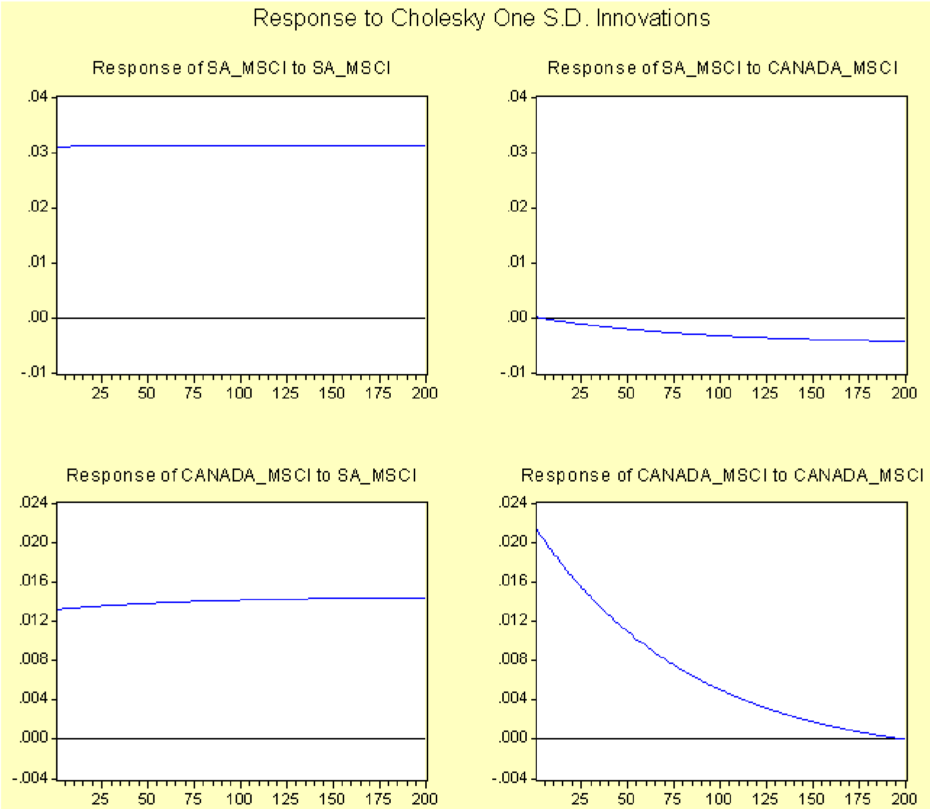
SA – Brazil, Cholesky ordering SA – Brazil



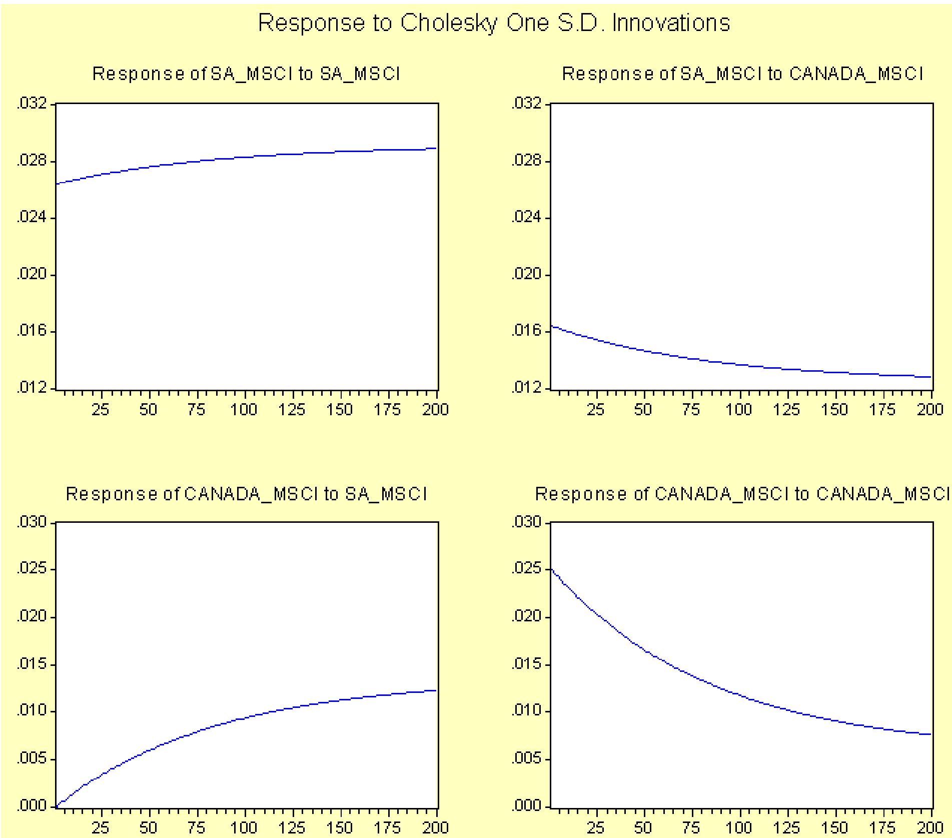
Cholesky Ordering Brazil – SA



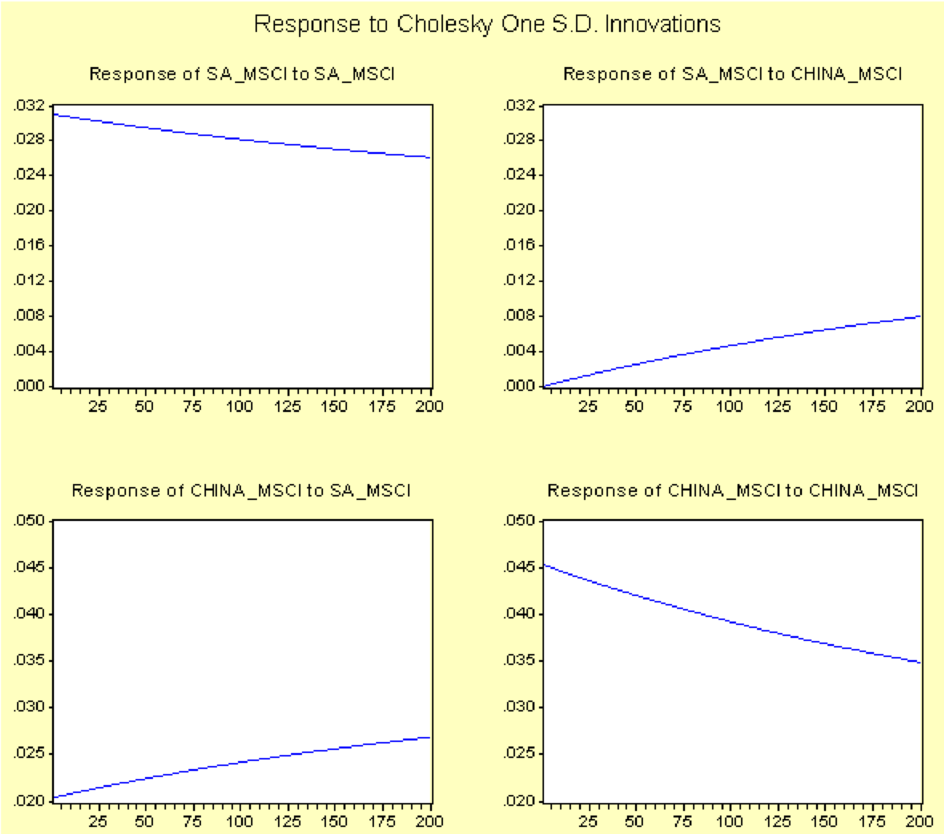
SA – Canada, Cholesky ordering SA – Canada



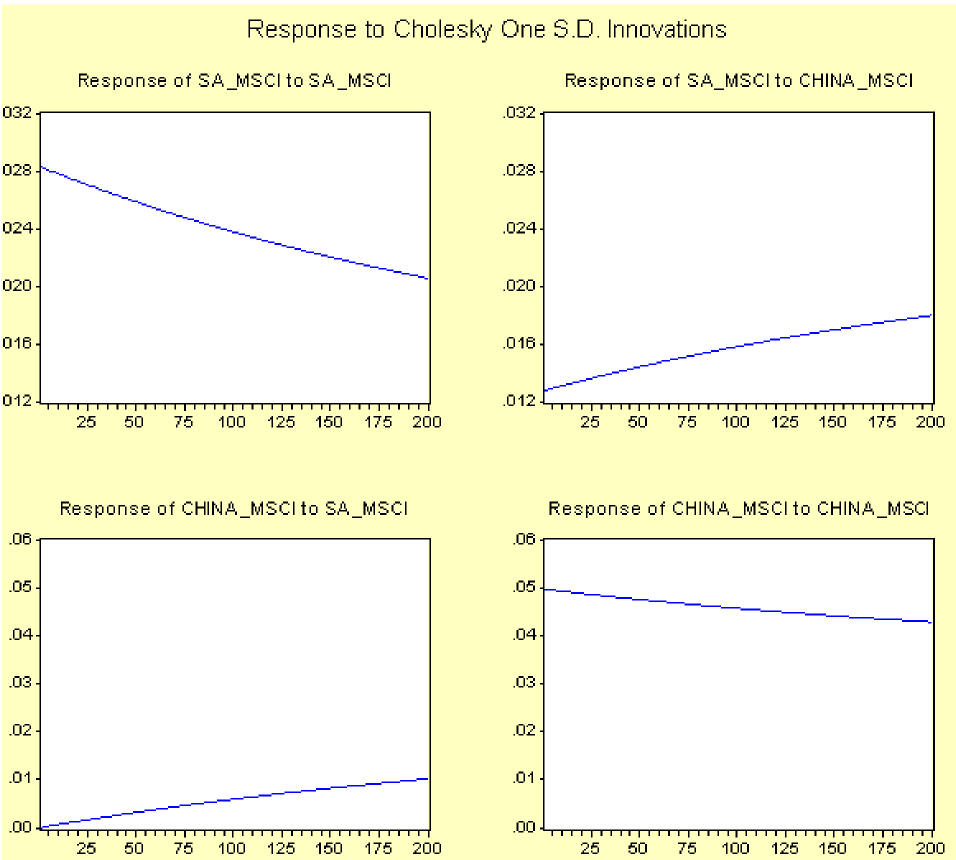
Cholesky ordering Canada – SA



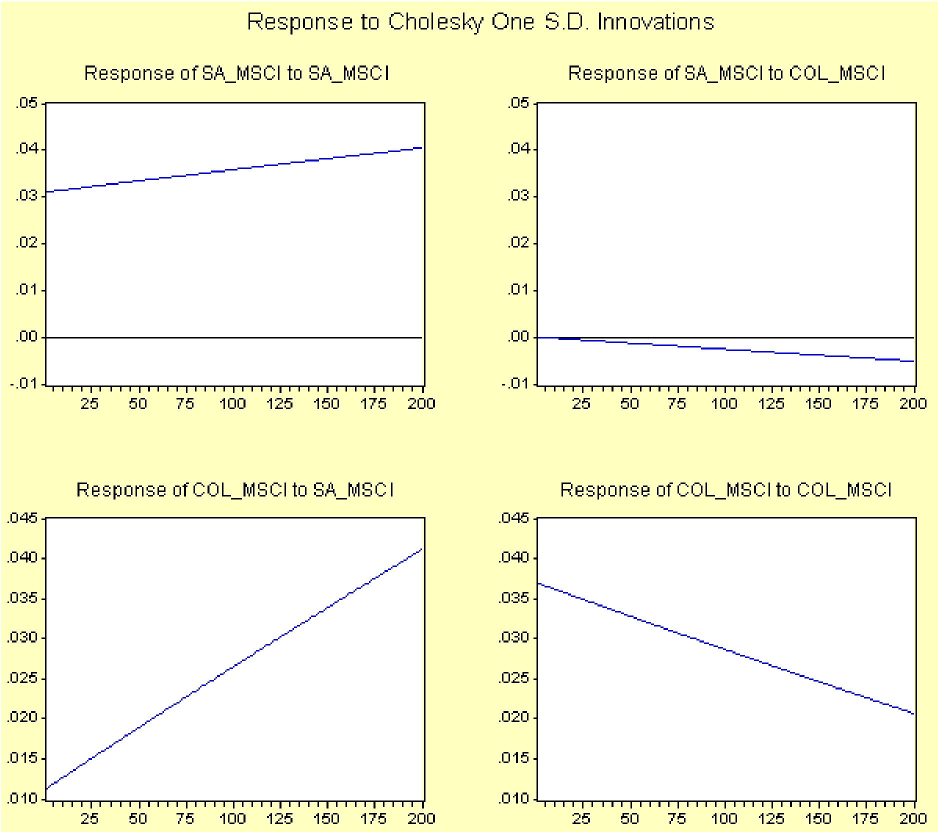
SA – China, Cholesky ordering SA – China



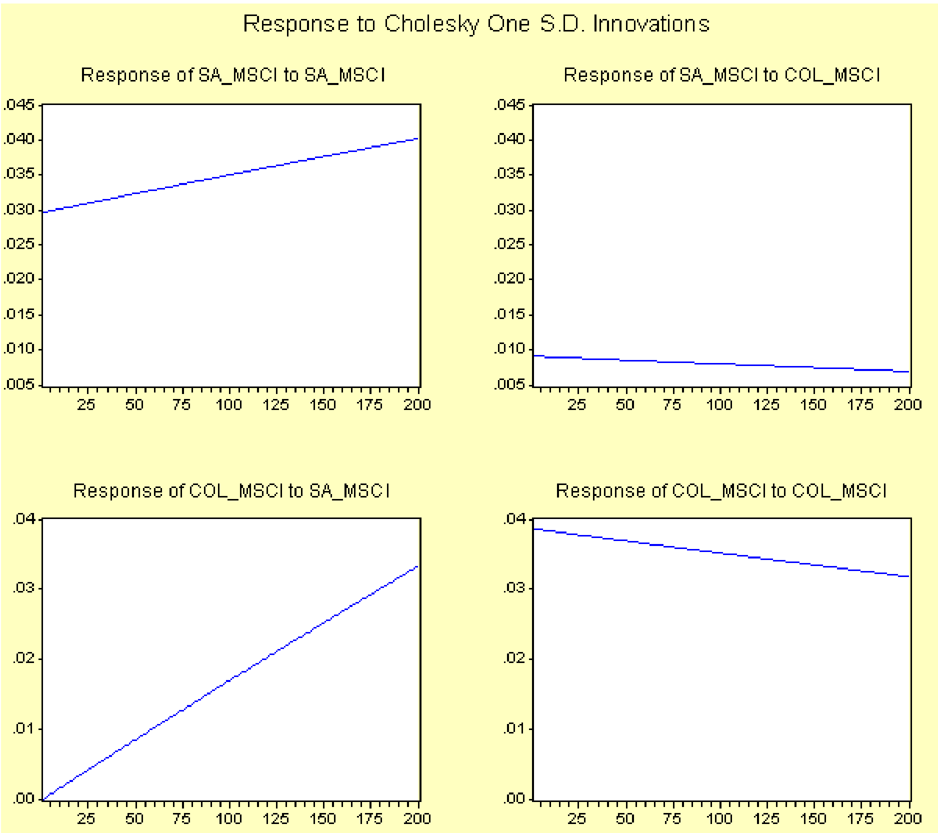
Cholesky ordering China – SA



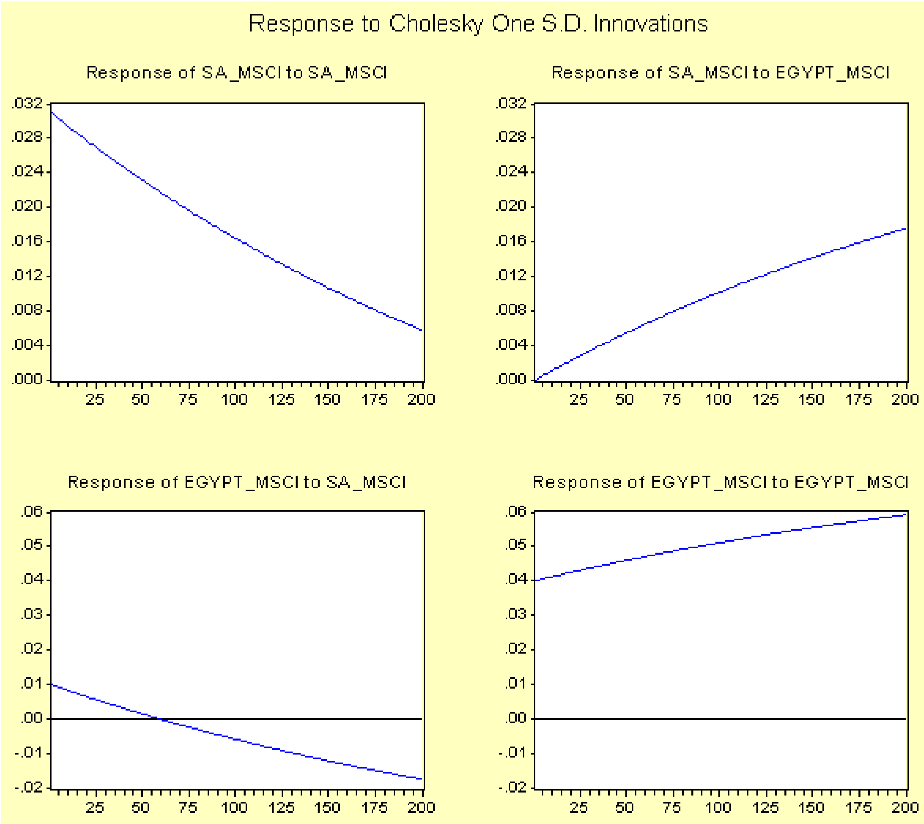
SA – Colombia, Cholesky ordering SA – Colombia



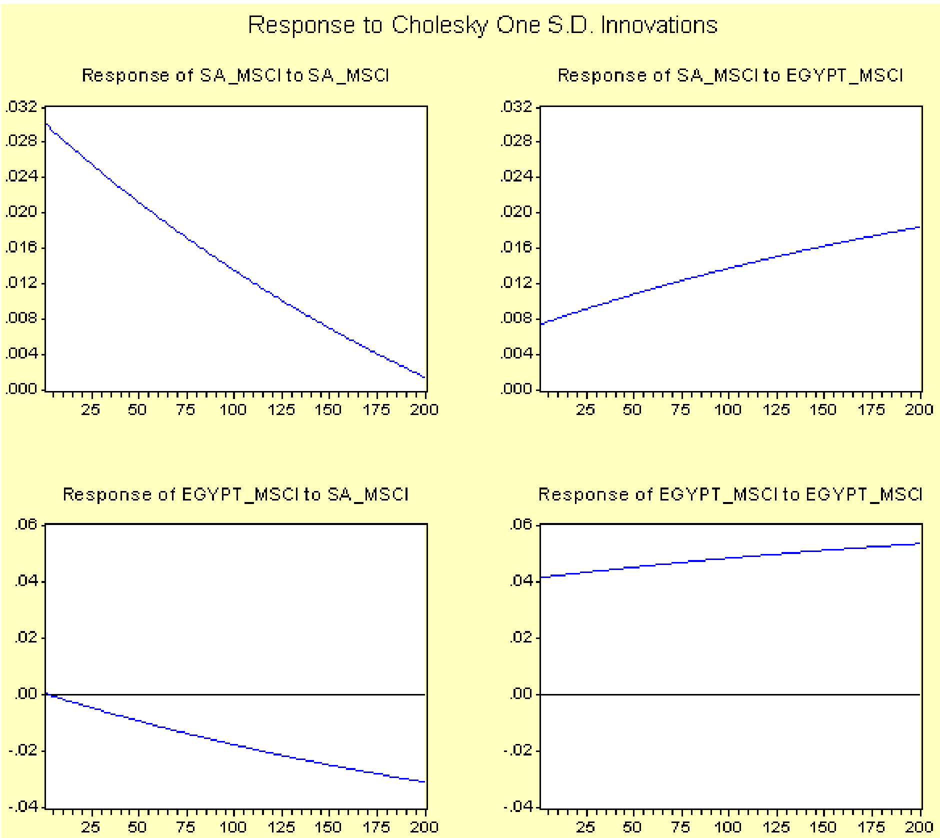
Cholesky ordering Colombia – SA



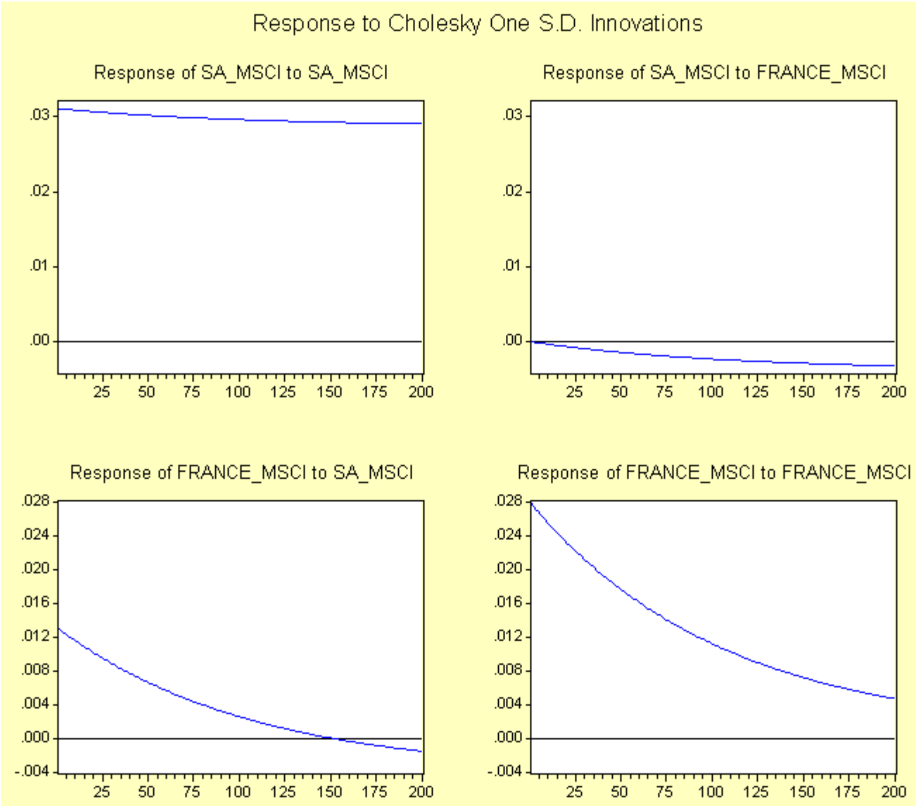
SA – Egypt Cholesky ordering SA – Egypt



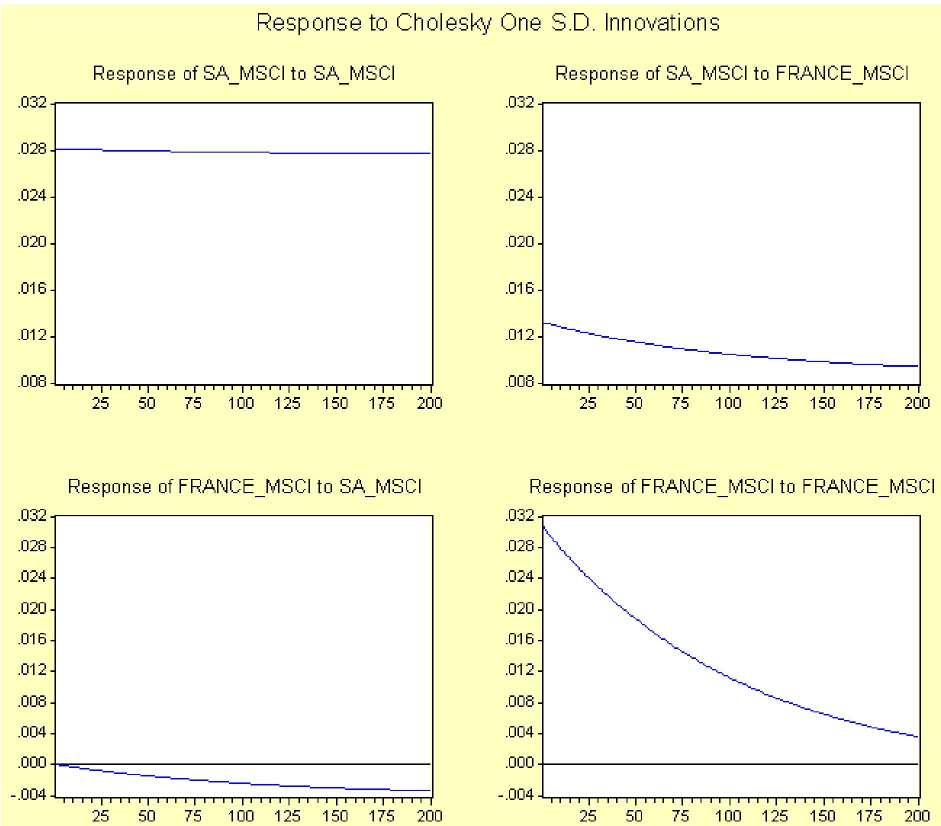
Cholesky ordering Egypt – SA



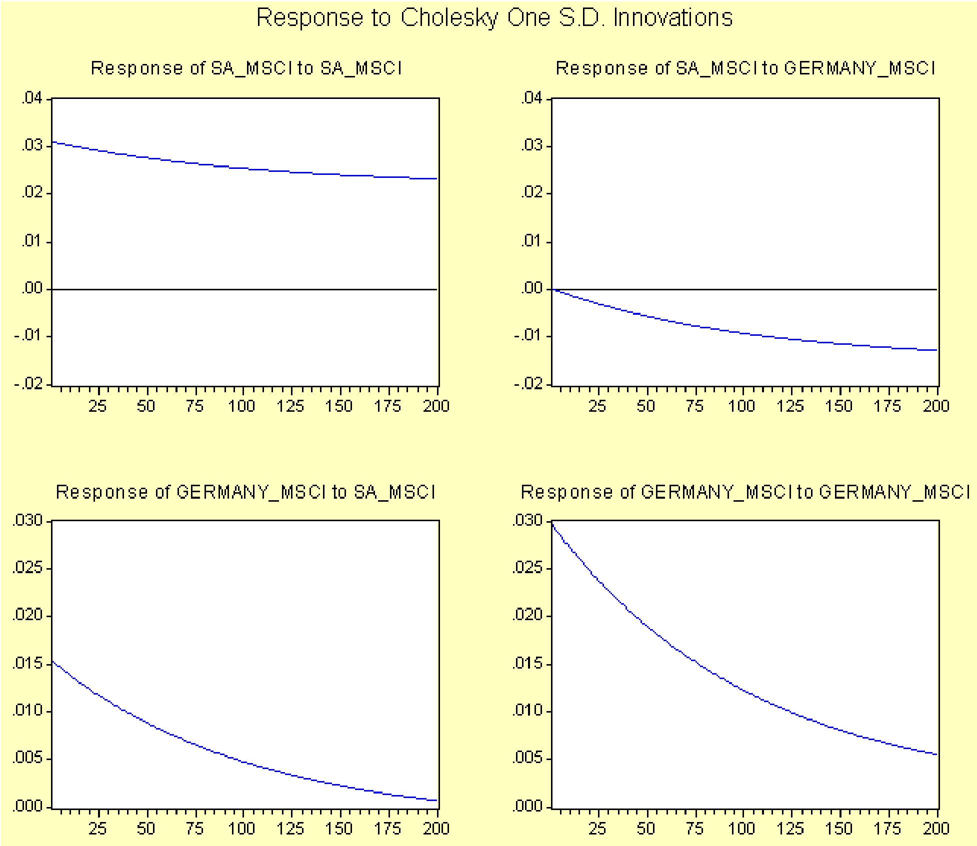
SA – France Cholesky ordering SA – France



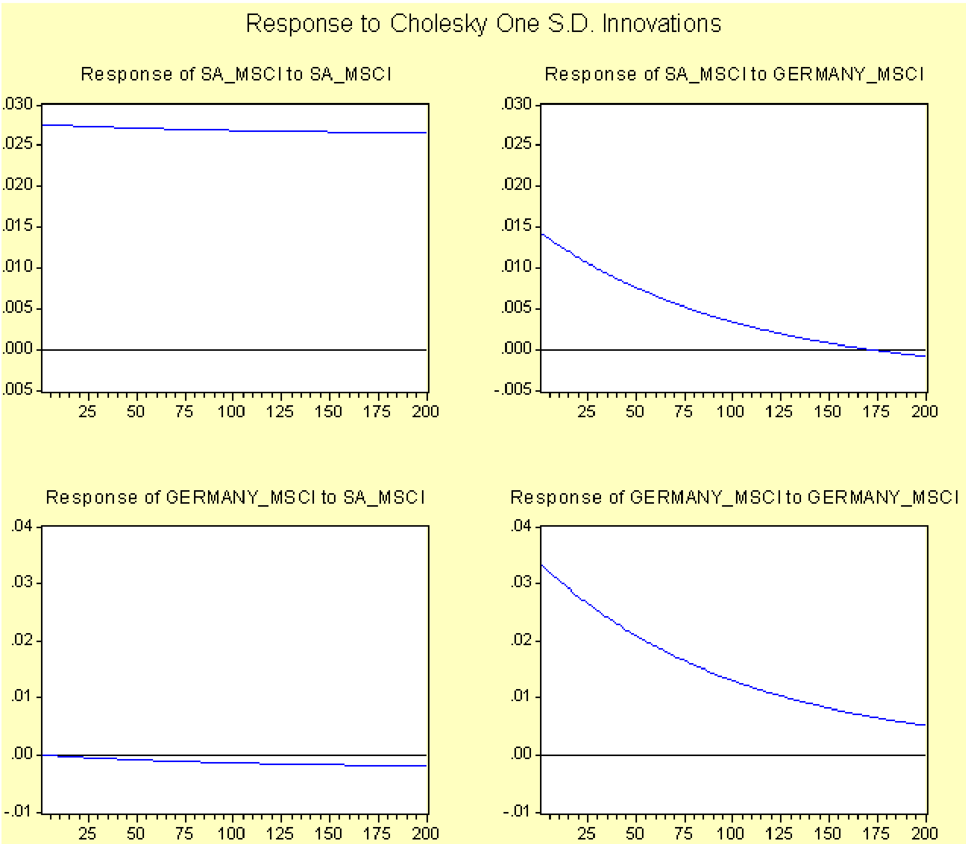
Cholesky ordering France – SA



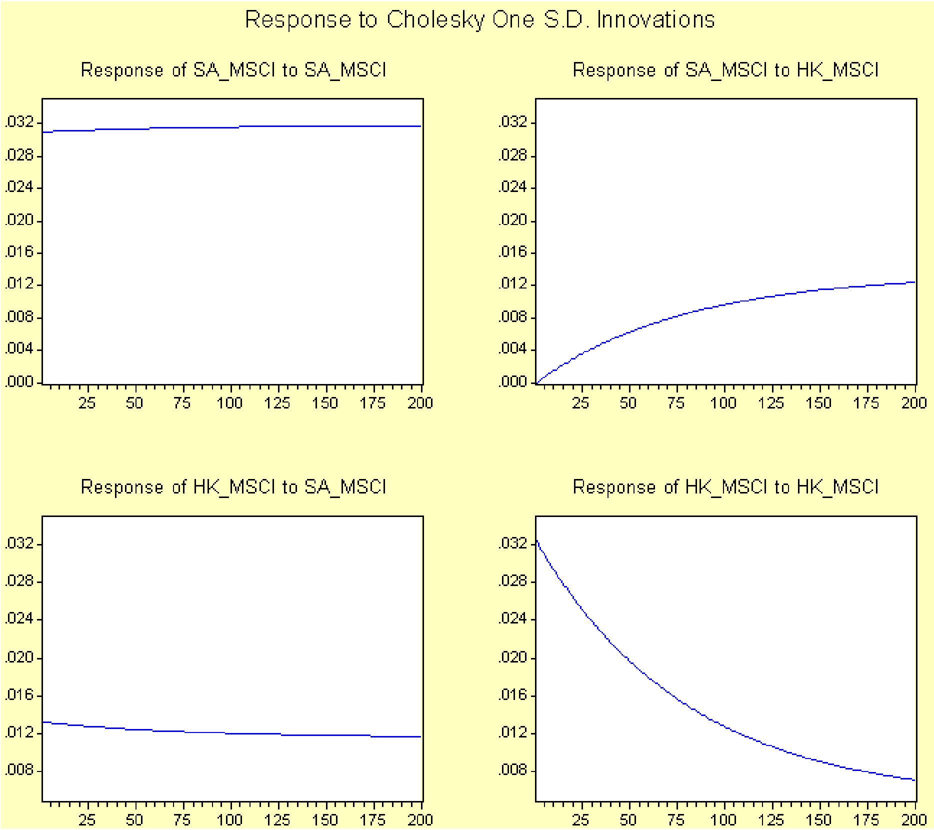
SA – Germany Cholesky ordering SA – Germany



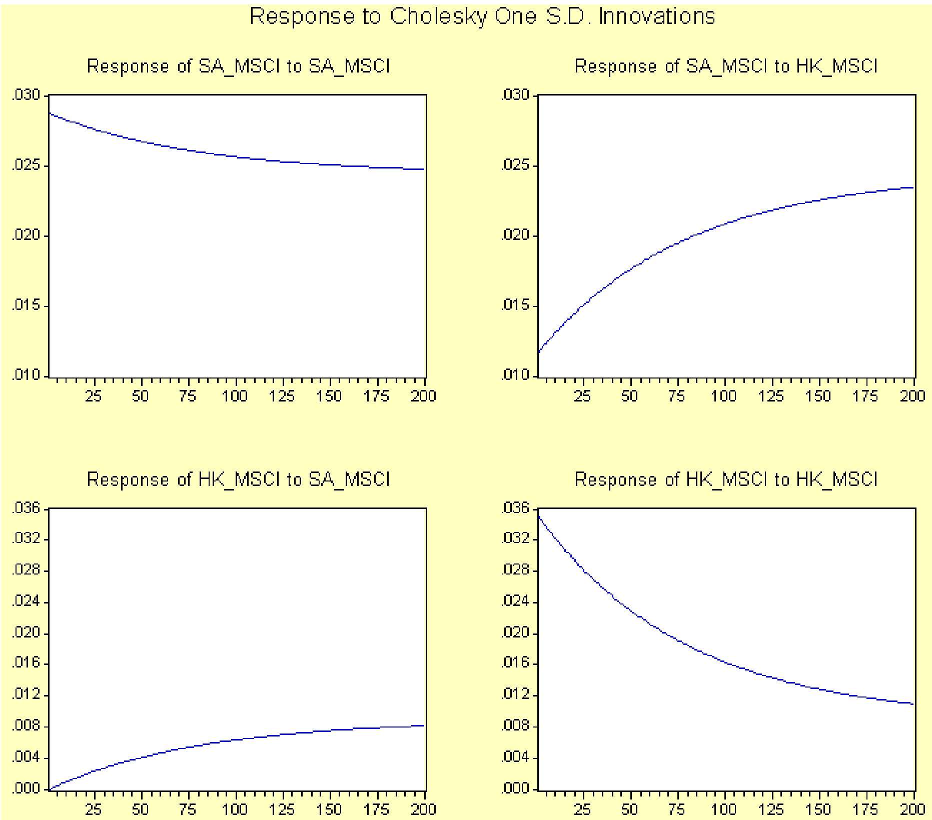
Cholesky ordering Germany – SA



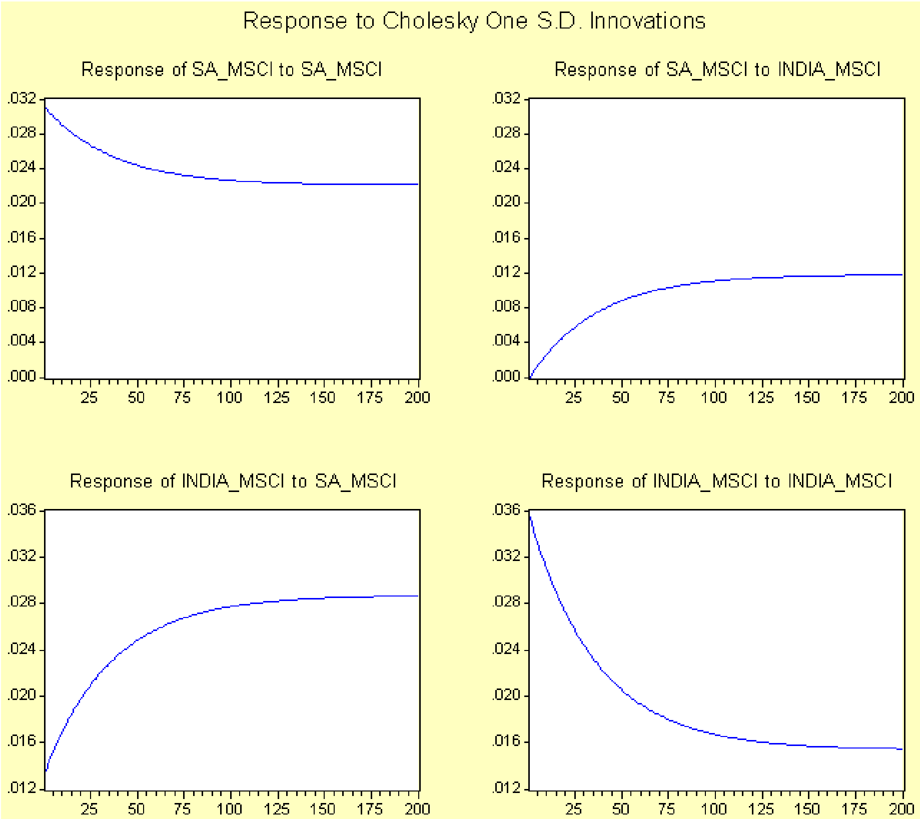
SA – Hong Kong Cholesky ordering SA – HK



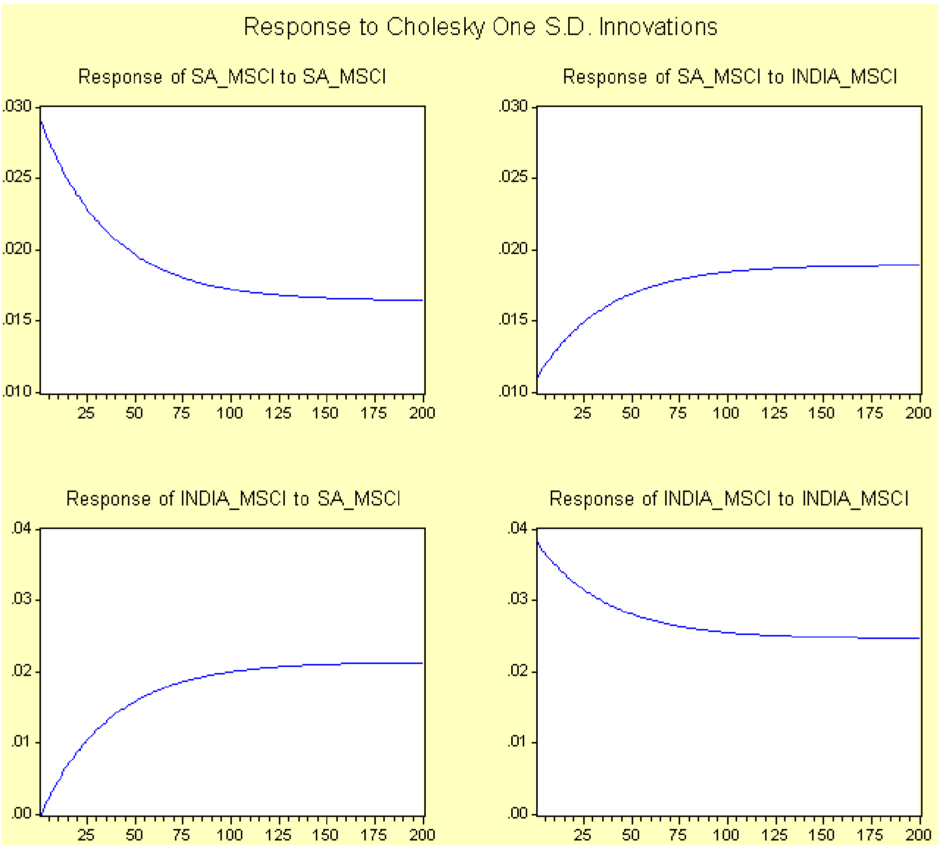
Cholesky ordering HK – SA



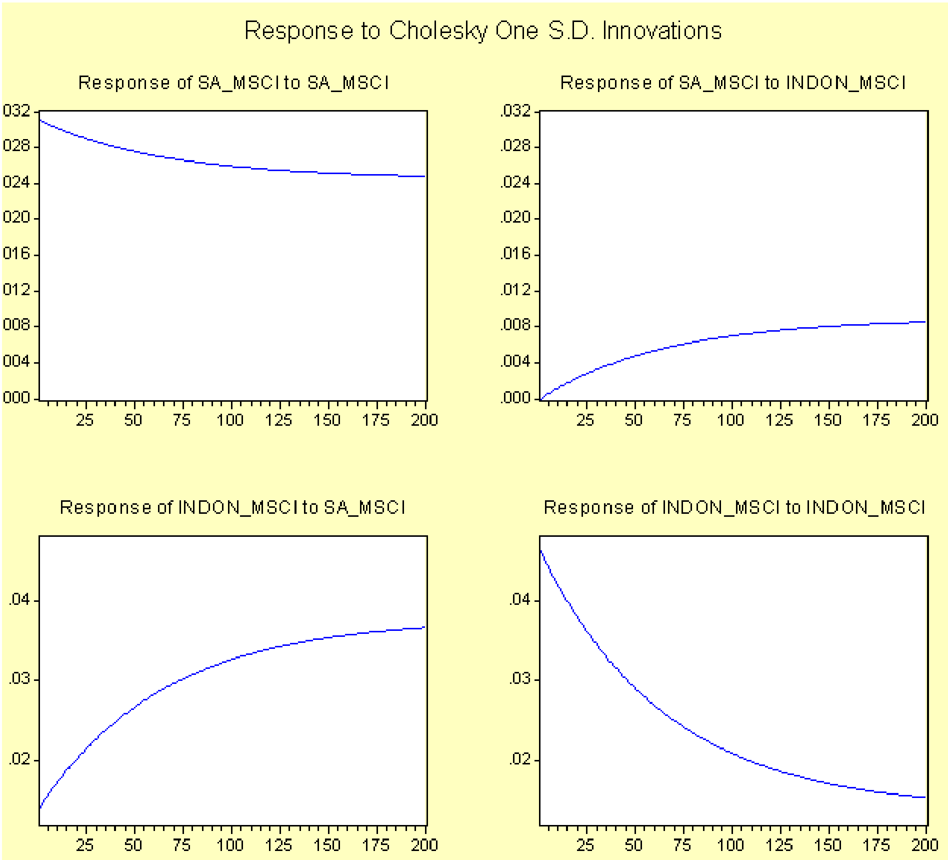
SA – India Cholesky ordering SA – India



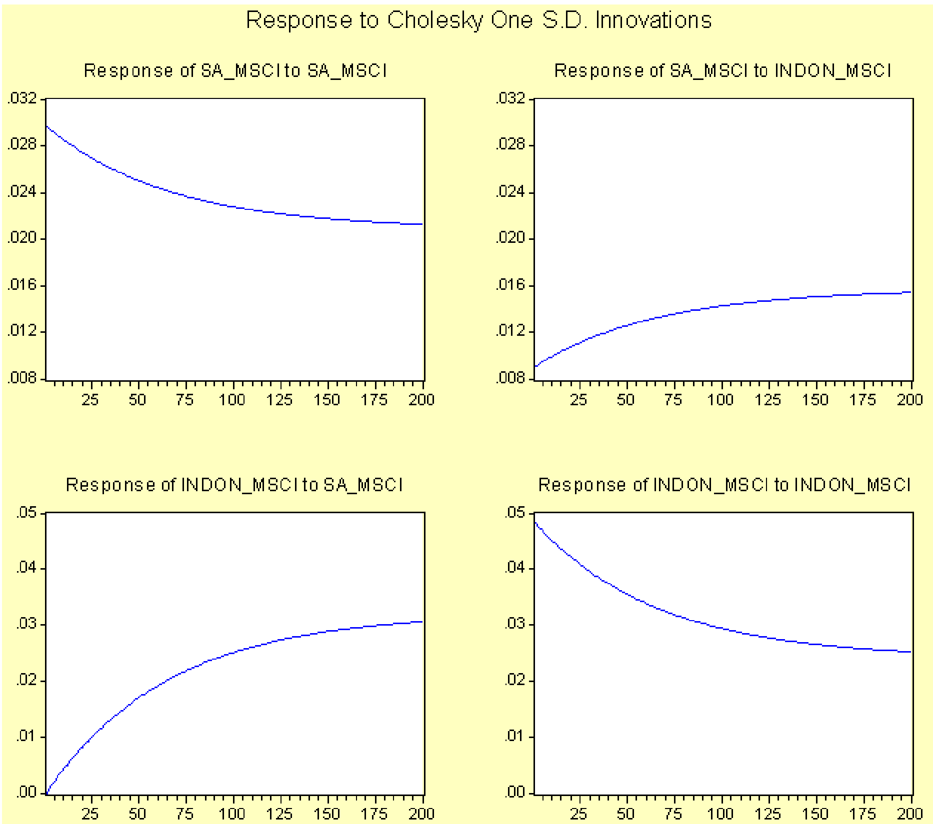
Cholesky ordering India – SA



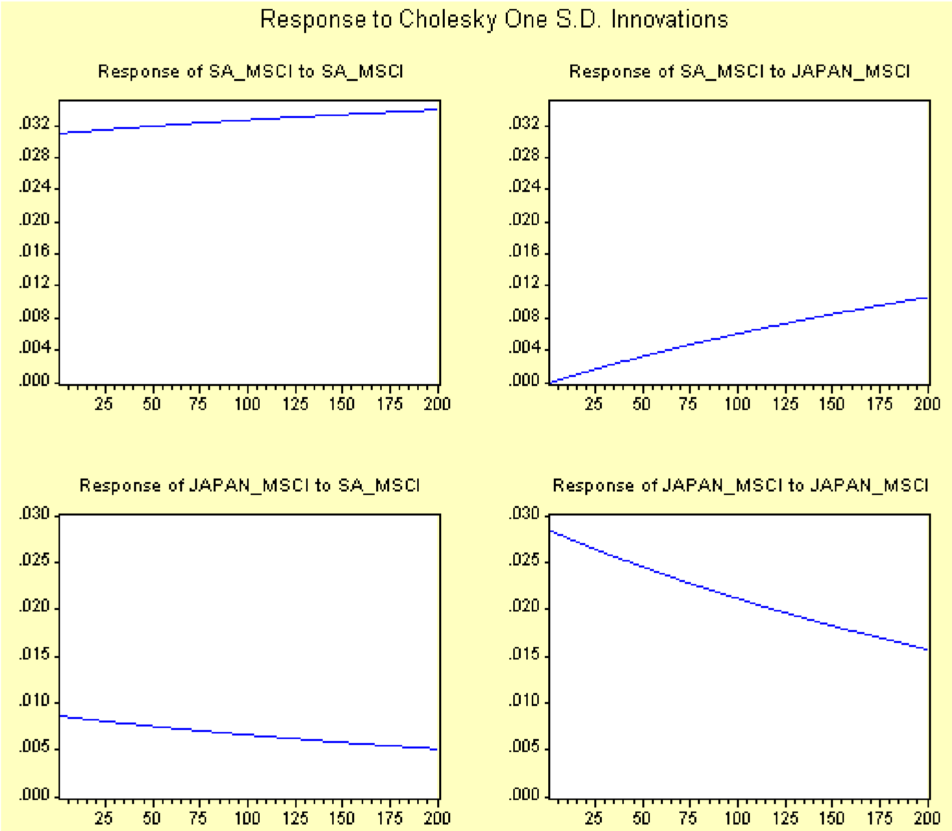
SA – Indonesia Cholesky ordering SA – Indonesia



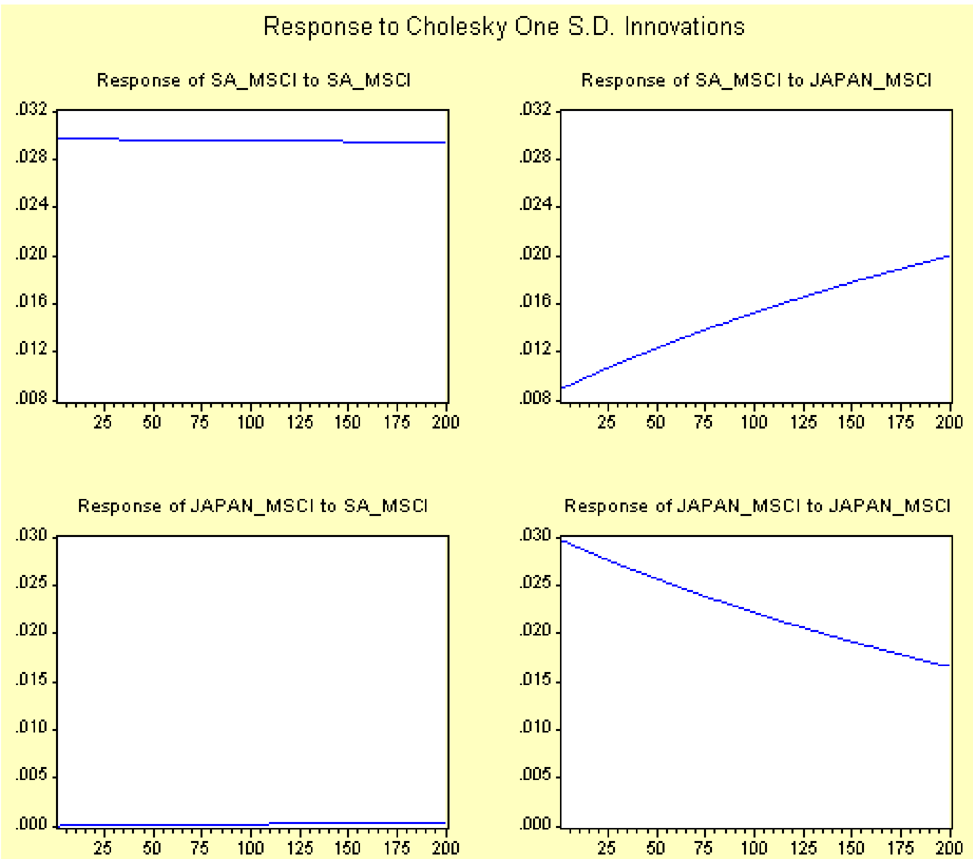
Cholesky ordering Indinesia – SA



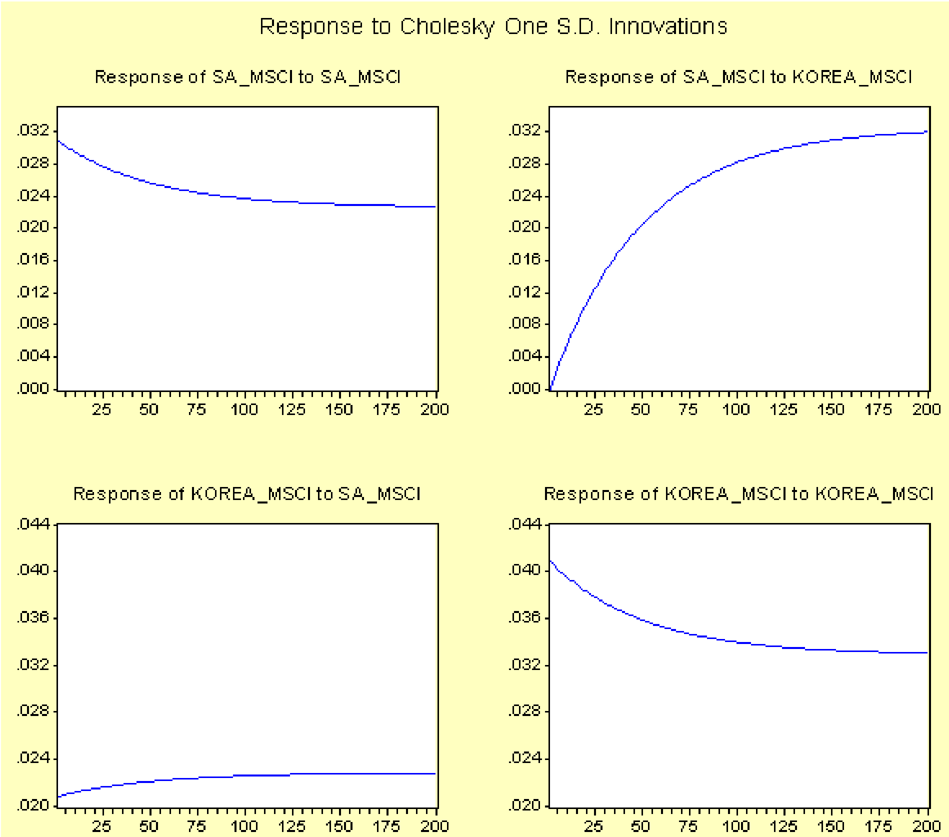
SA – Japan Cholesky ordering SA – Japan



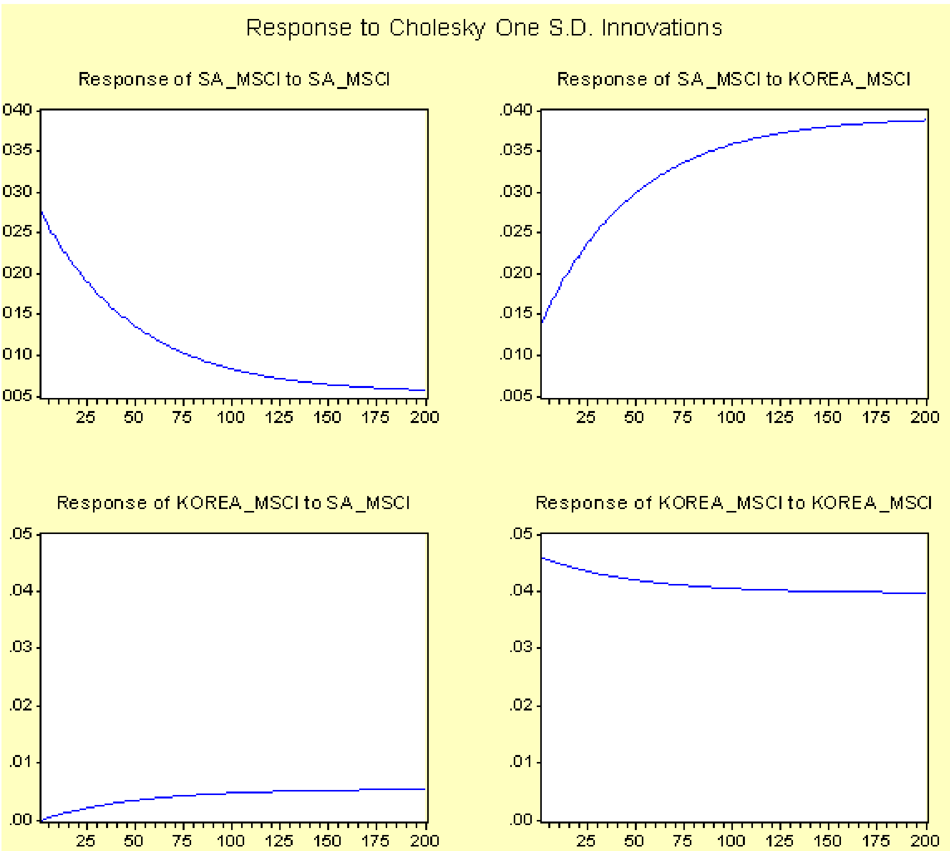
Cholesky ordering Japan – SA



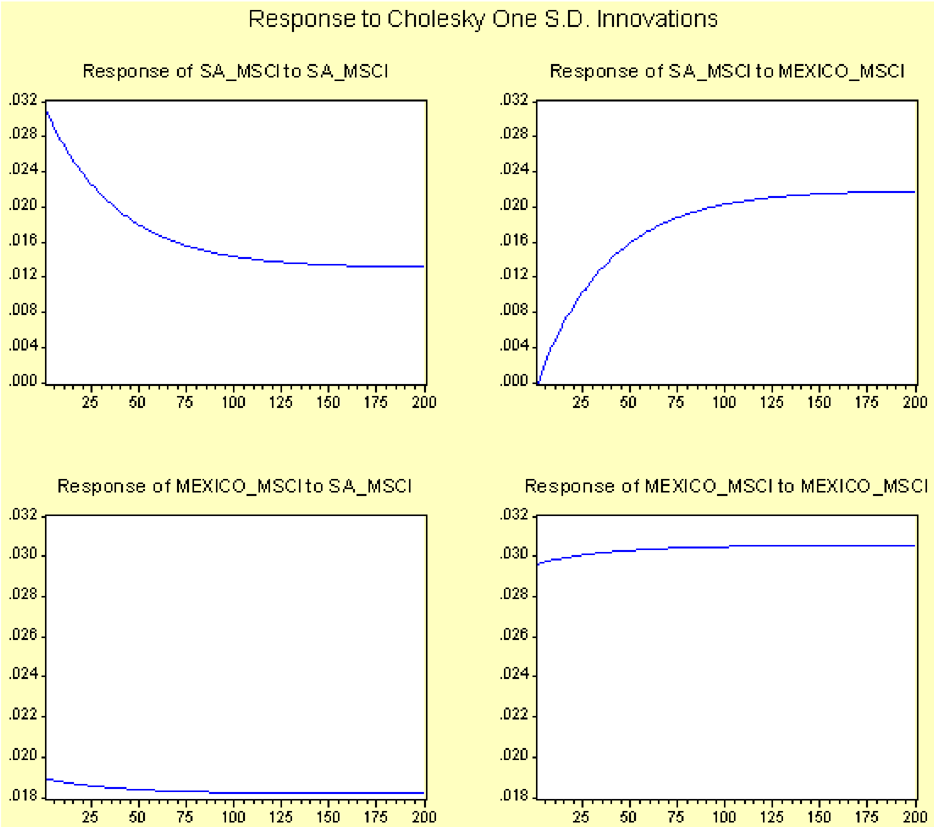
SA – Korea Cholesky ordering SA – Korea



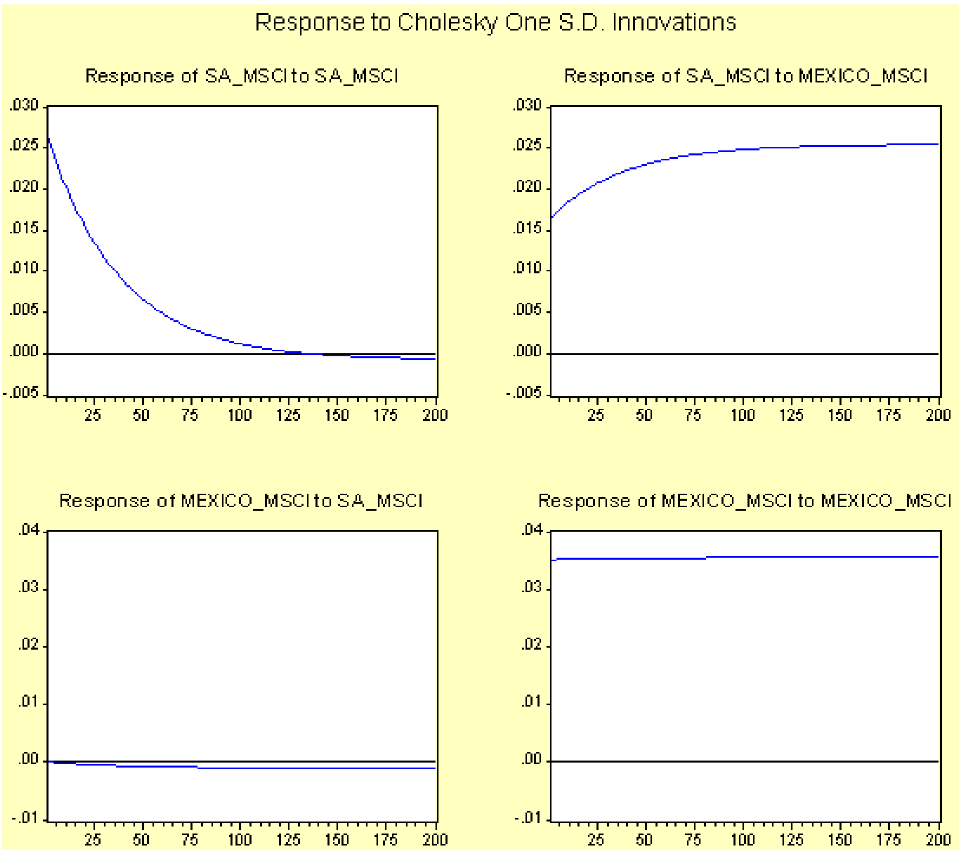
Cholesky ordering Korea – SA



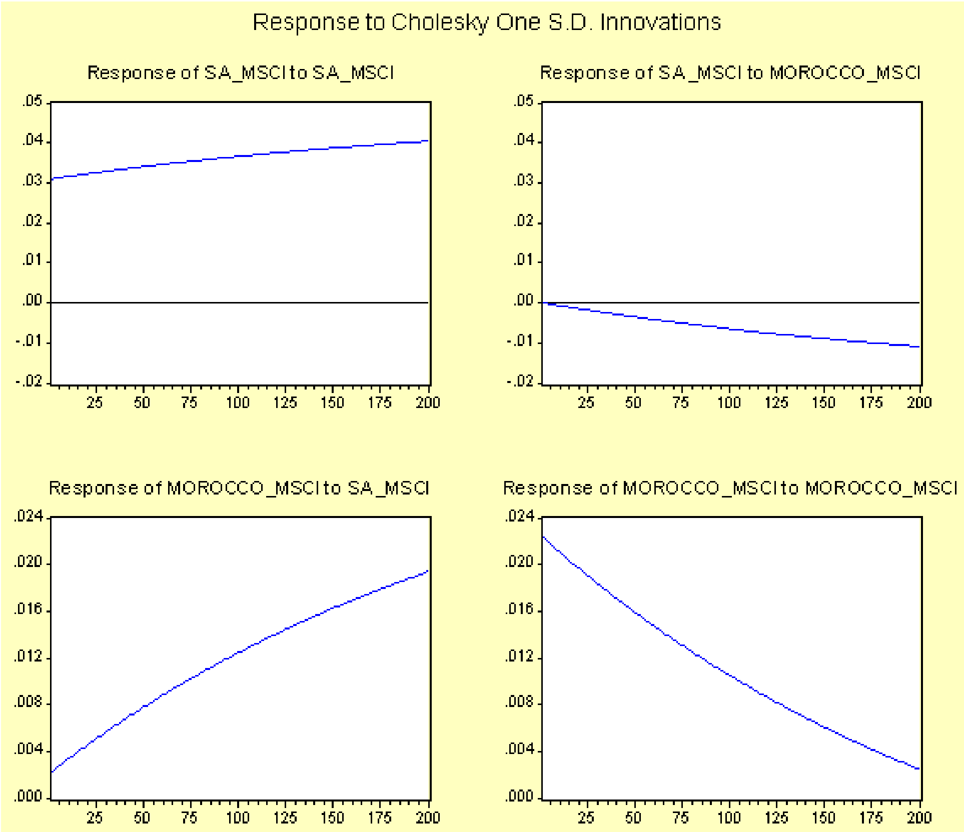
SA – Mexico Cholesky ordering SA – Mexico



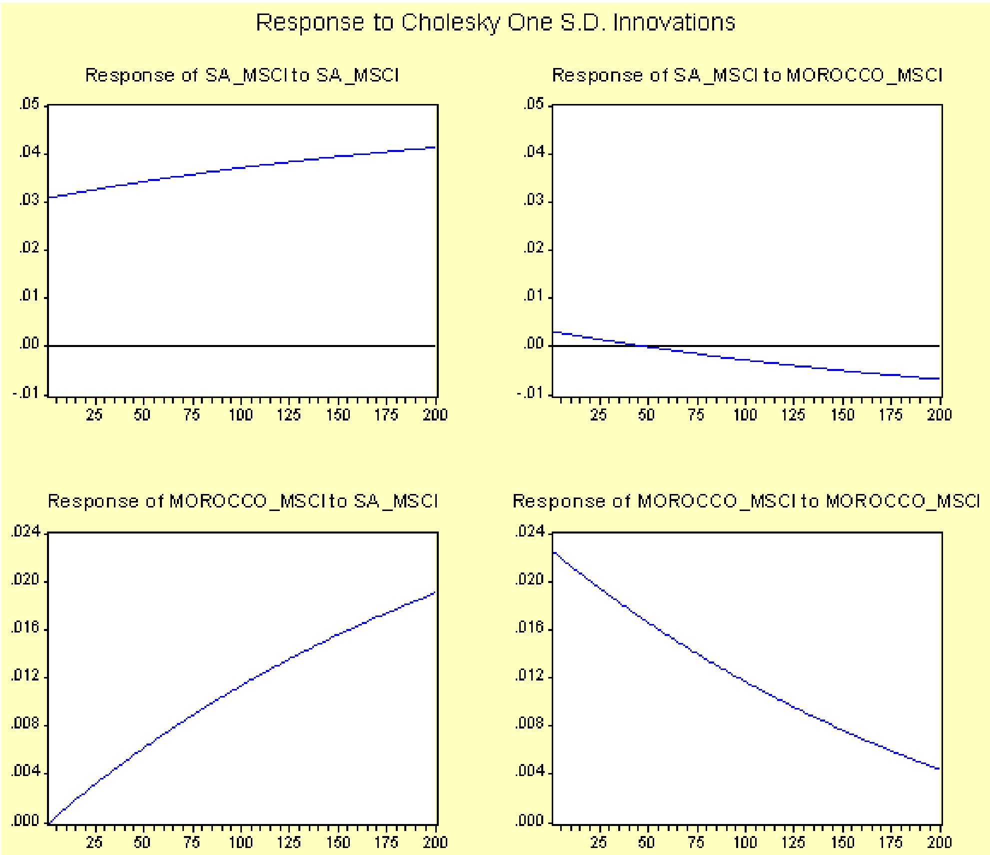
Cholesky ordering Mexico – SA



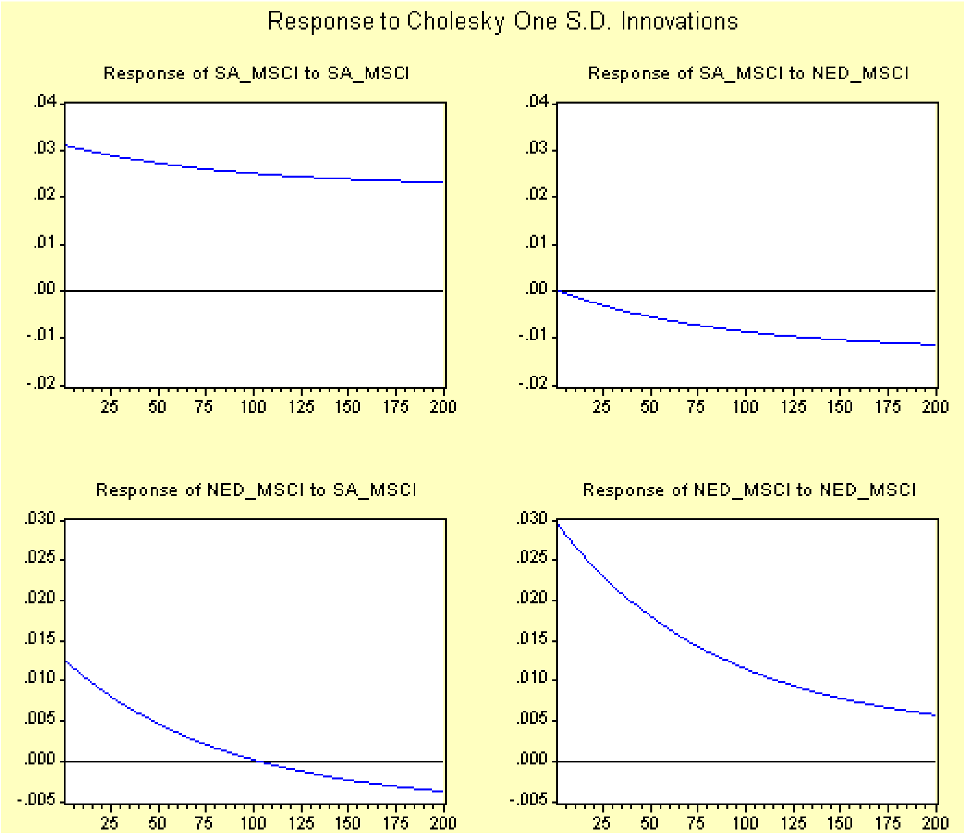
SA – Morocco Cholesky ordering SA – Morocco



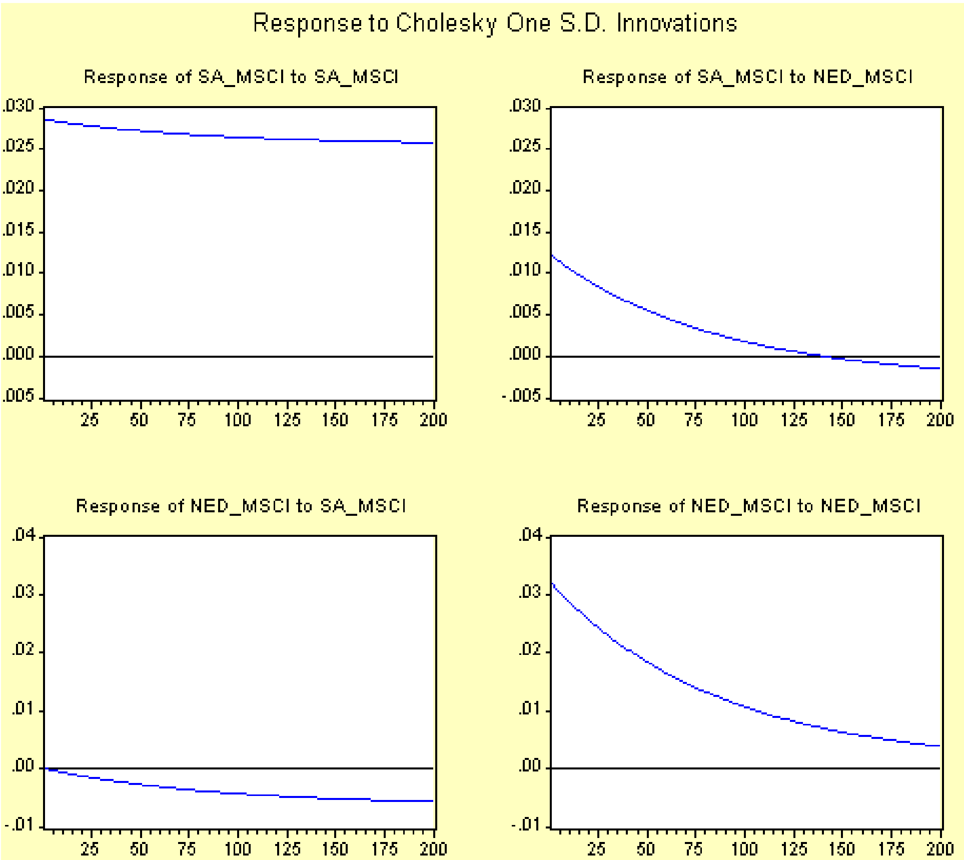
Cholesky ordering Morocco – SA



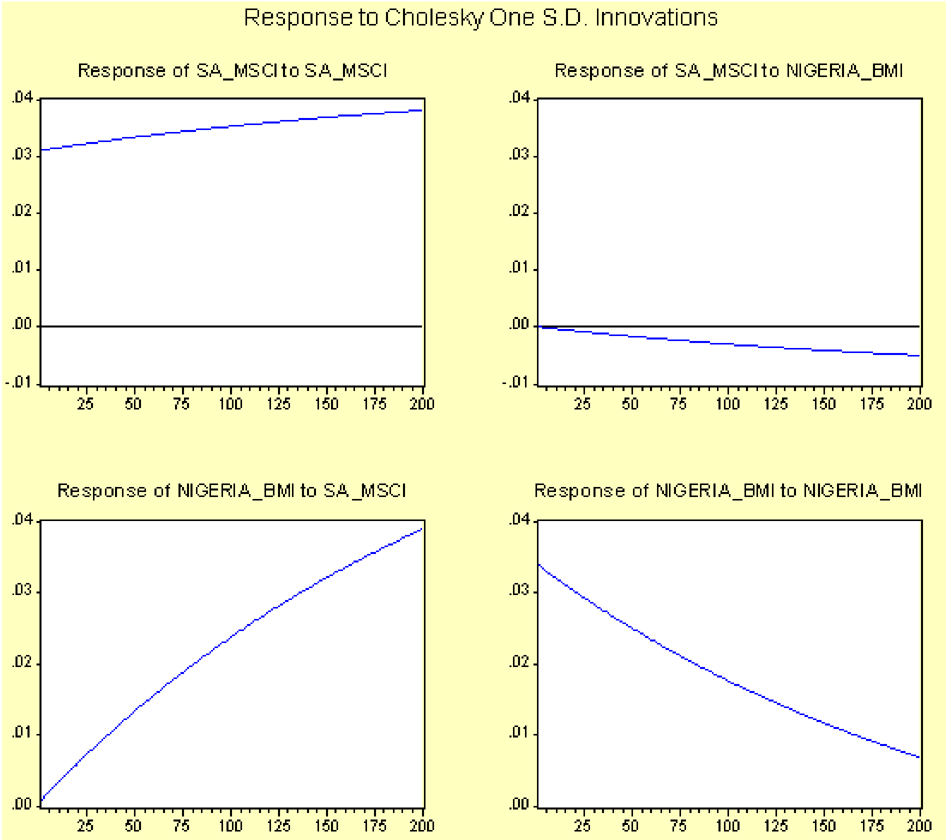
SA – Netherlands Cholesky ordering SA – Netherlands



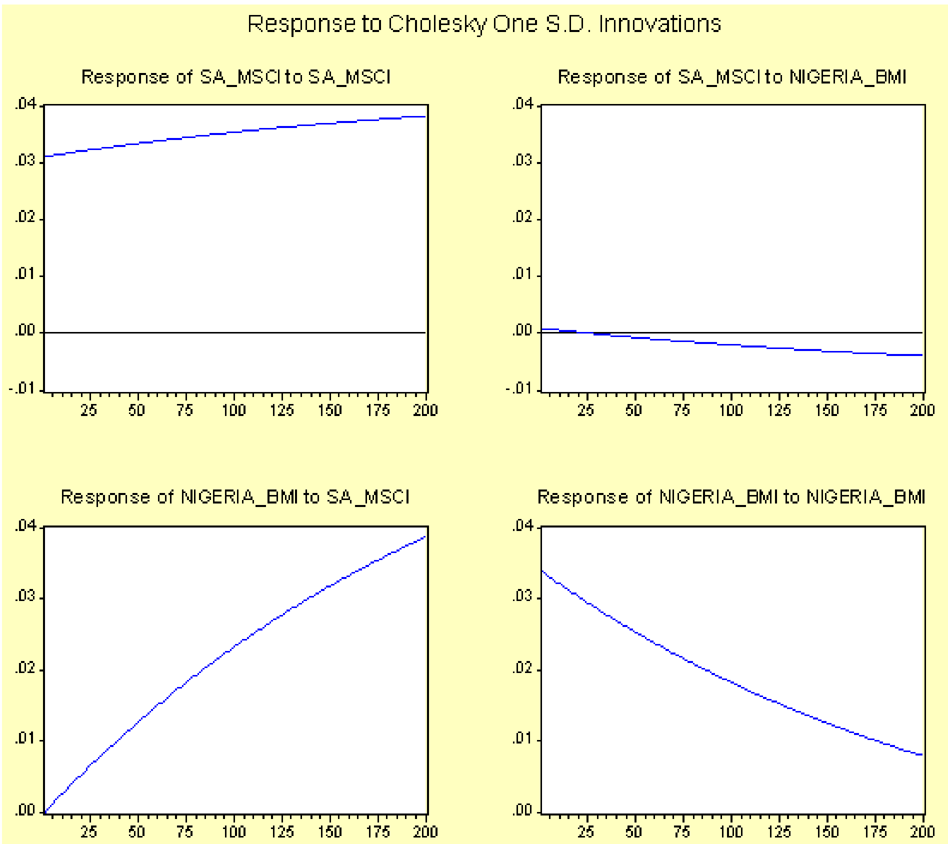
Cholesky ordering Netherlands – SA



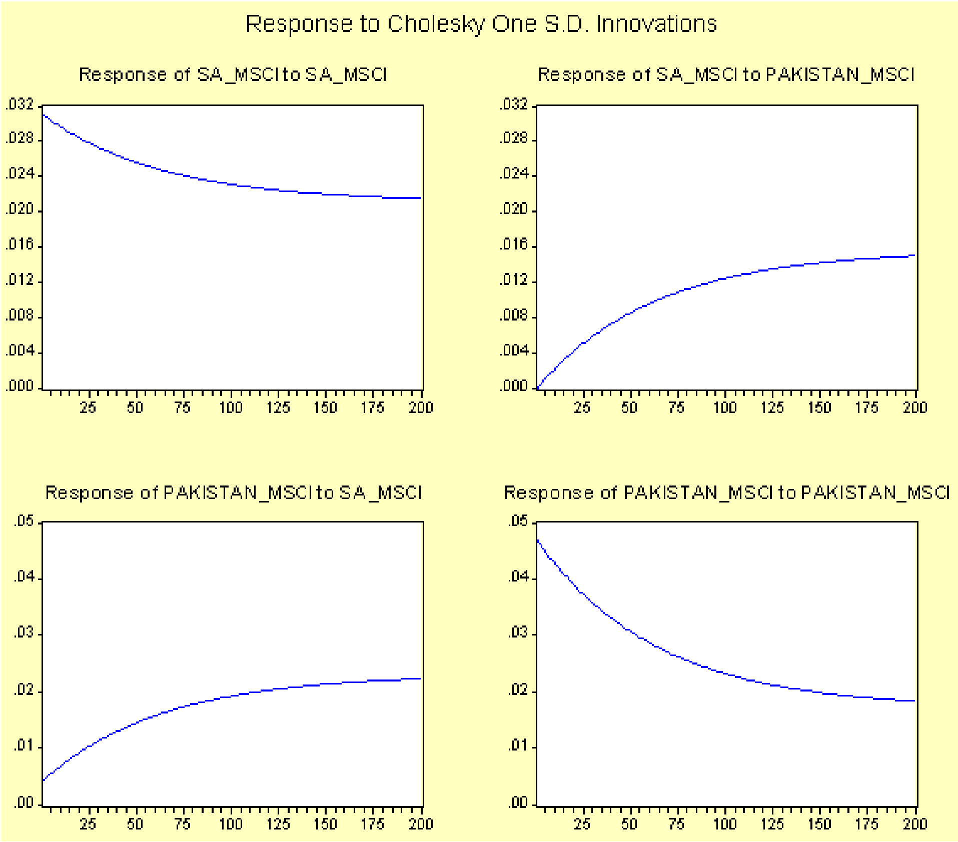
SA – Nigeria Cholesky ordering SA – Nigeria



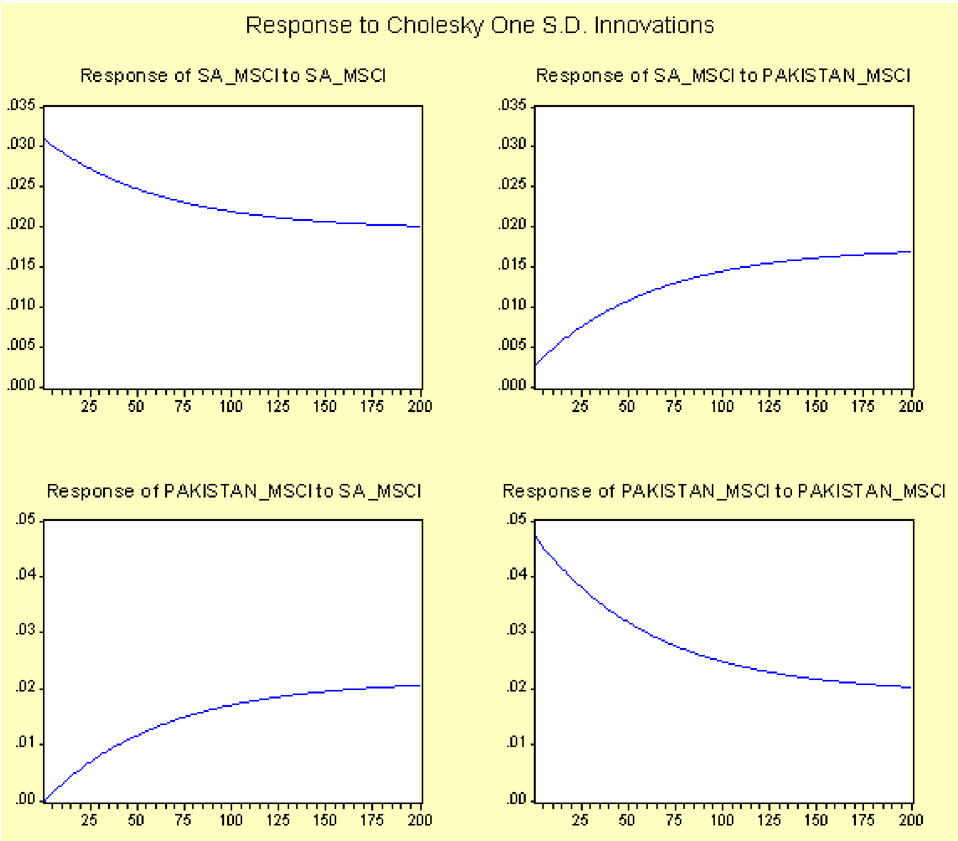
Cholesky ordering Nigeria – SA



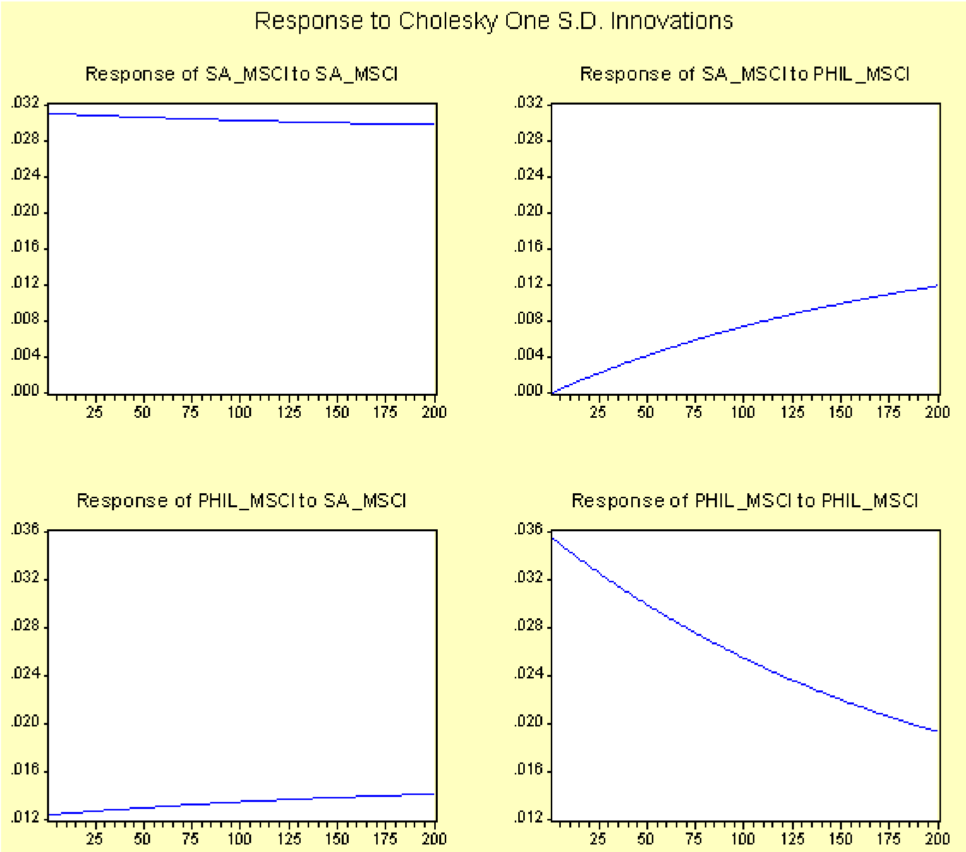
SA – Pakistan Cholesky ordering SA – Pakistan



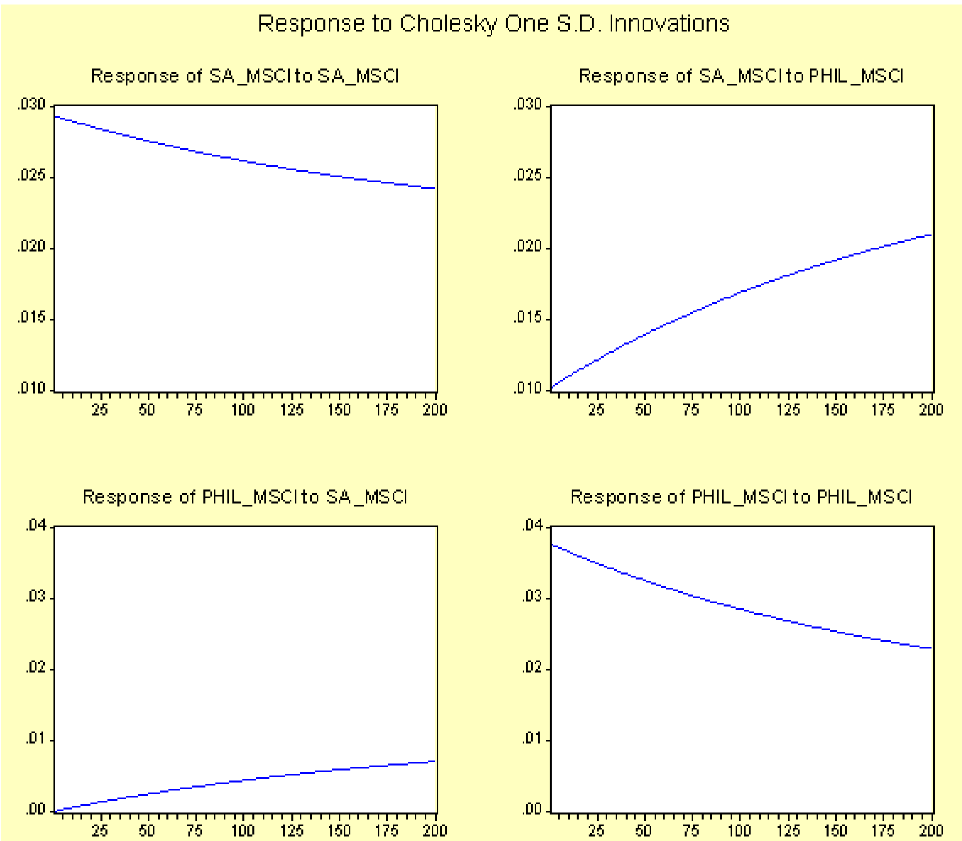
Cholesky ordering Pakistan – SA



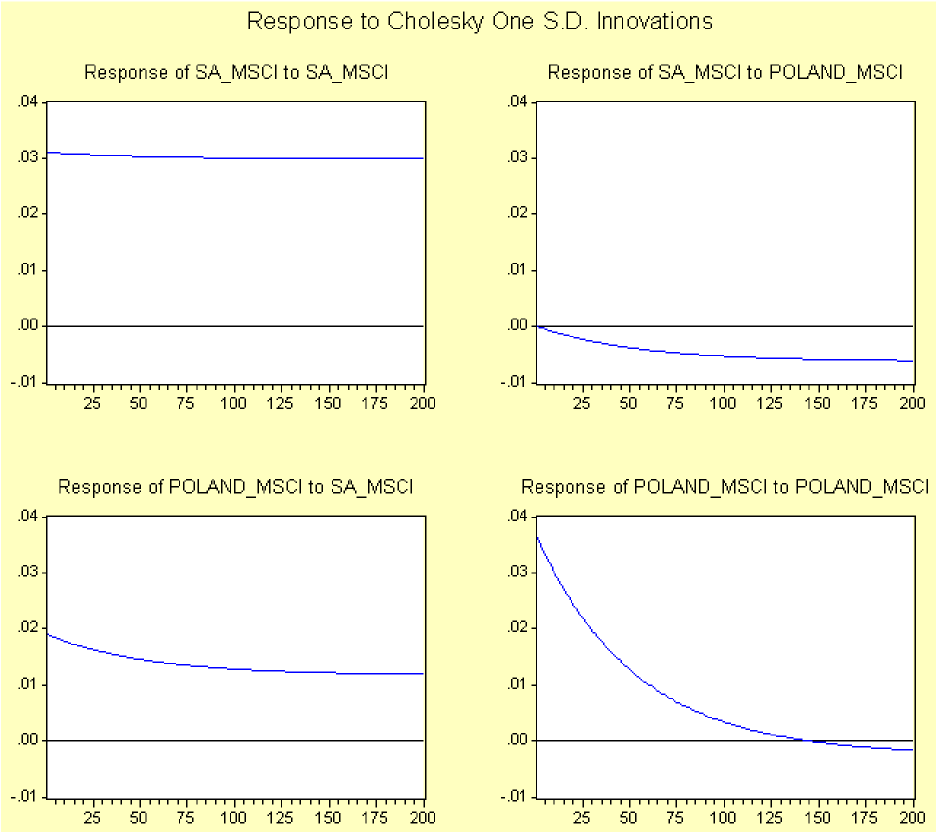
SA – Philippines Cholesky ordering SA – Philippines



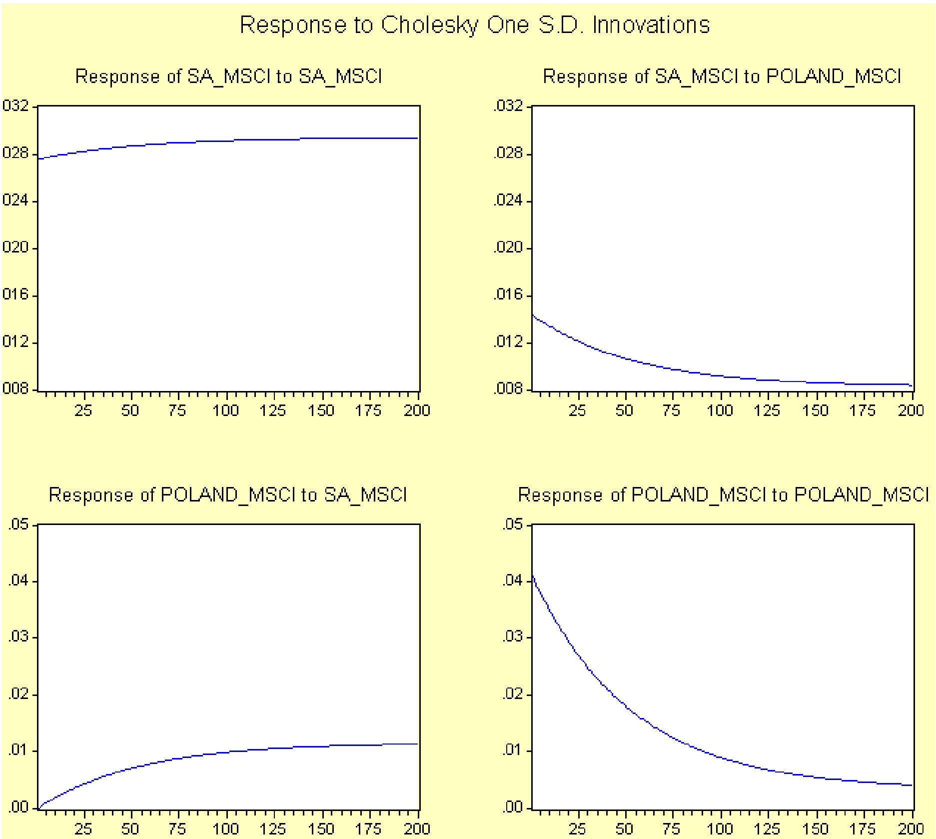
Cholesky ordering Philippines – SA



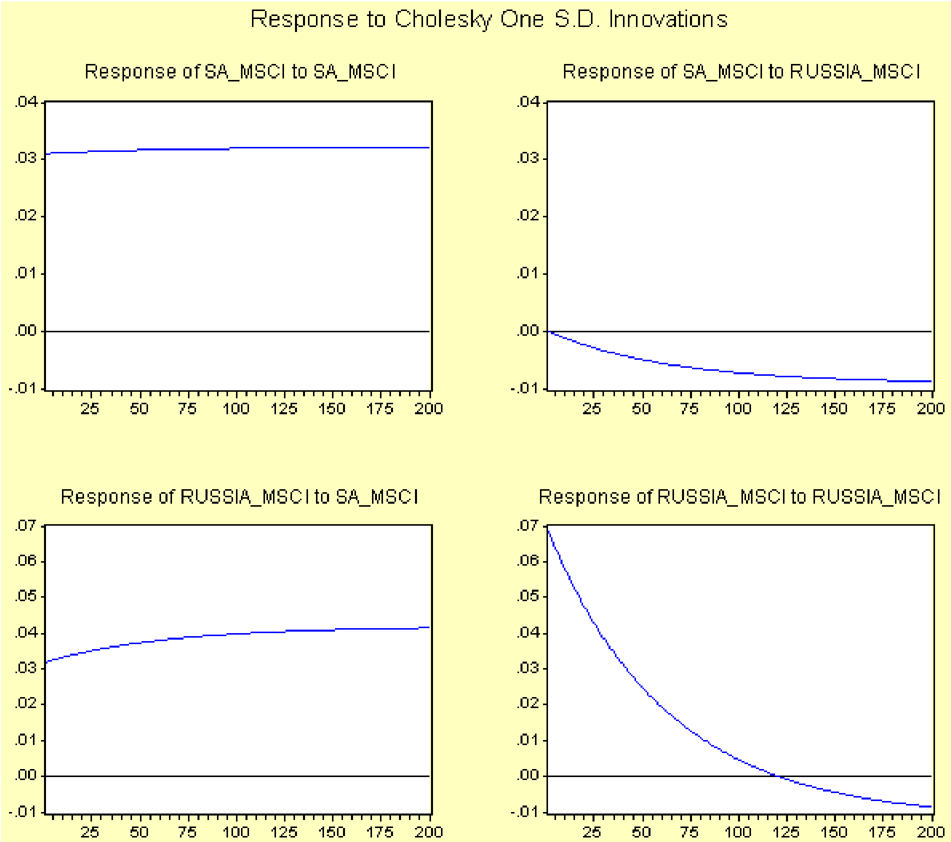
SA – Poland Cholesky ordering SA – Poland



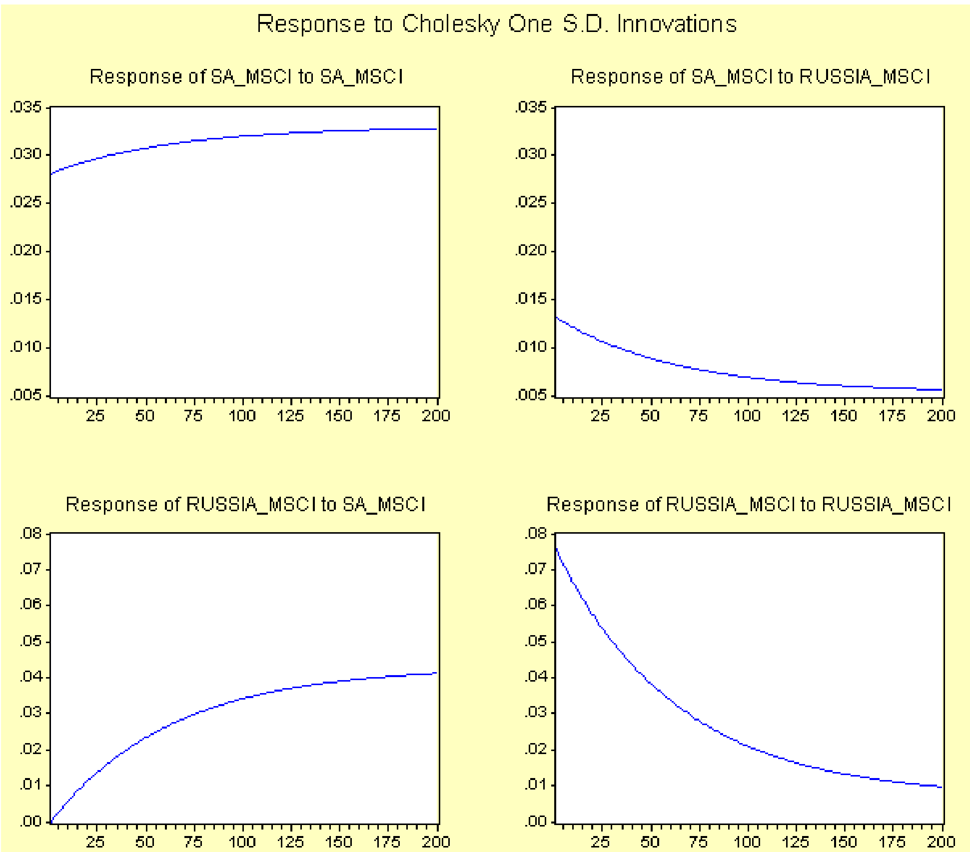
Cholesky ordering Poland – SA



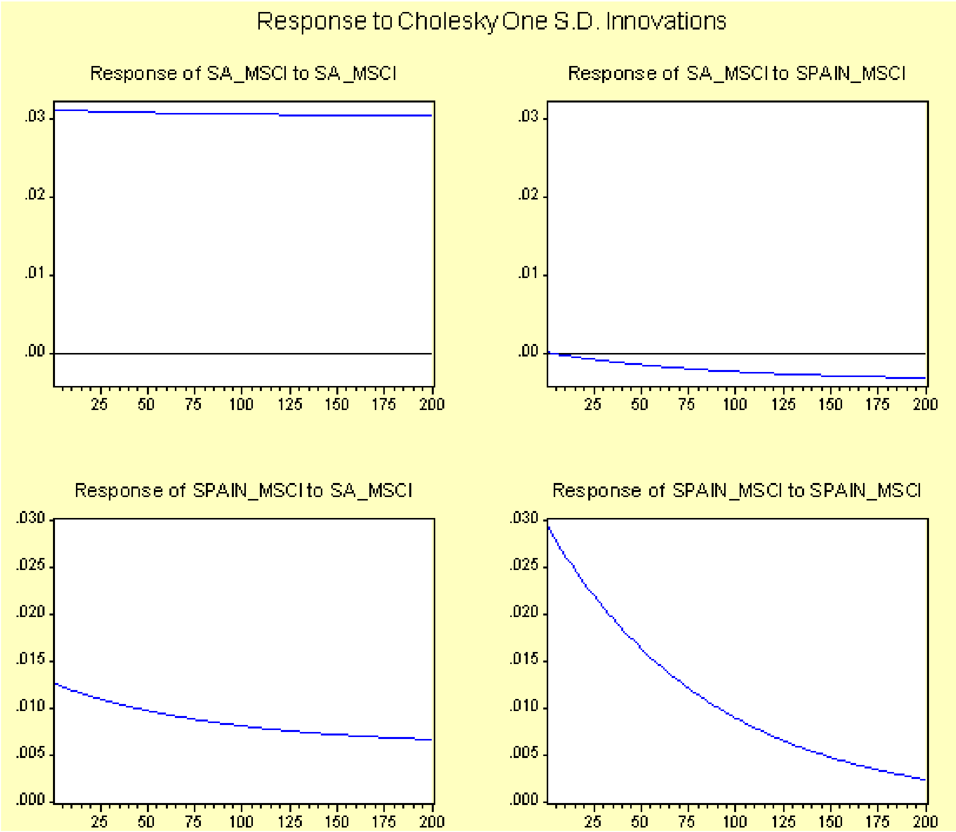
SA – Russia Cholesky ordering SA – Russia



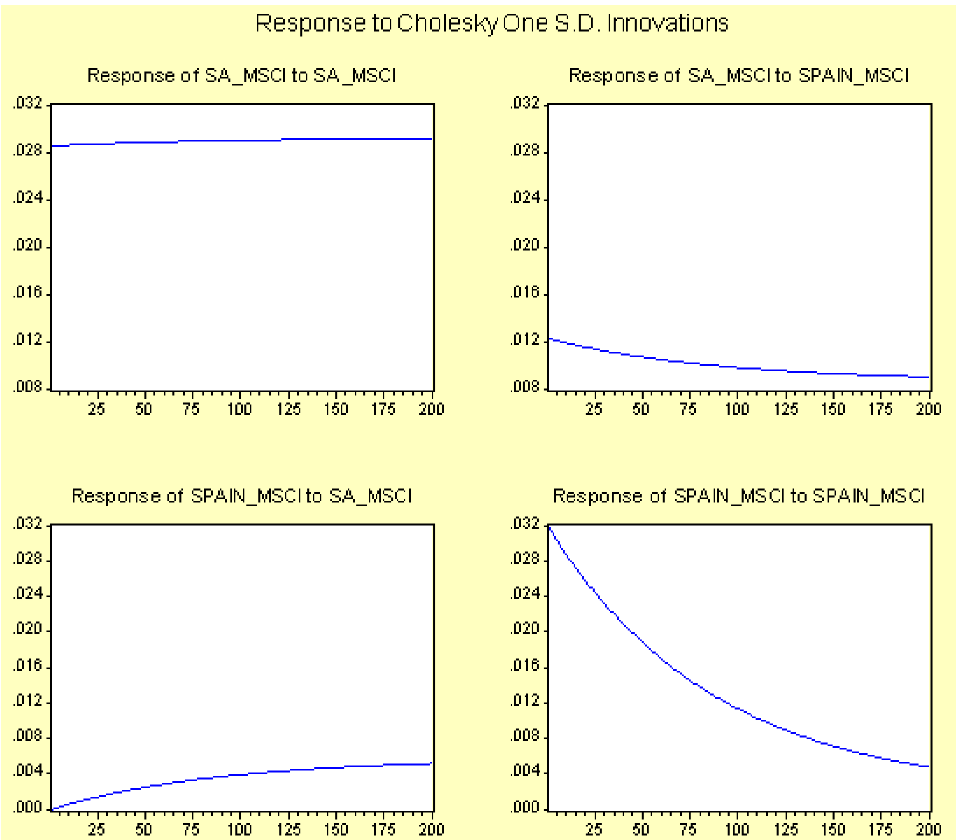
Cholesky ordering Russia – SA



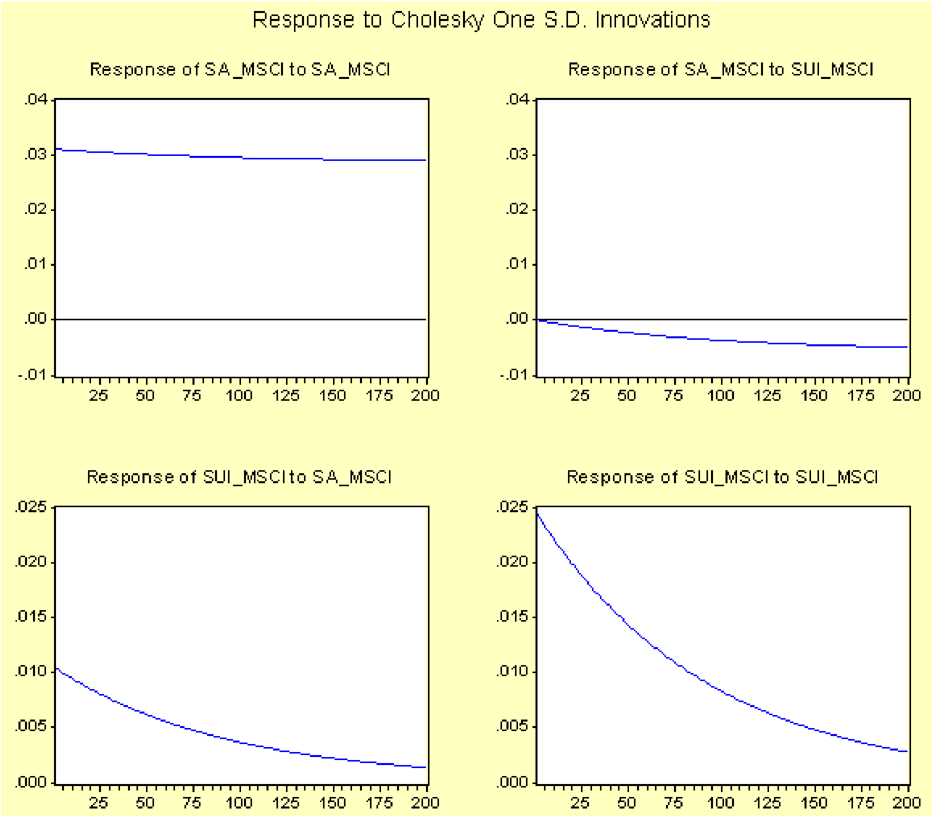
SA – Spain Cholesky ordering SA – Spain



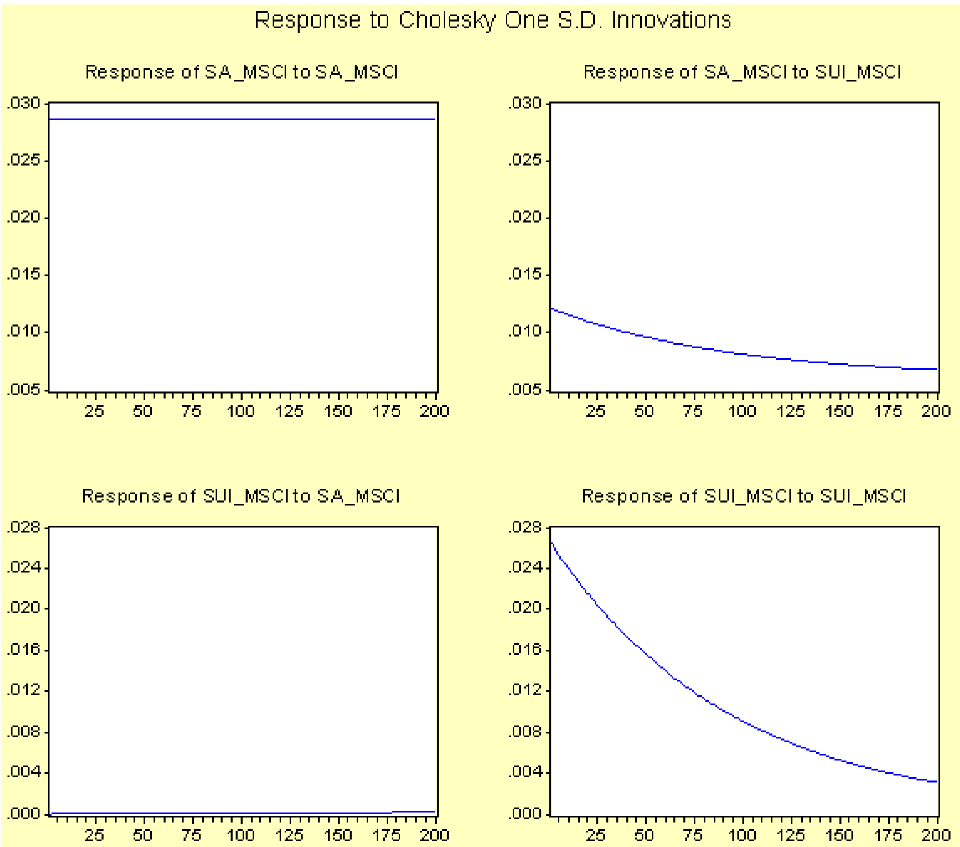
Cholesky ordering Spain – SA



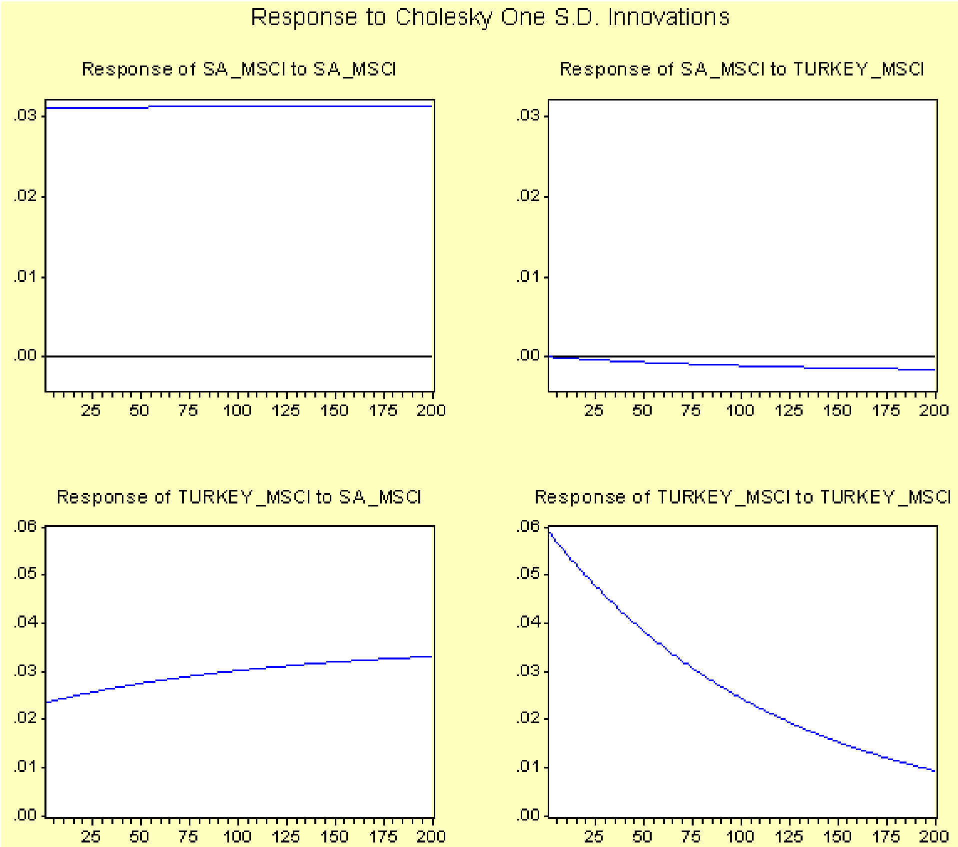
SA – Switzerland Cholesky ordering SA – Switzerland



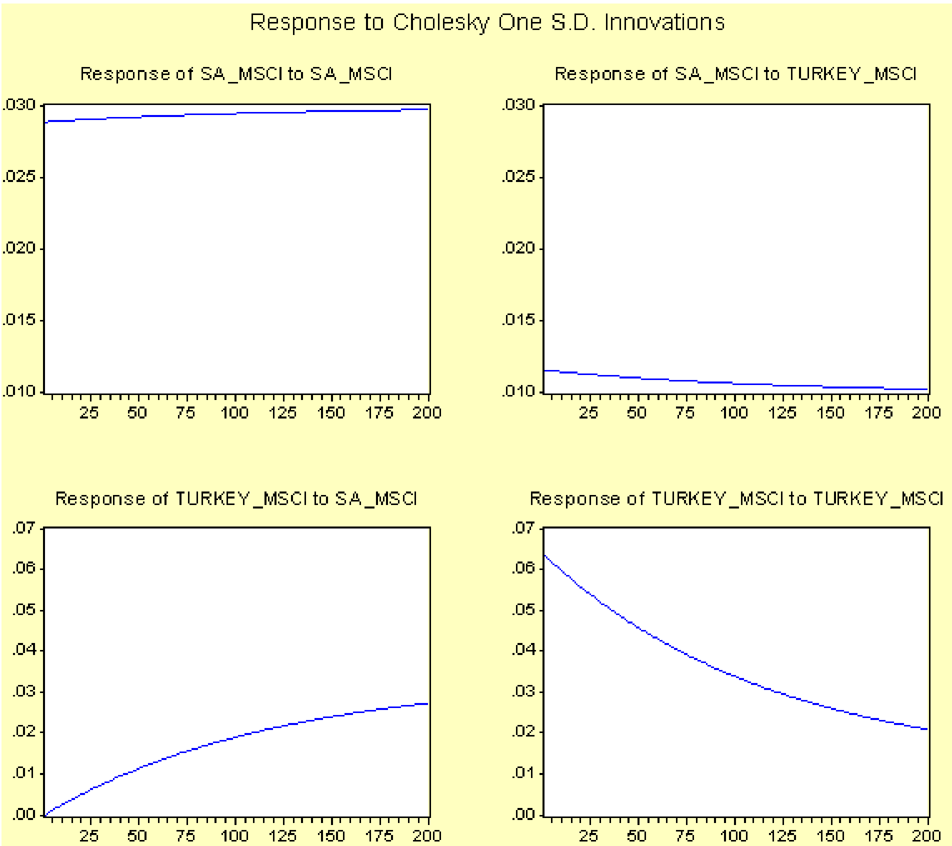
Cholesky ordering Switzerland – SA



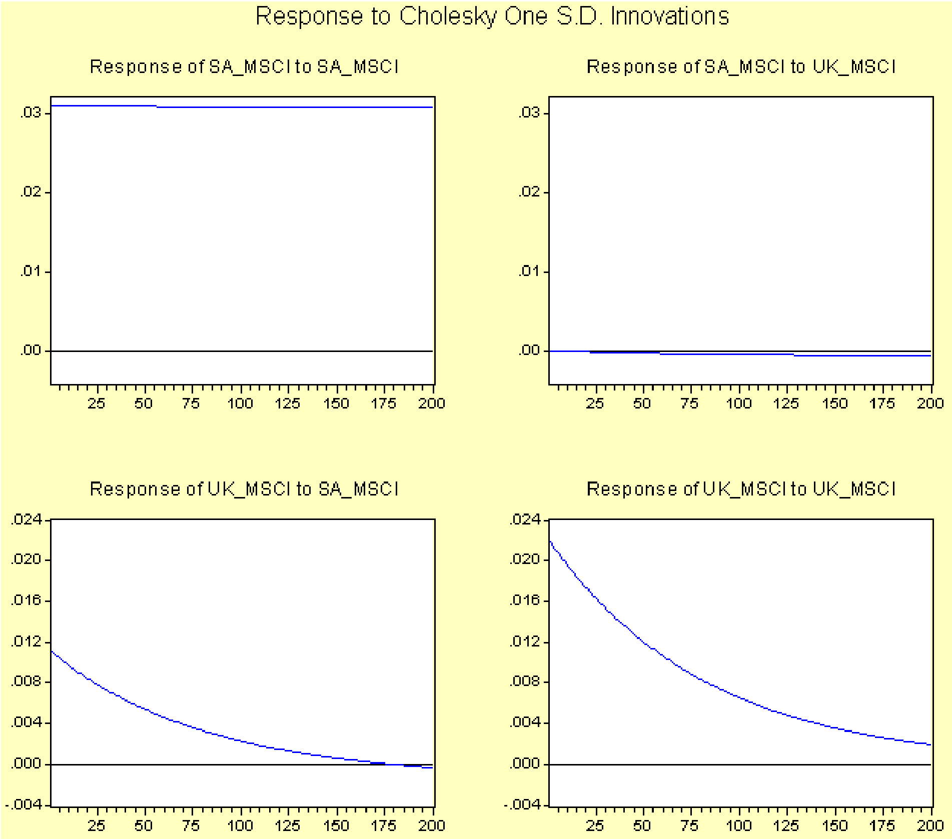
SA – Turkey Cholesky ordering SA – Turkey



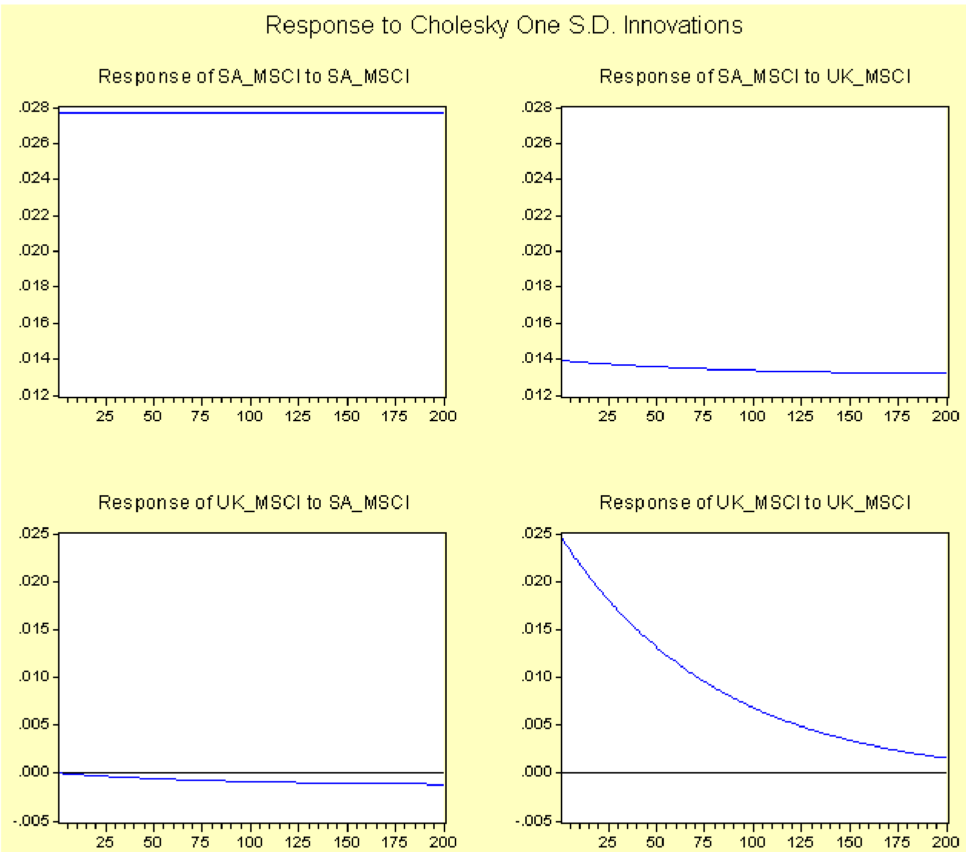
Cholesky ordering Turkey – SA



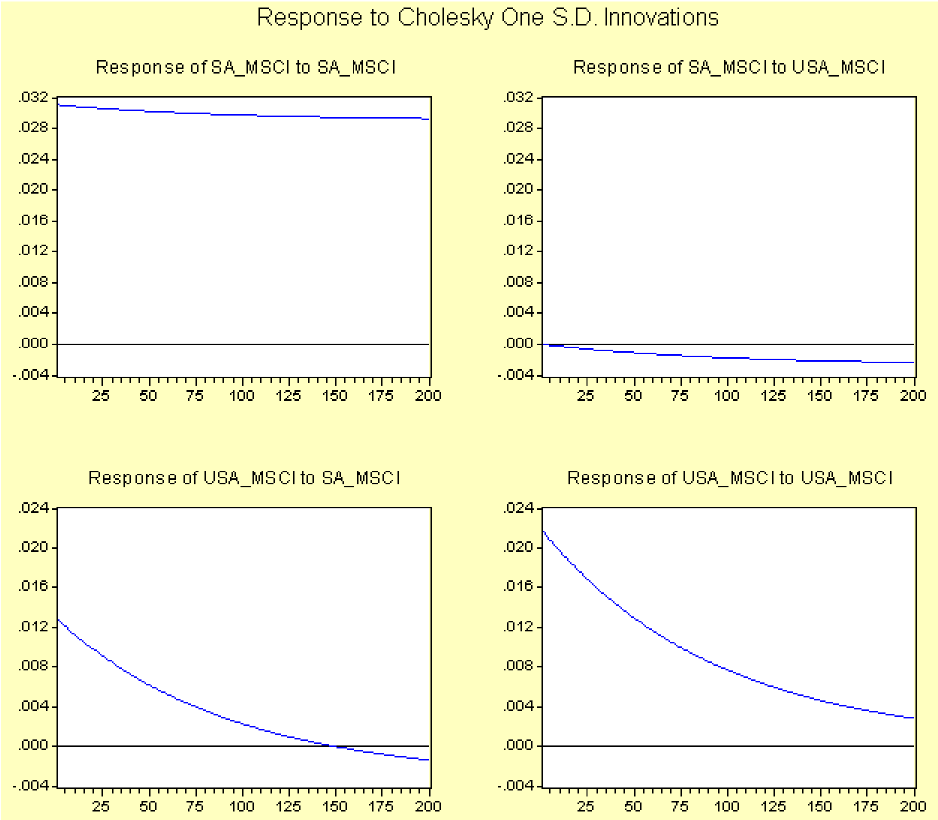
SA – UK Cholesky ordering SA – UK



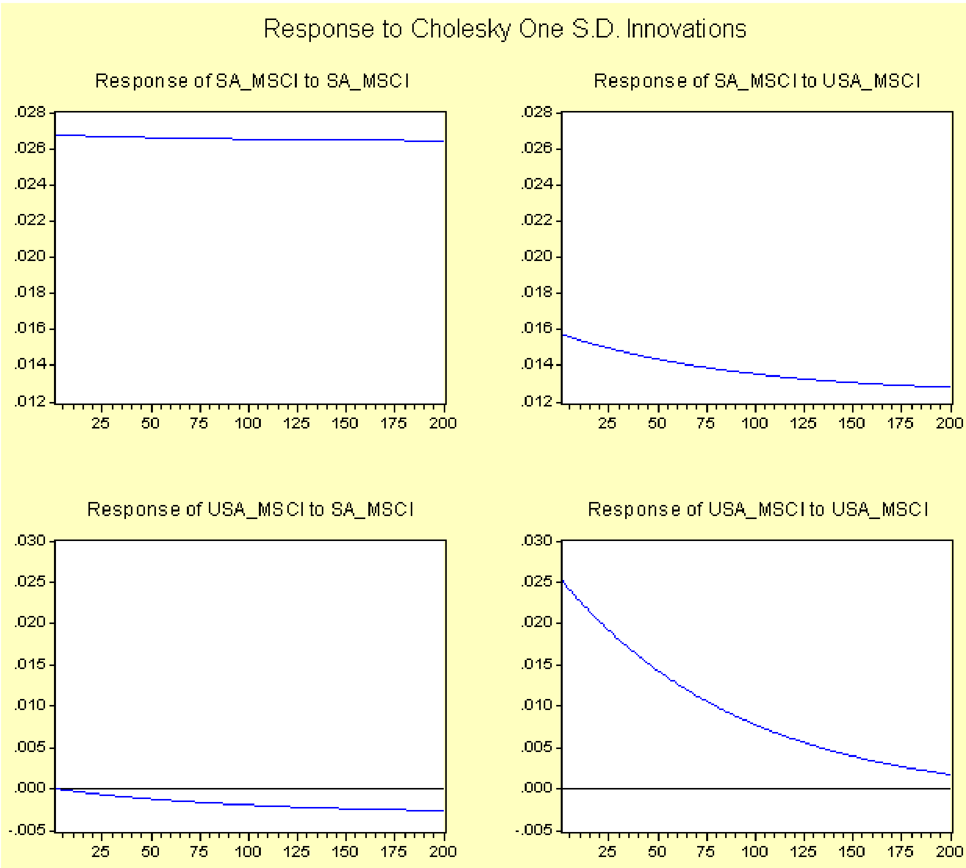
Cholesky ordering UK – SA



SA – USA Cholesky ordering SA – USA

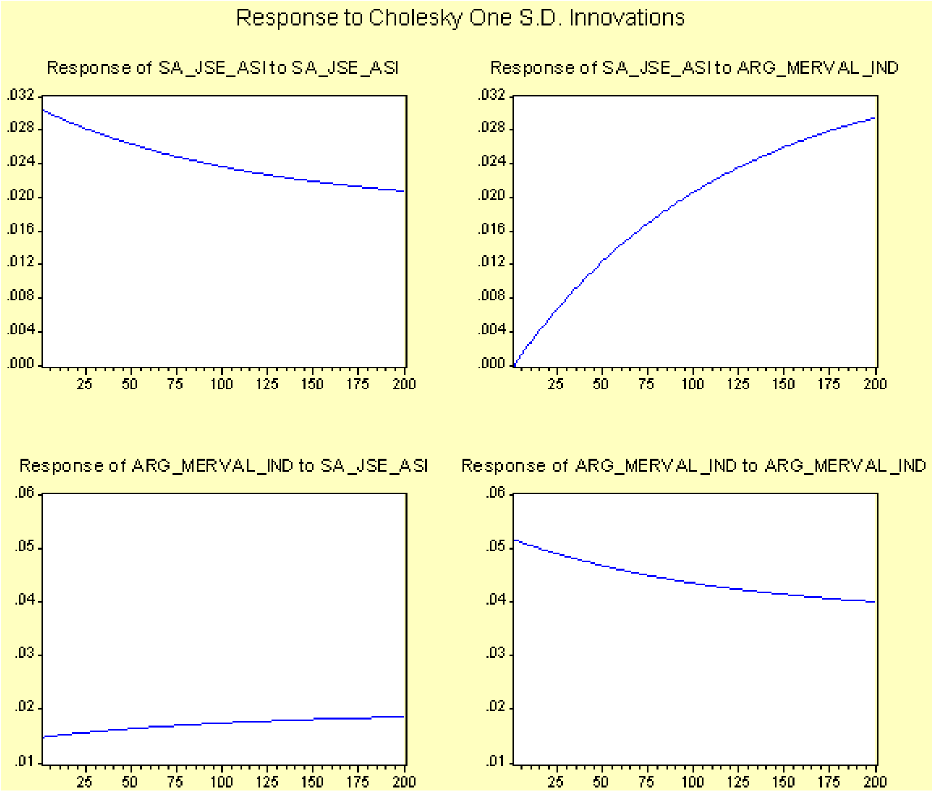


Cholesky ordering USA – SA

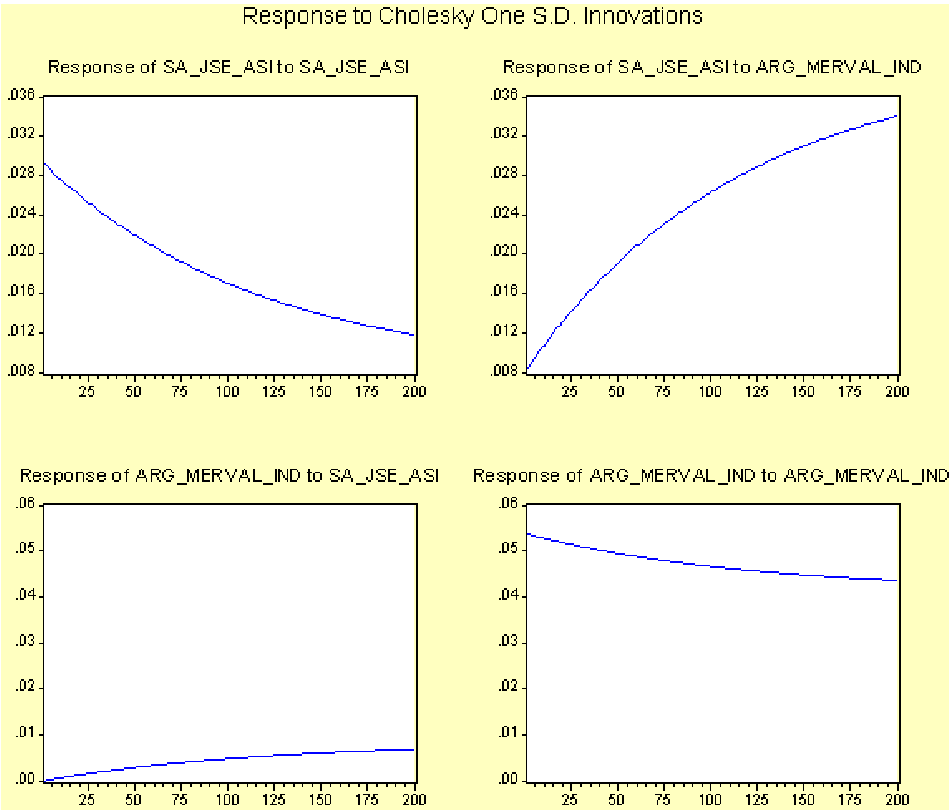


Appendix I – bivariate IRFs at 1 lag, using intercept in CE specification, price indices

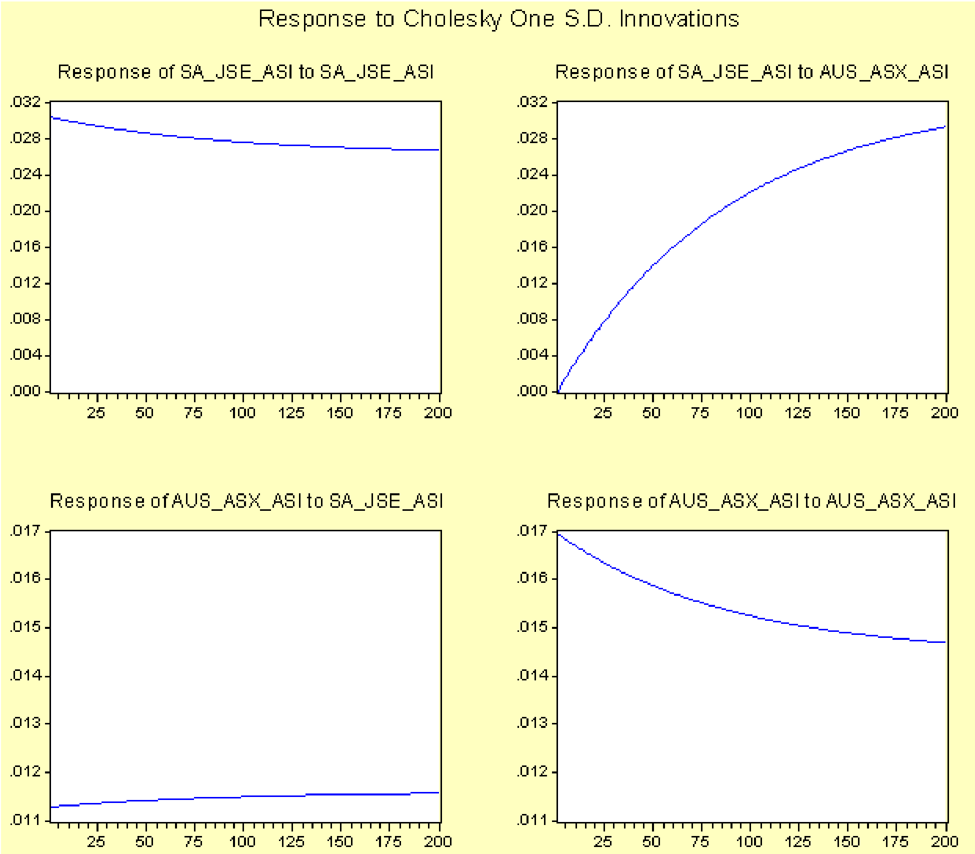
SA – Argentina, Merval. Cholesky ordering SA – Argentina



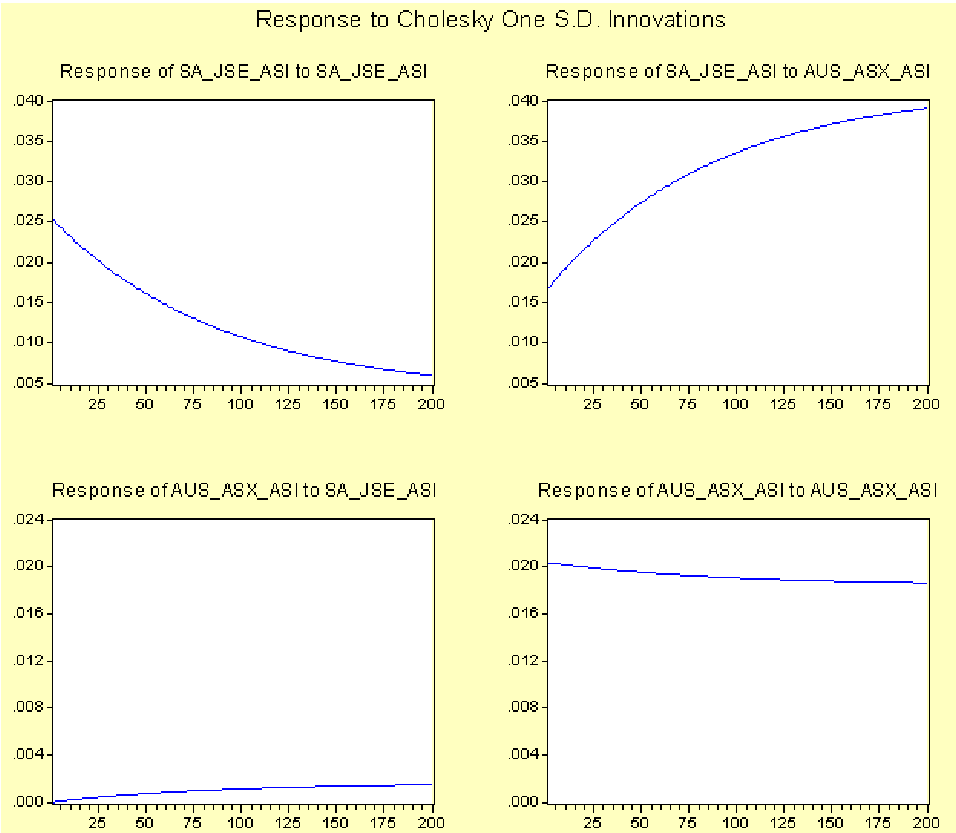
Cholesky ordering Argentina – SA



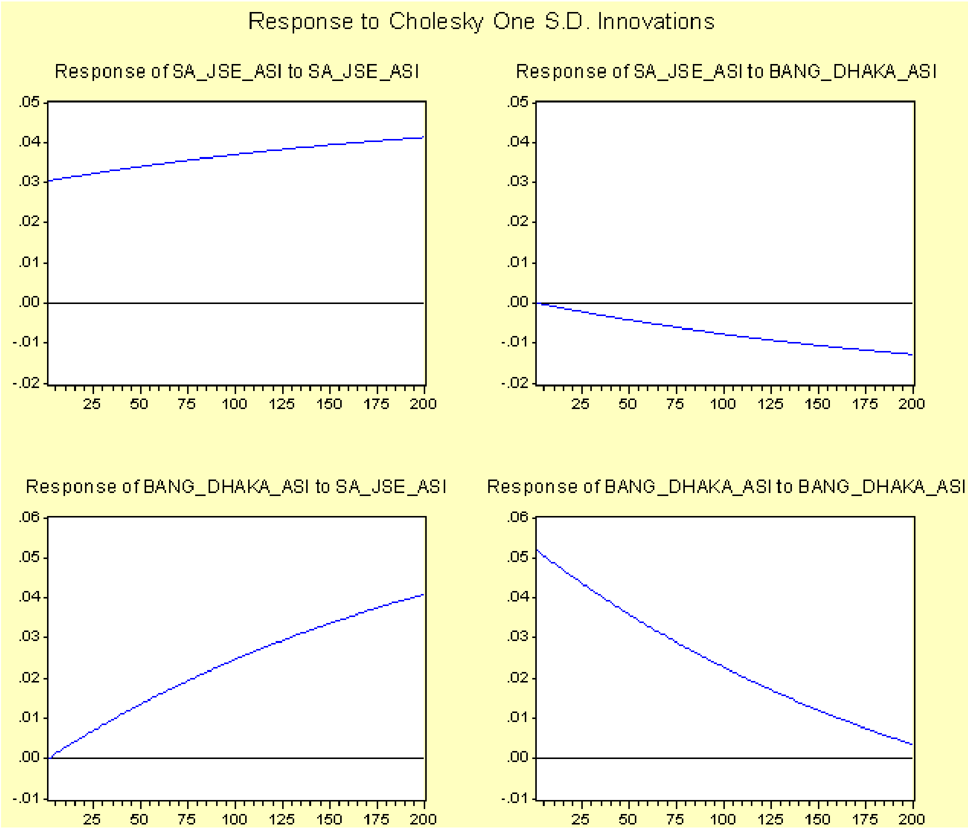
SA – Australia, ASX. Cholesky ordering SA – Australia



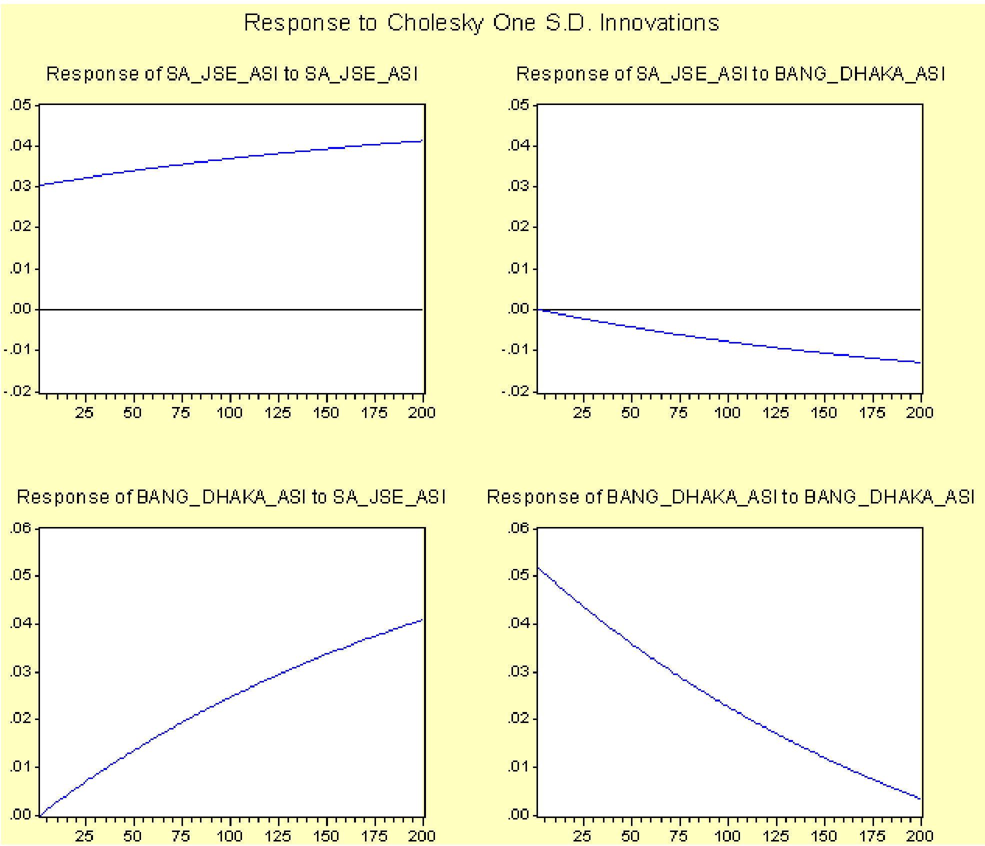
Cholesky ordering Australia – SA



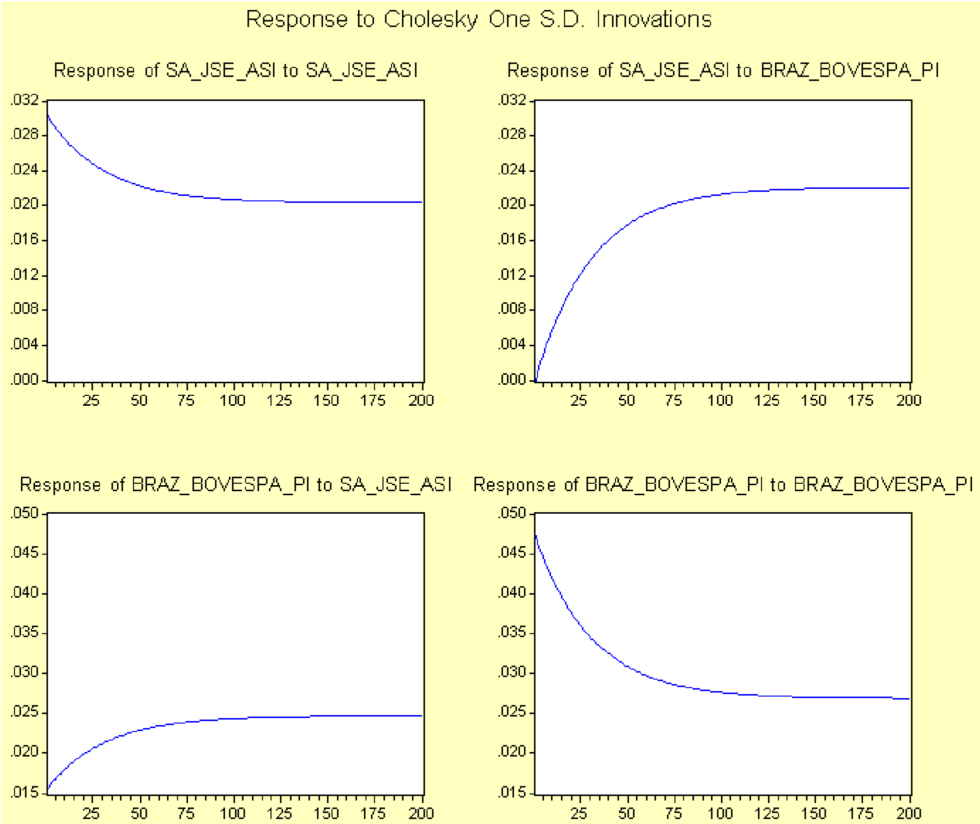
SA – Bangladesh, Dhaka. Cholesky ordering SA – Bangladesh



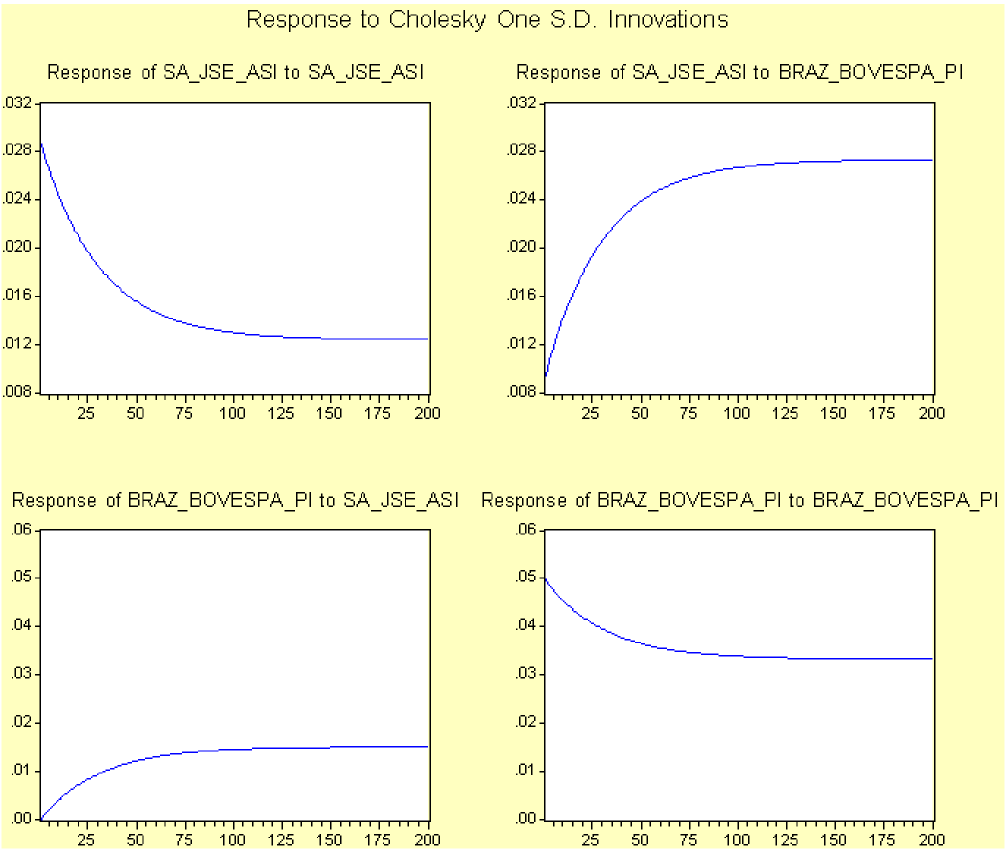
Cholesky ordering Bangladesh – SA



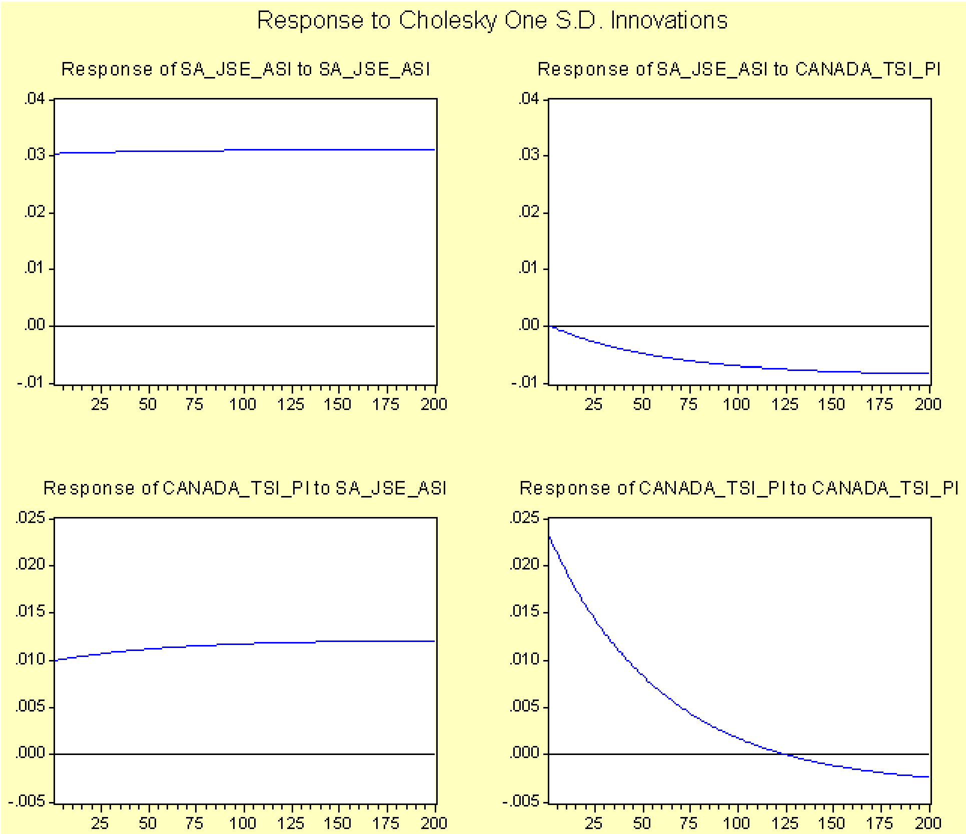
SA – Brazil, Bovespa. Cholesky ordering SA – Brazil



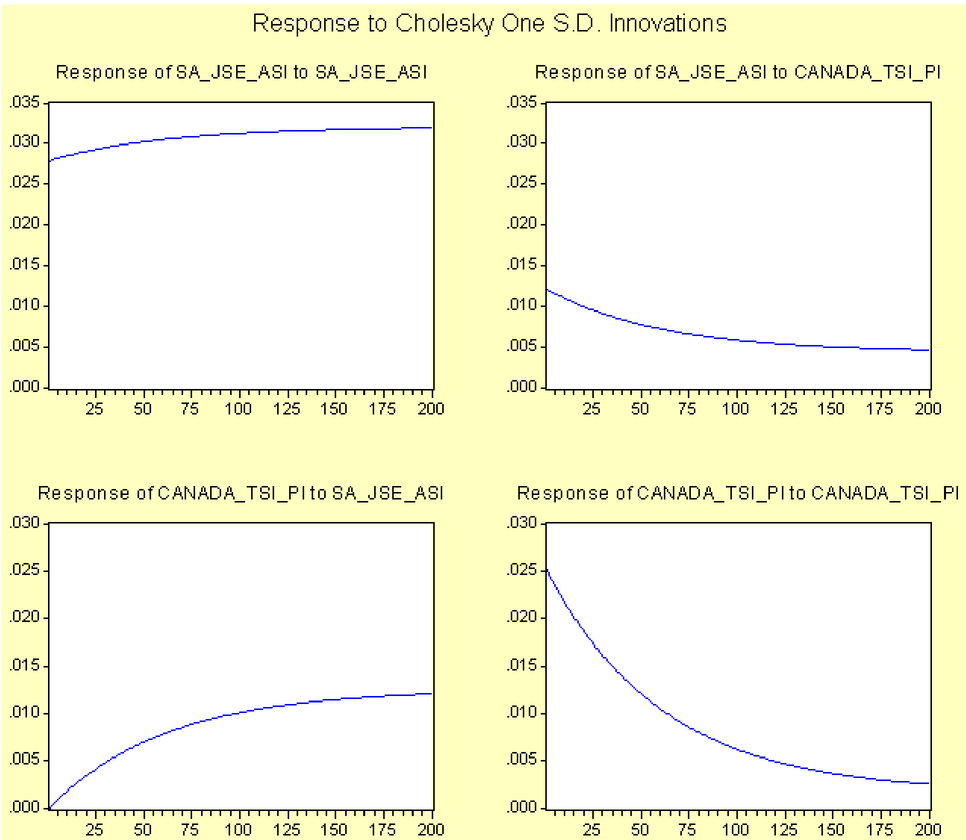
Cholesky ordering Brazil – SA



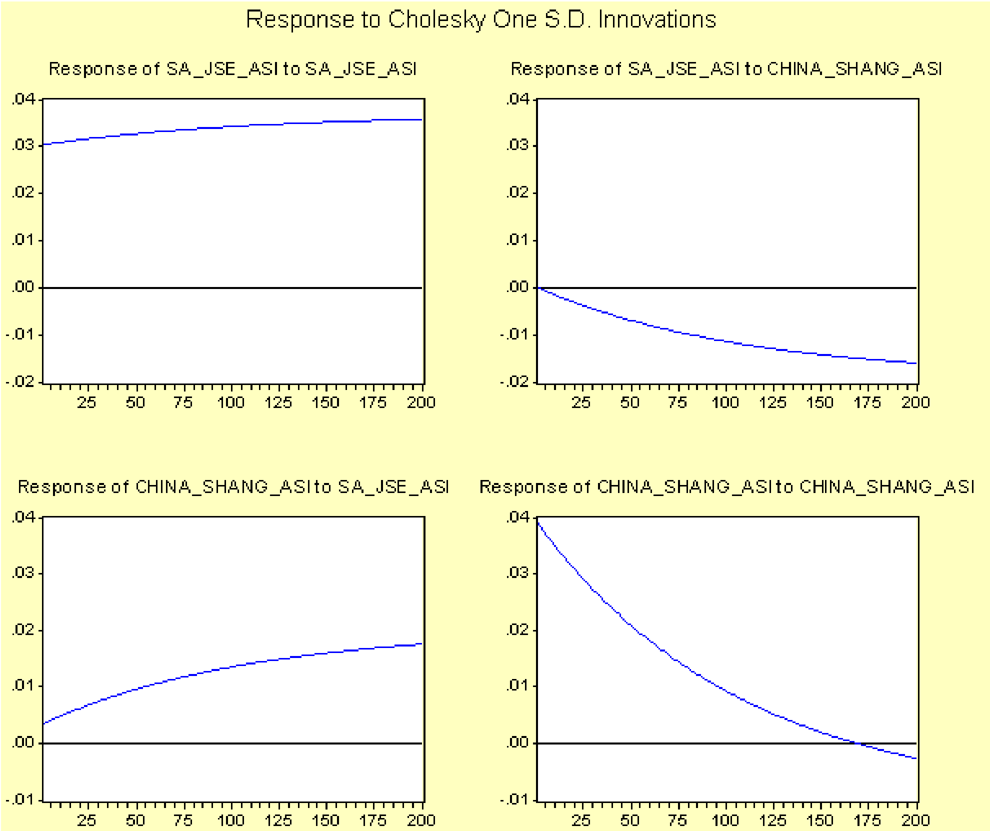
SA – Canada, TSI. Cholesky ordering SA – Canada



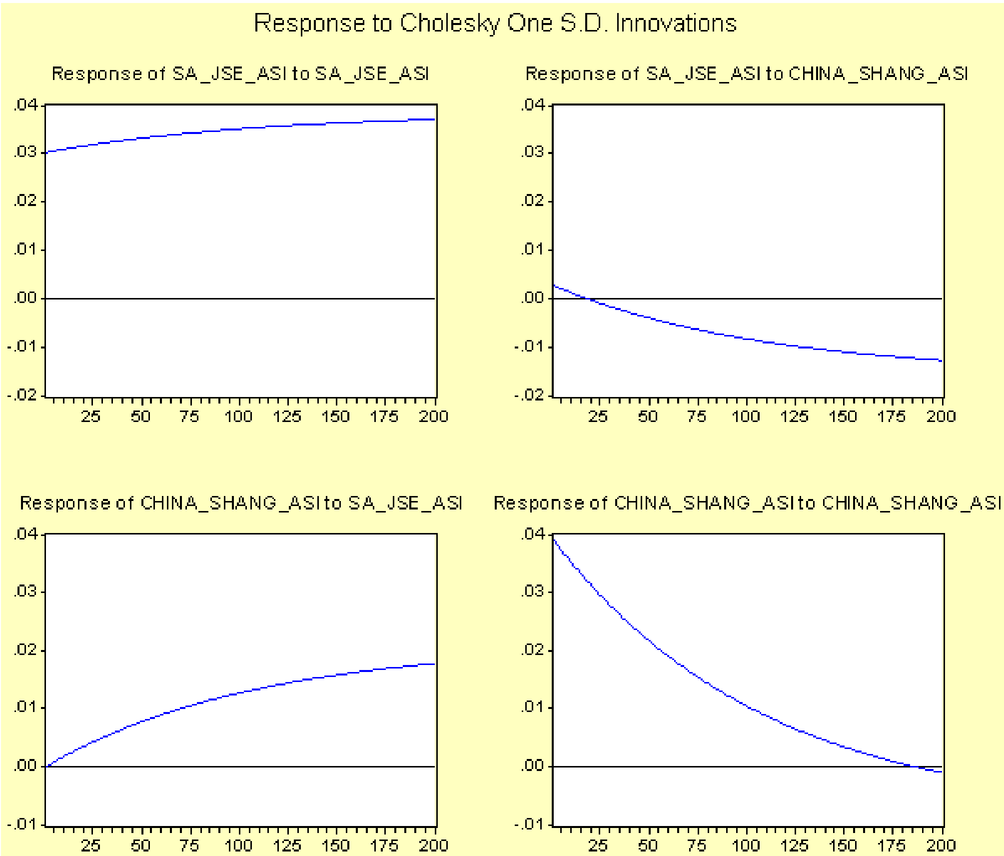
Cholesky ordering Canada – SA



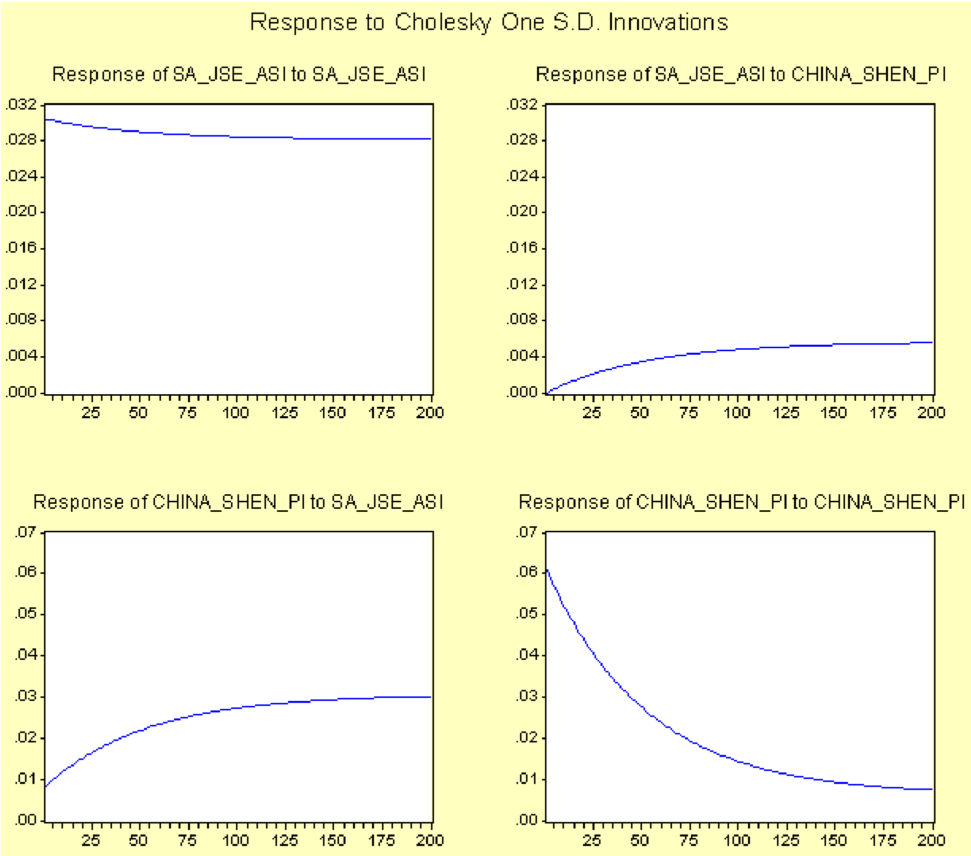
SA – China, Shanghai. Cholesky ordering SA – China



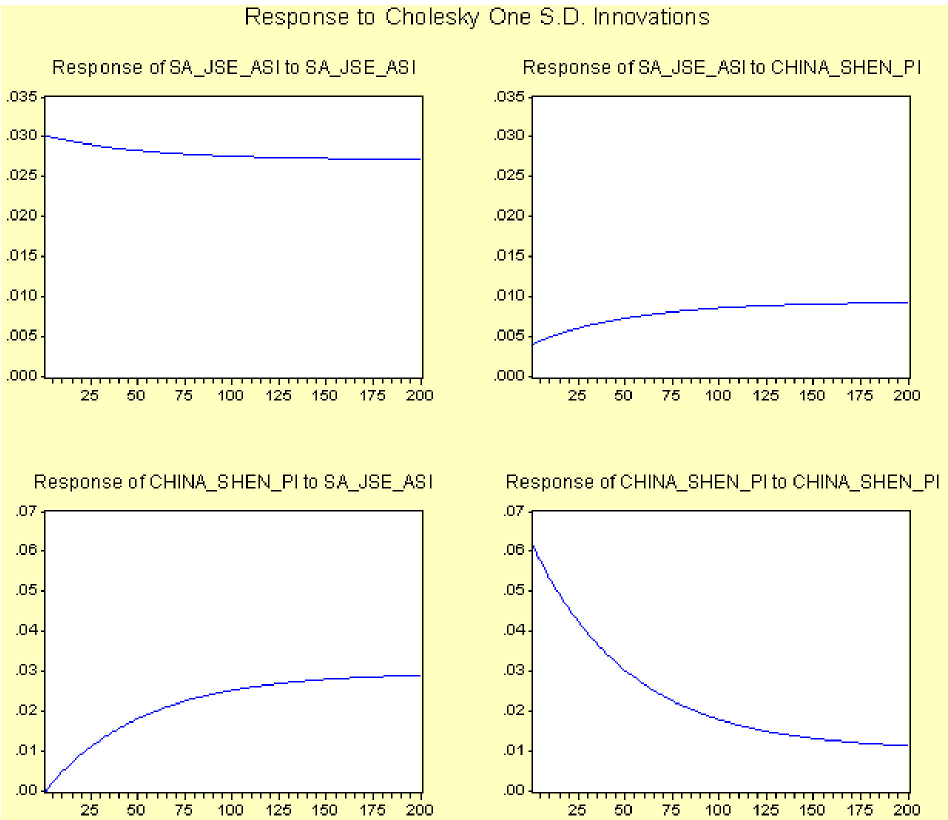
Cholesky ordering China – SA



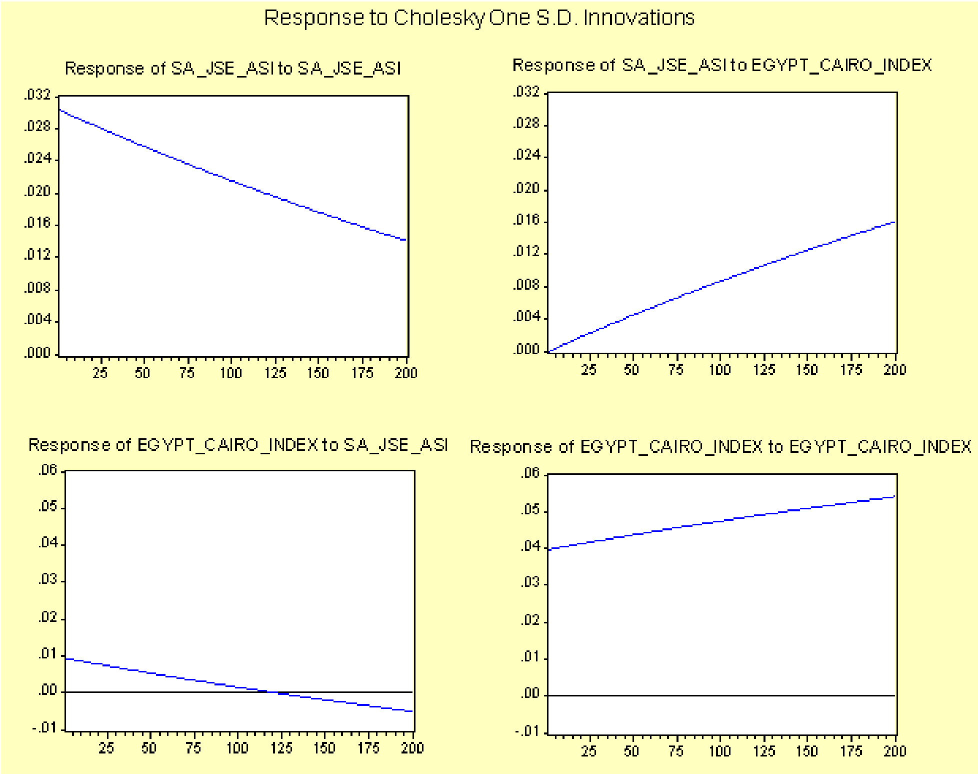
SA – China, Shenzhen. Cholesky ordering SA – China



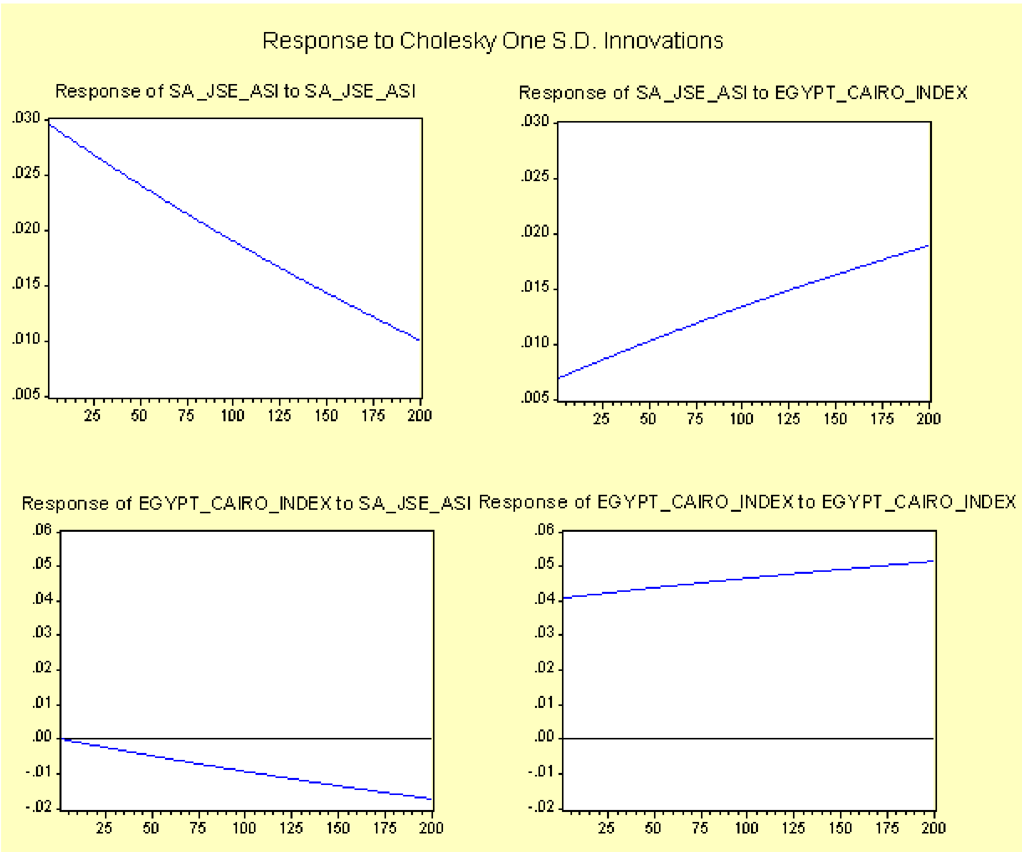
Cholesky ordering China – SA



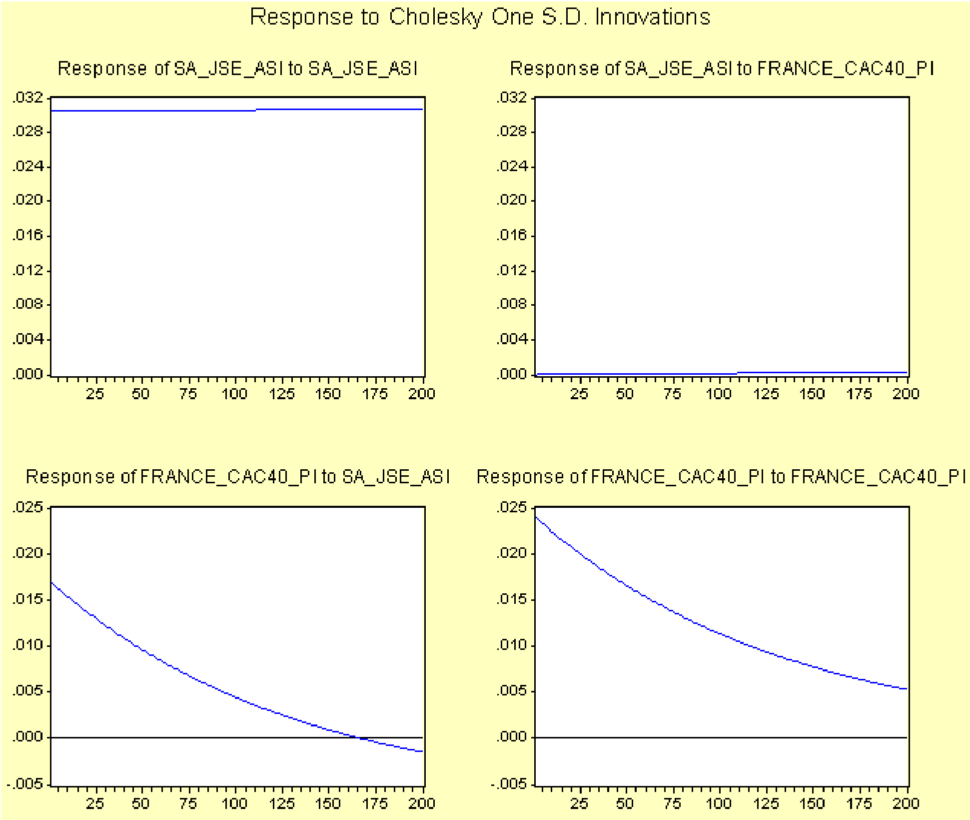
SA – Egypt, Cairo. Cholesky ordering SA – Egypt



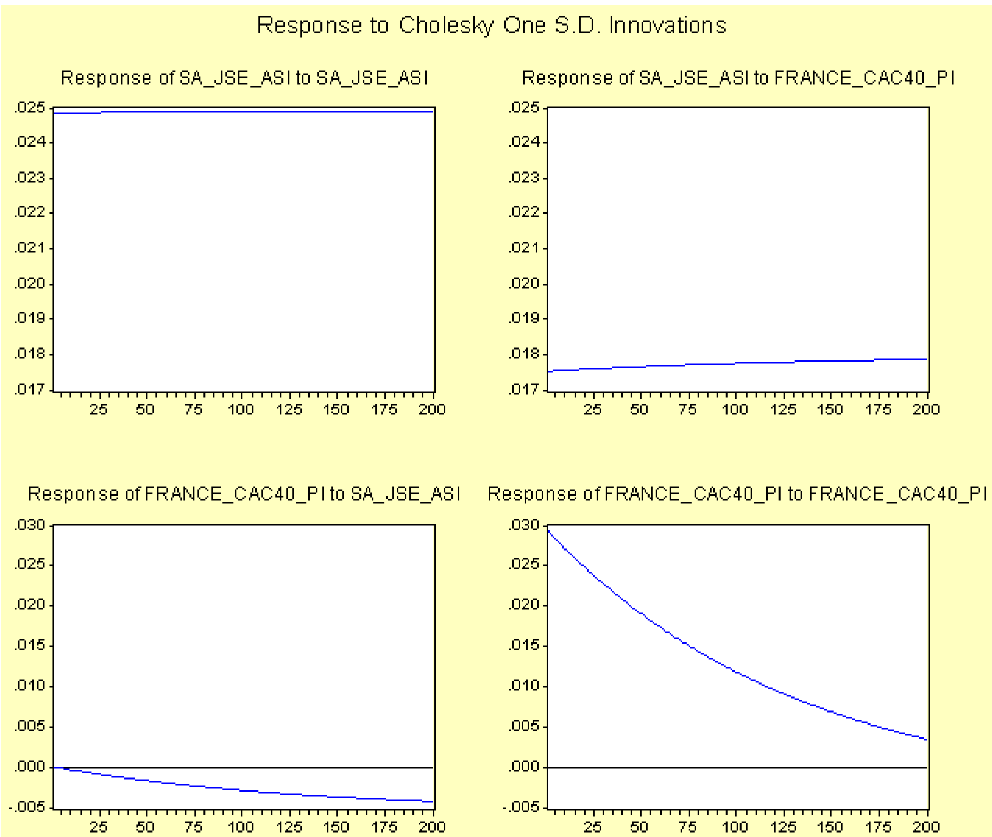
Cholesky ordering Egypt – SA



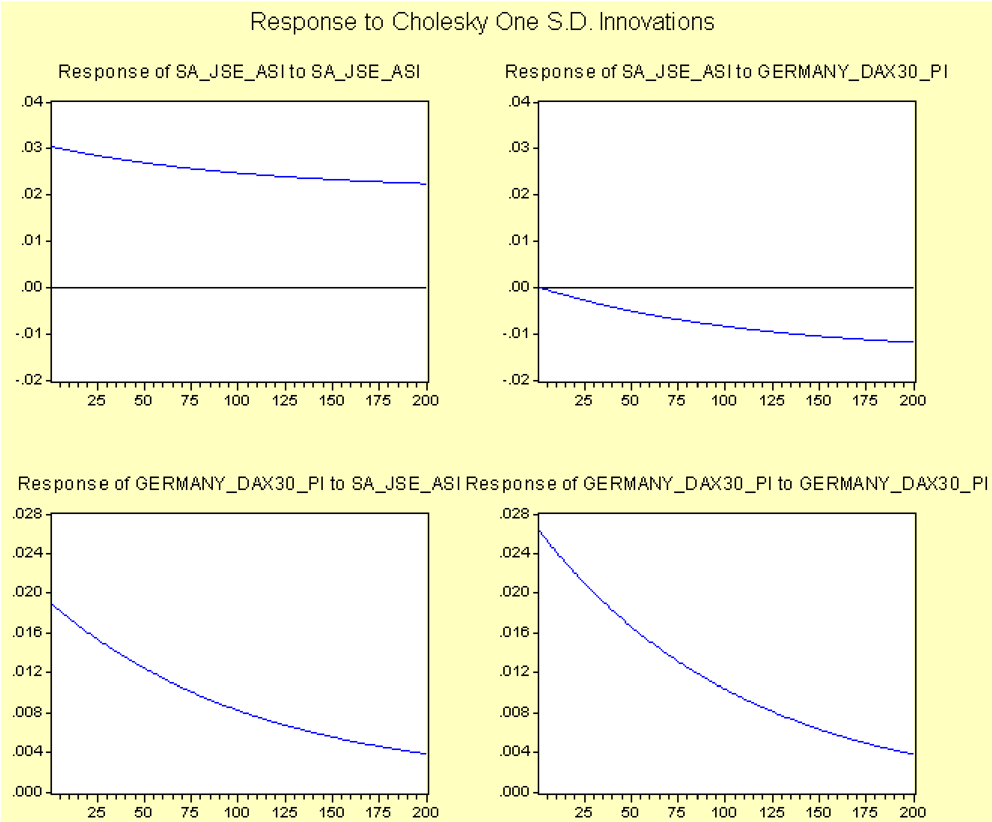
SA – France, Cac40. Cholesky ordering SA – France



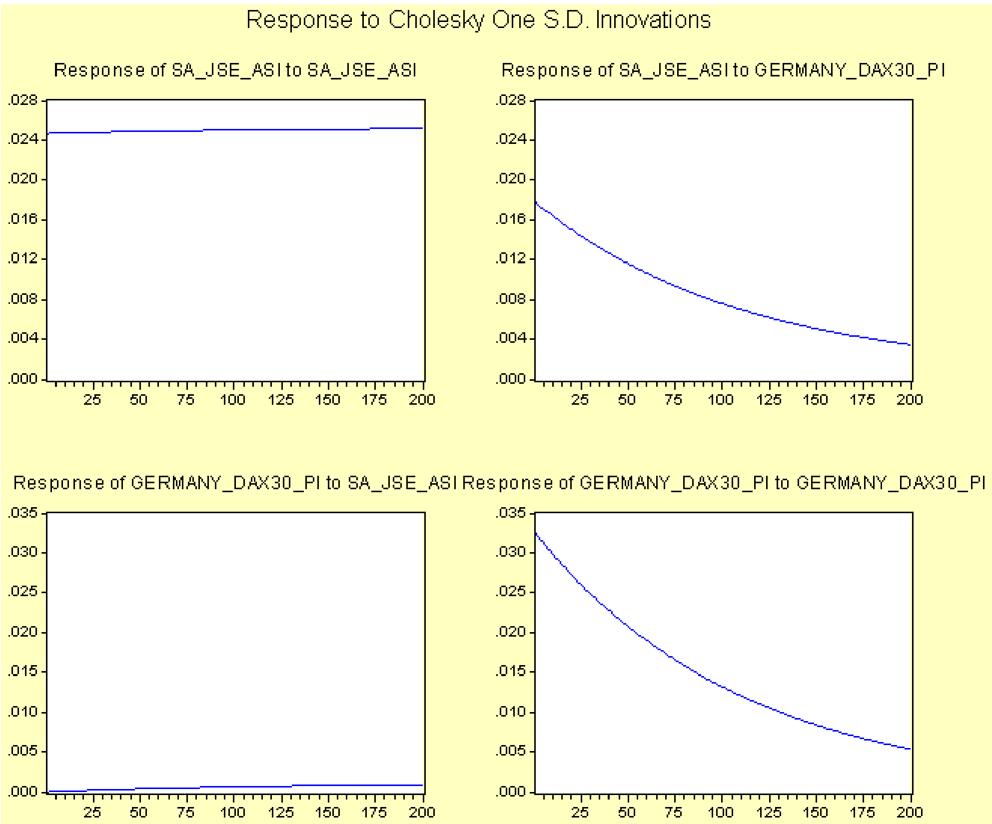
Cholesky ordering France – SA



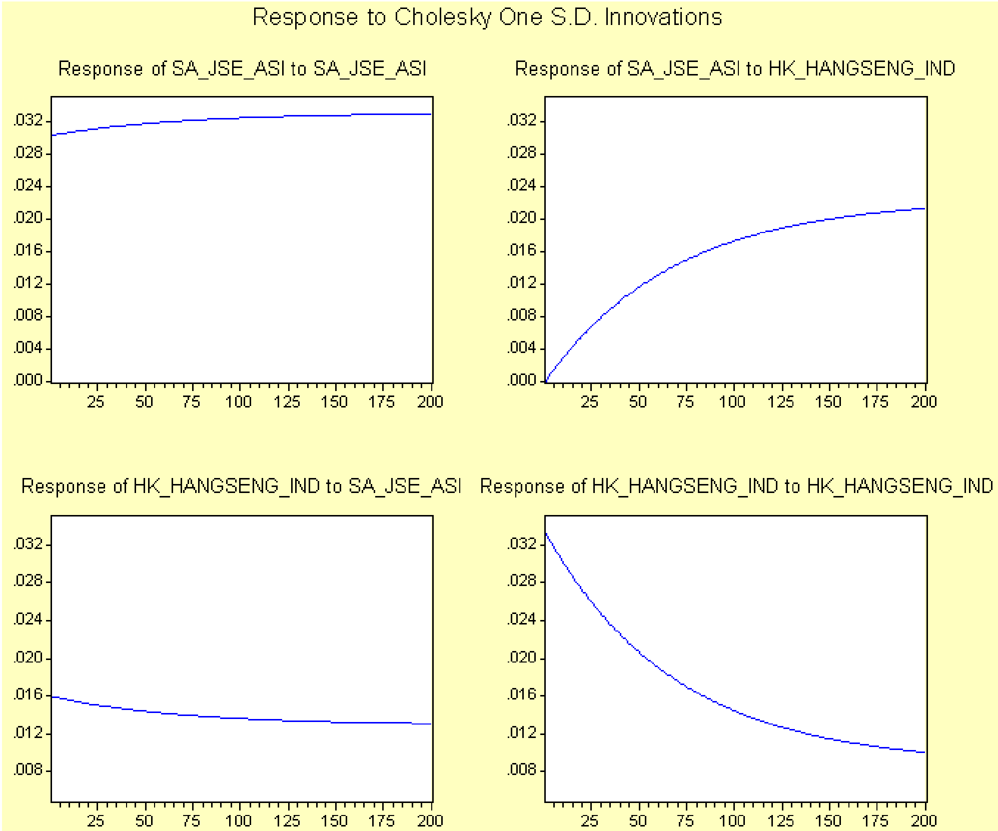
SA – Germany, Dax30. Cholesky ordering SA – Germany



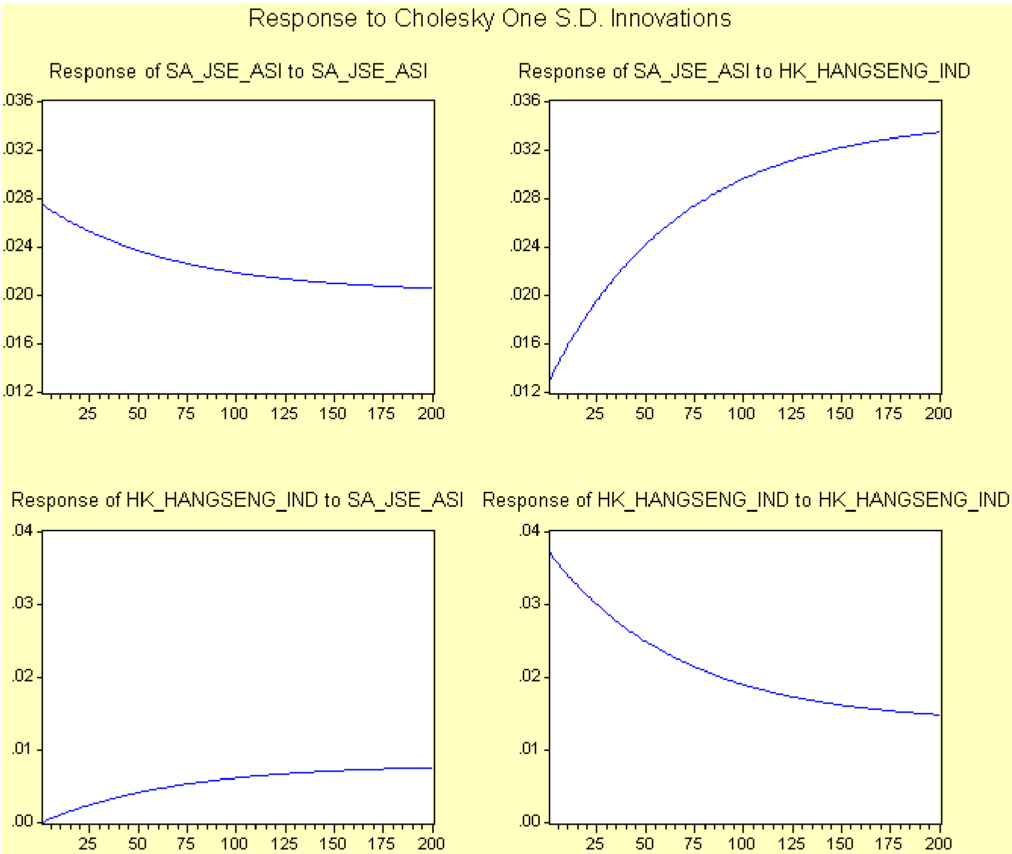
Cholesky ordering Germany – SA



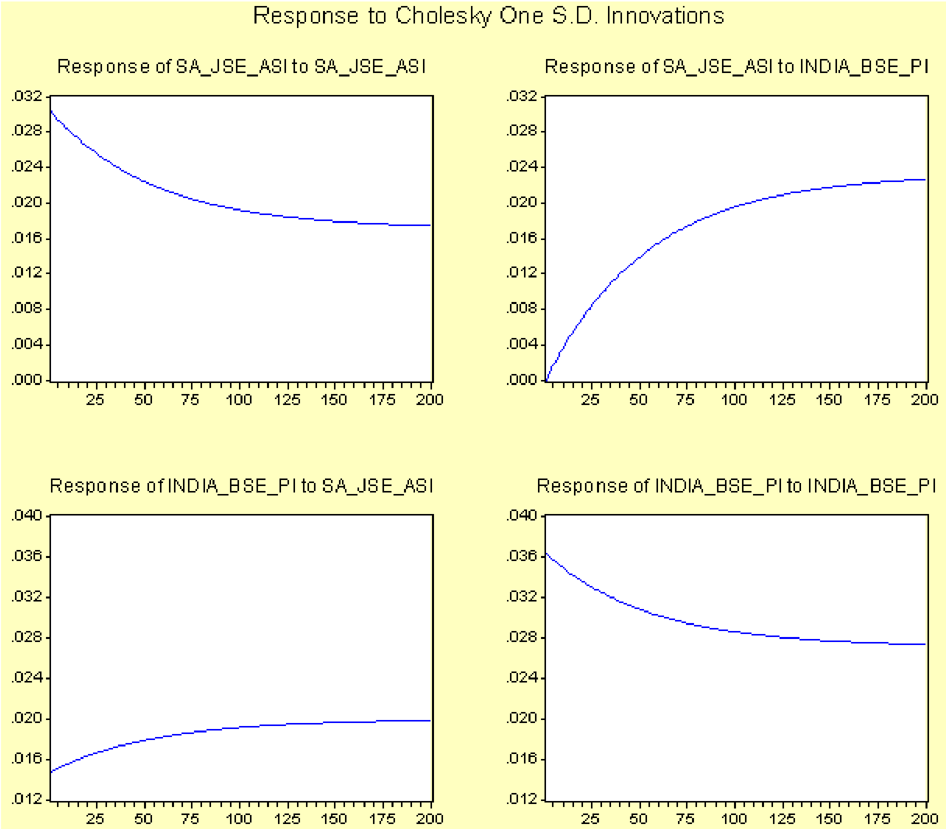
SA – Hong Kong, Hangseng. Cholesky ordering SA – HK



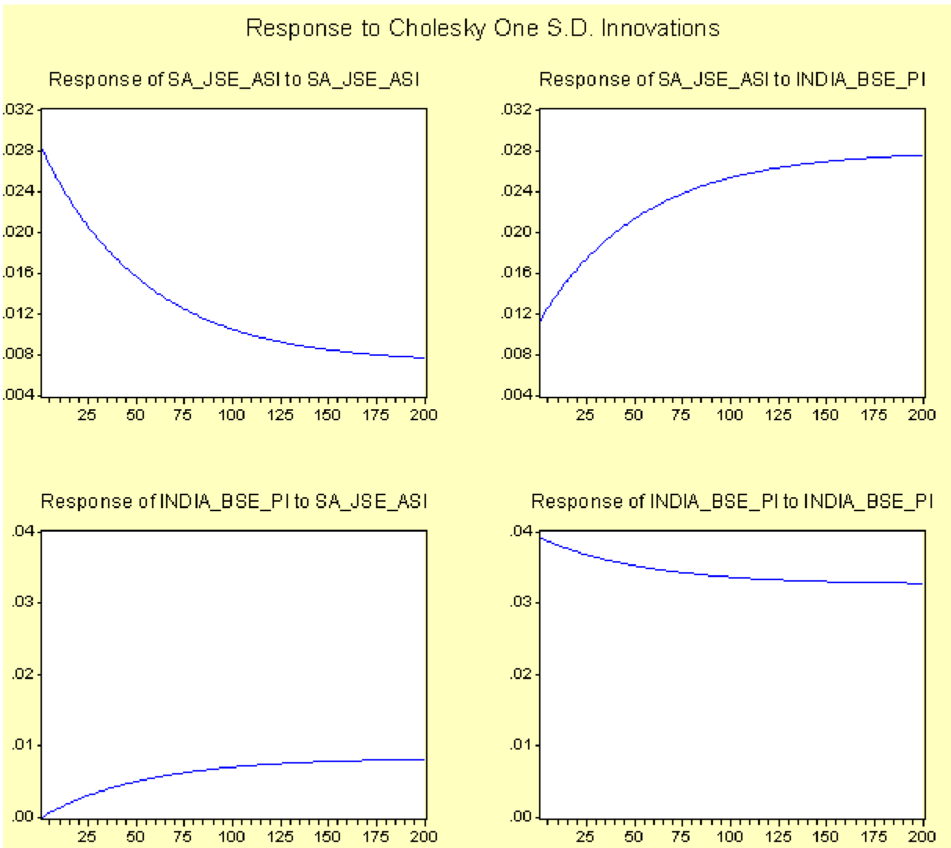
Cholesky ordering HK – SA



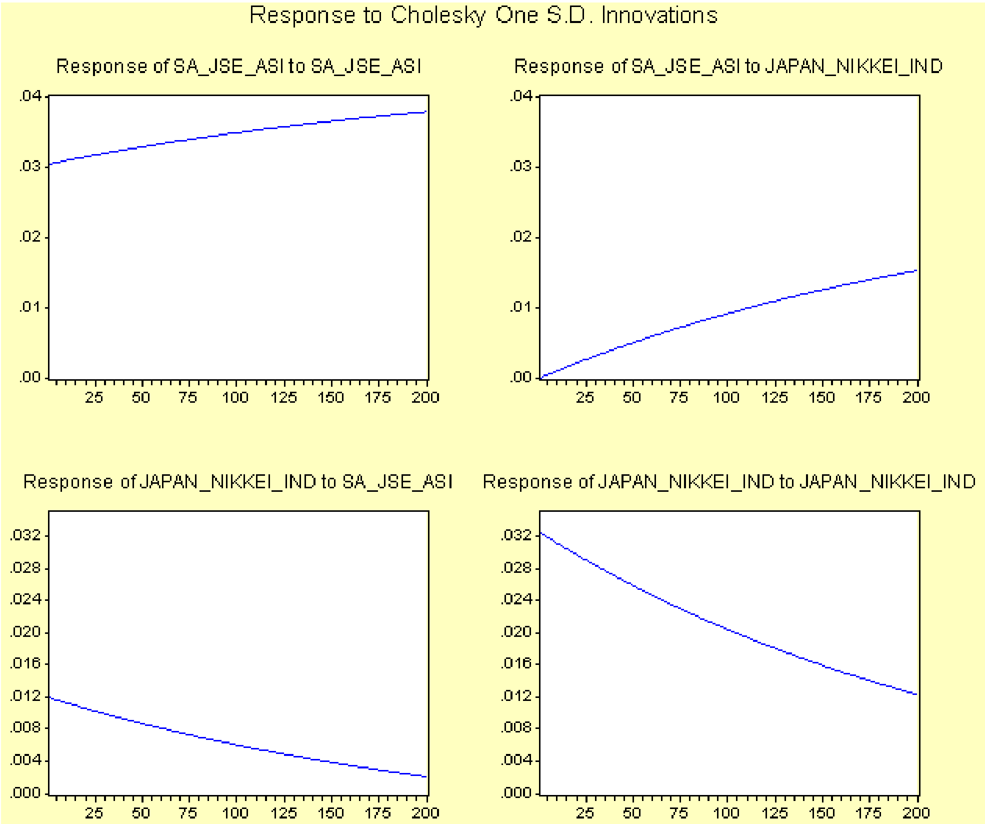
SA – India, BSE. Cholesky ordering SA – India



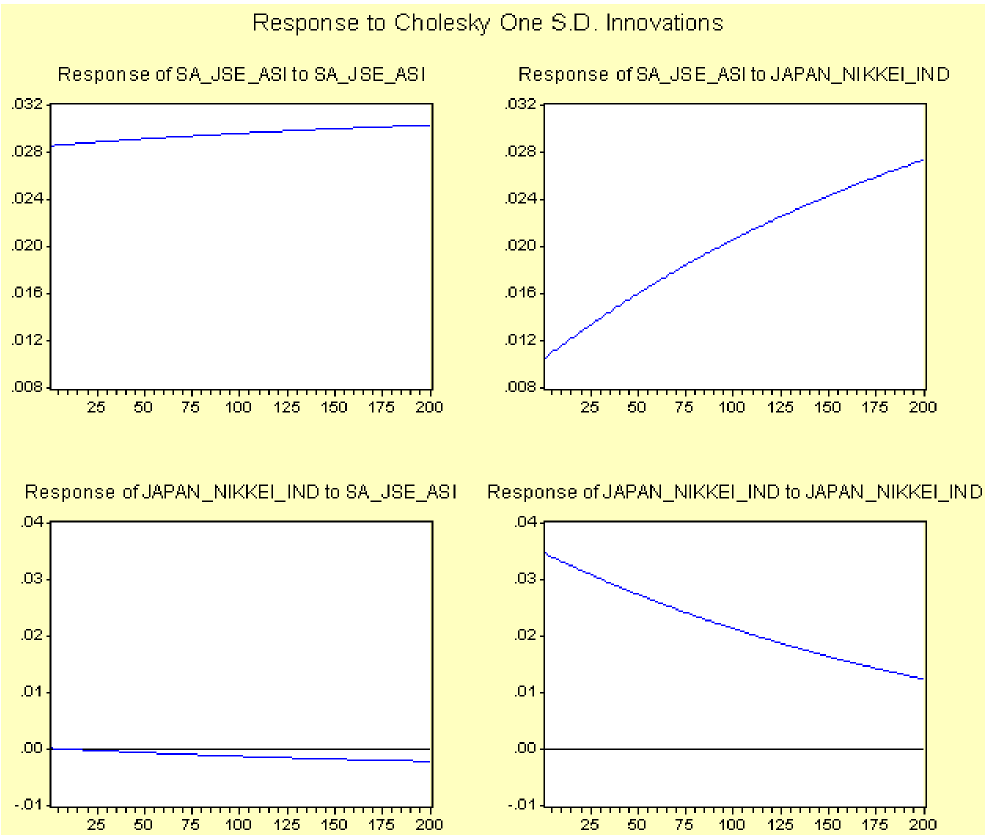
Cholesky ordering India – SA



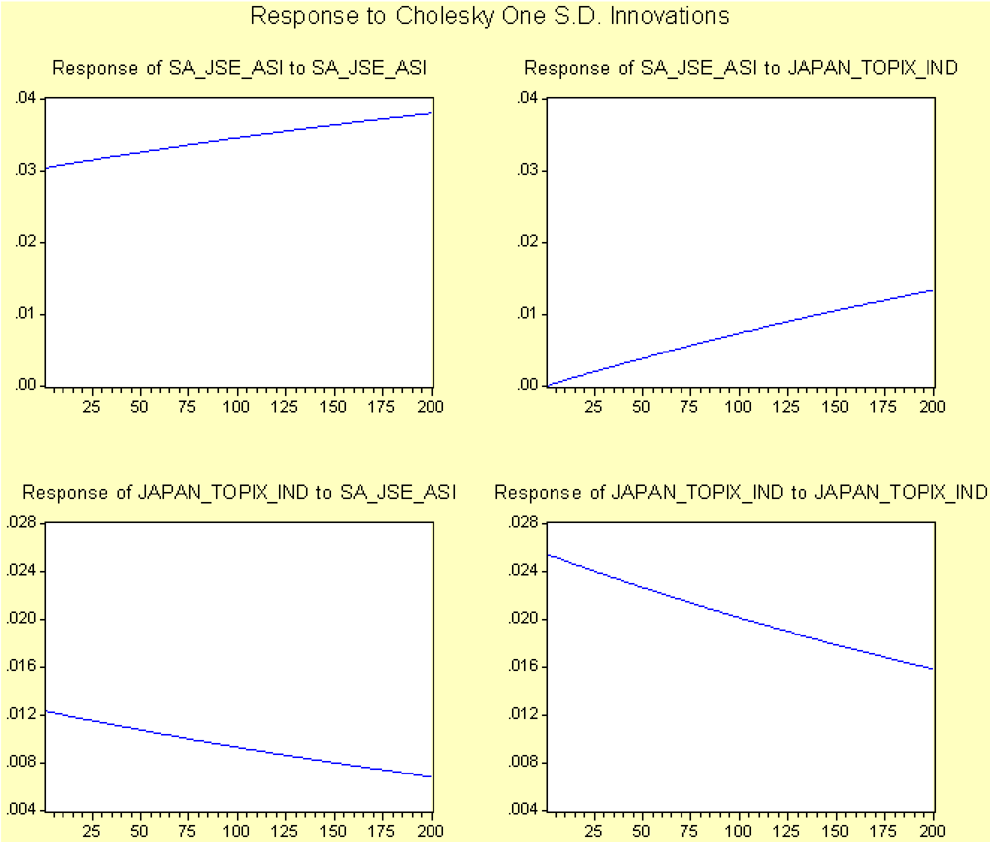
SA – Japan, Nikkei. Cholesky ordering SA – Japan



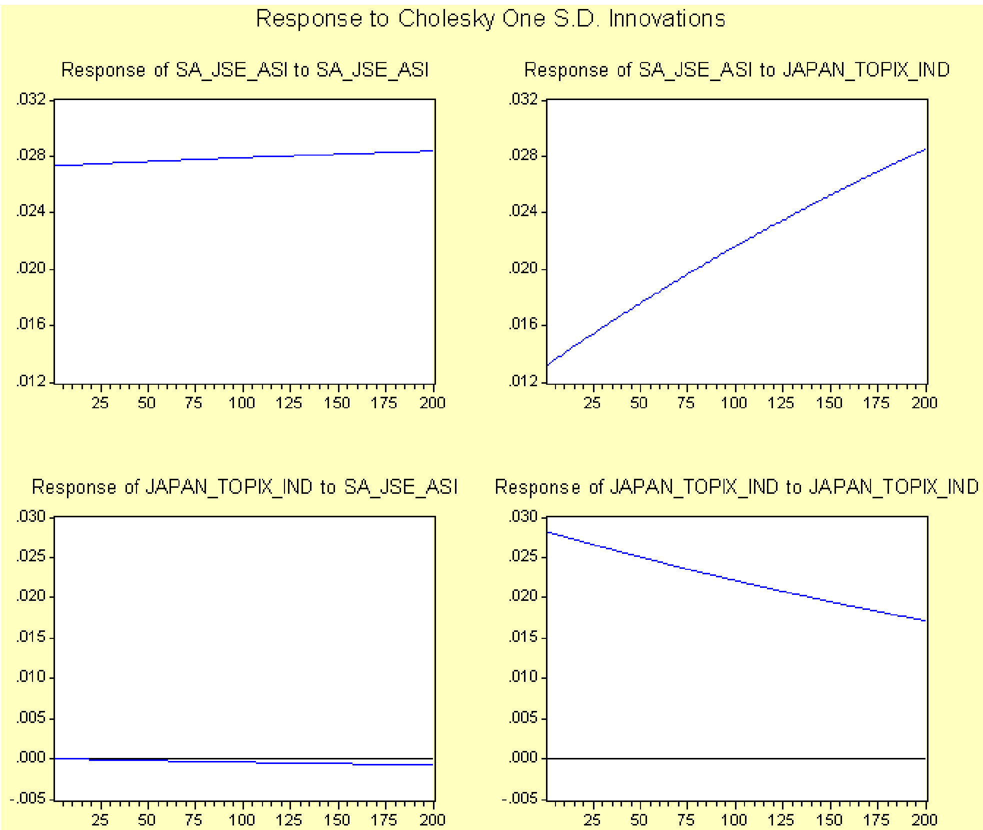
Cholesky ordering Japan – SA



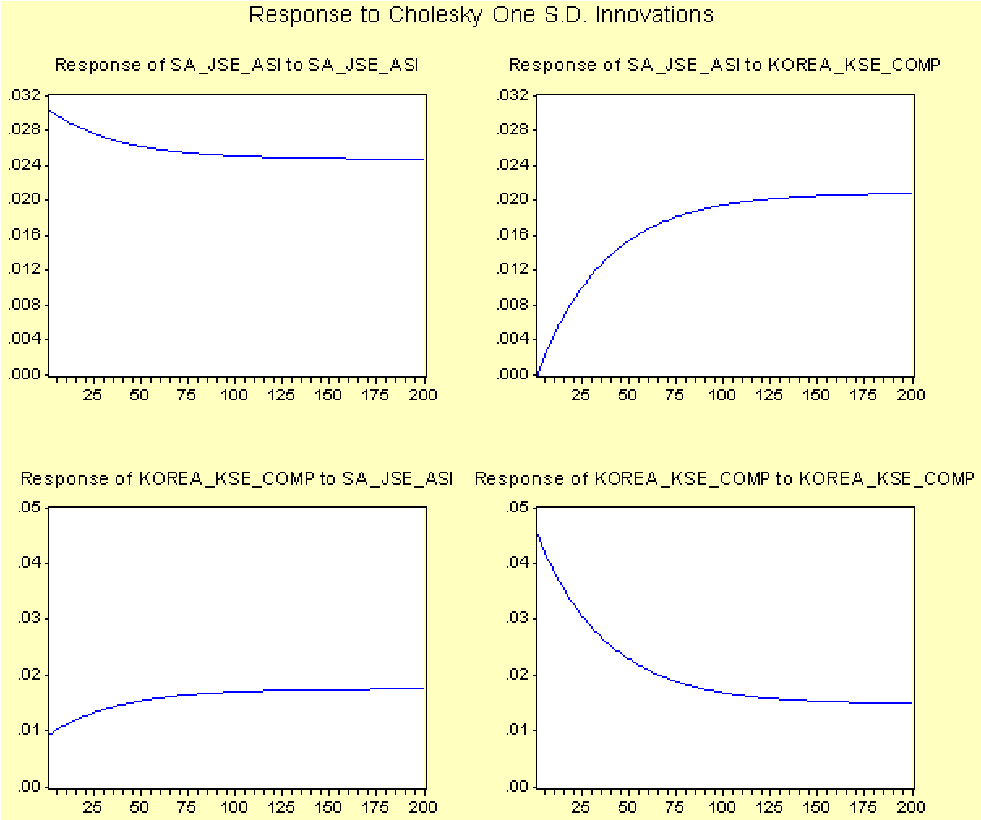
SA – Japan, Topix. Cholesky ordering SA – Japan



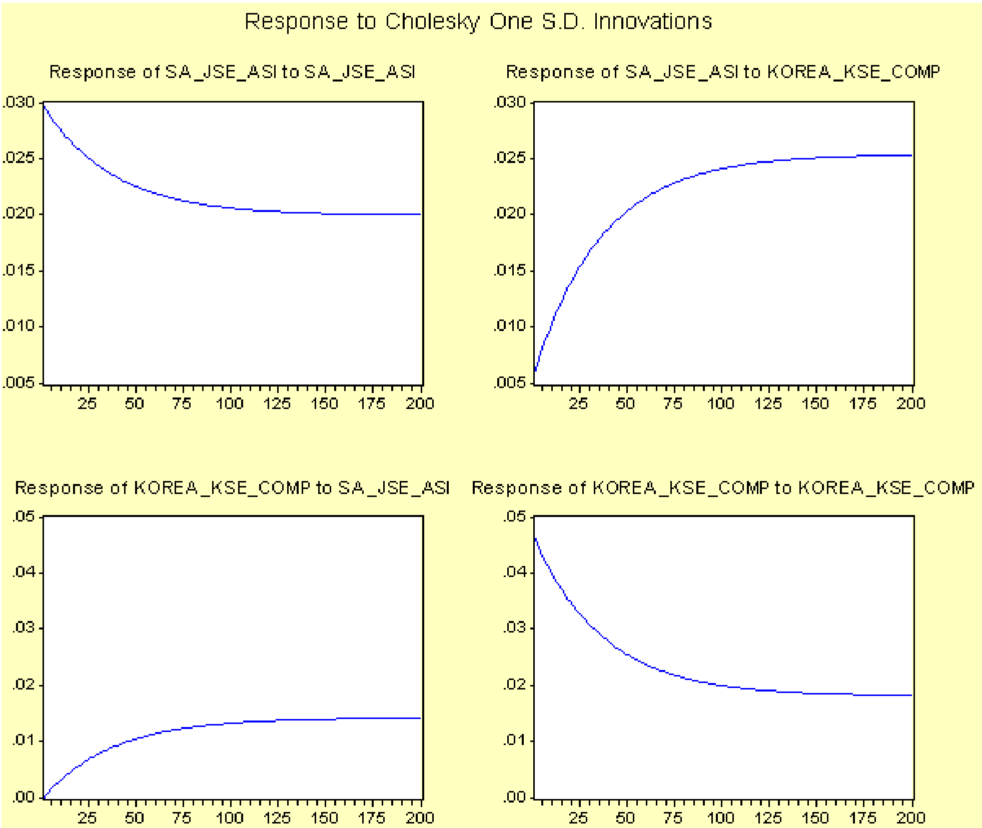
Cholesky ordering Japan – SA



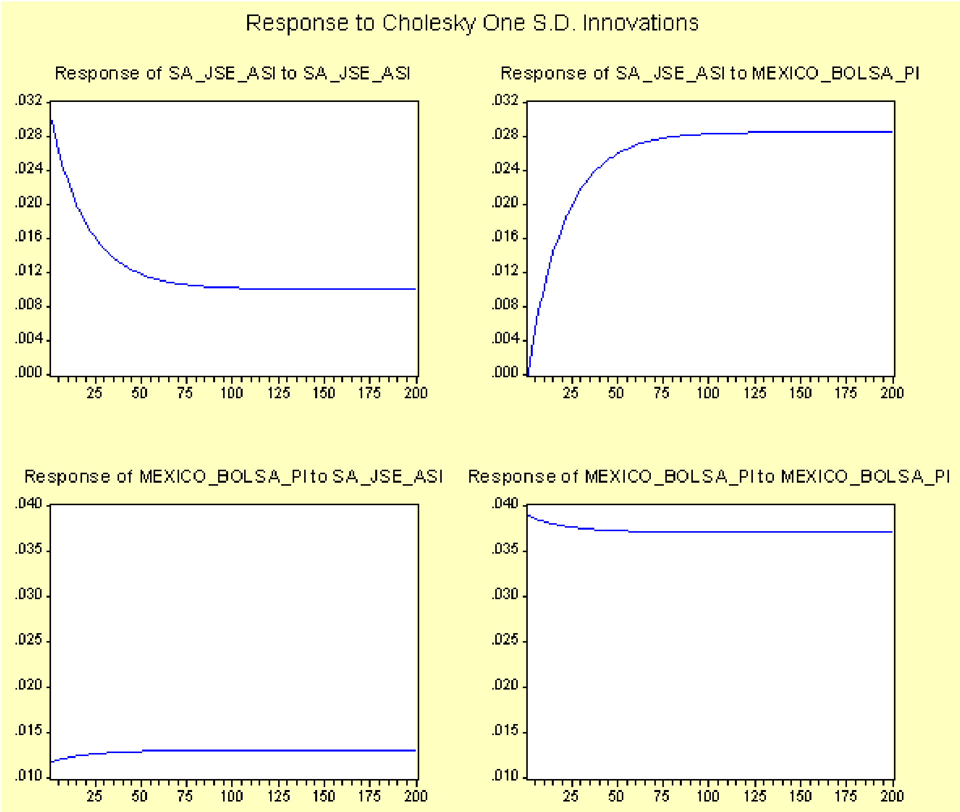
SA – Korea, KSE. Cholesky ordering SA – Korea



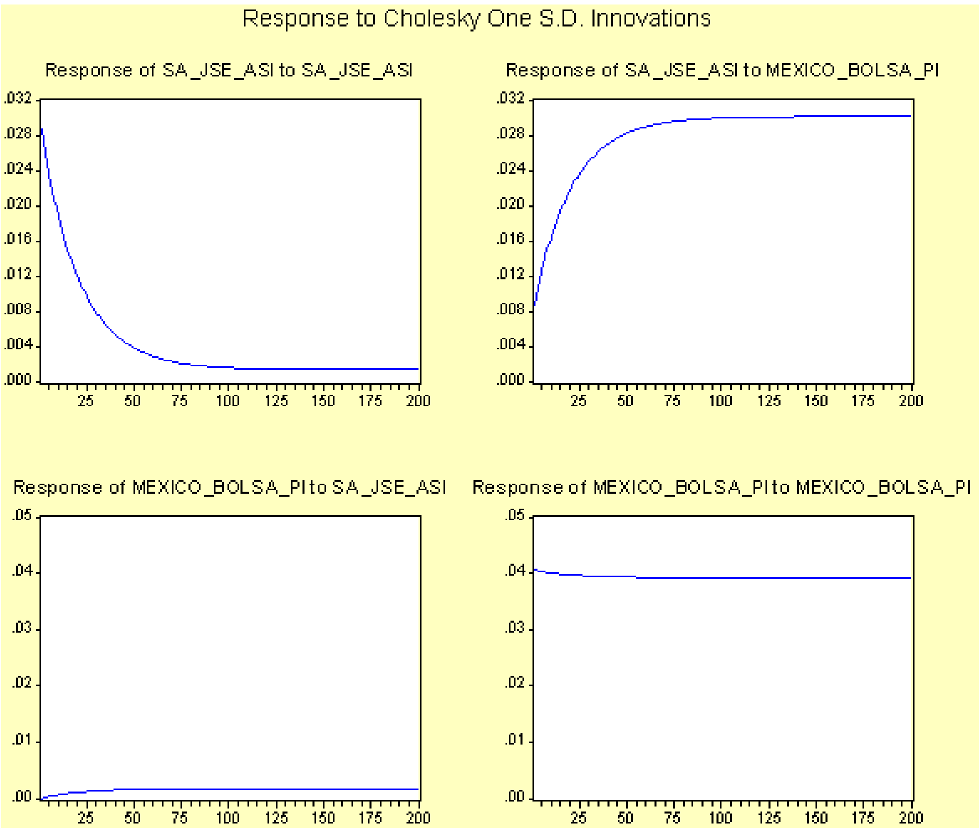
Cholesky ordering Korea – SA



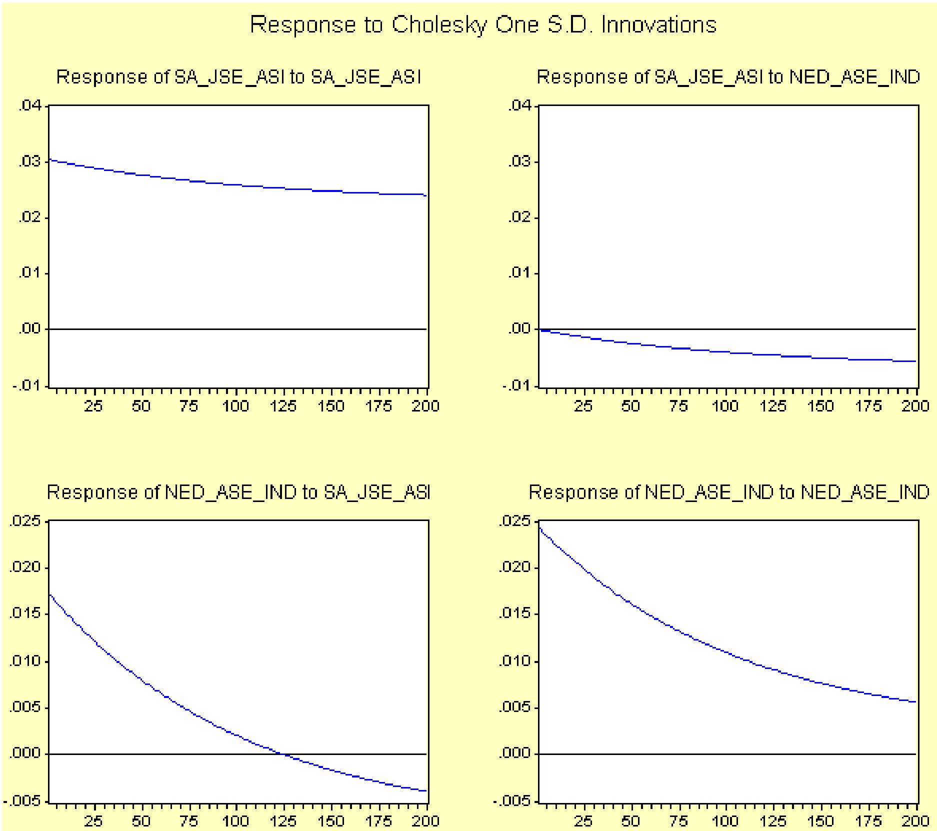
SA – Mexico, Bolsa. Cholesky ordering SA – Mexico



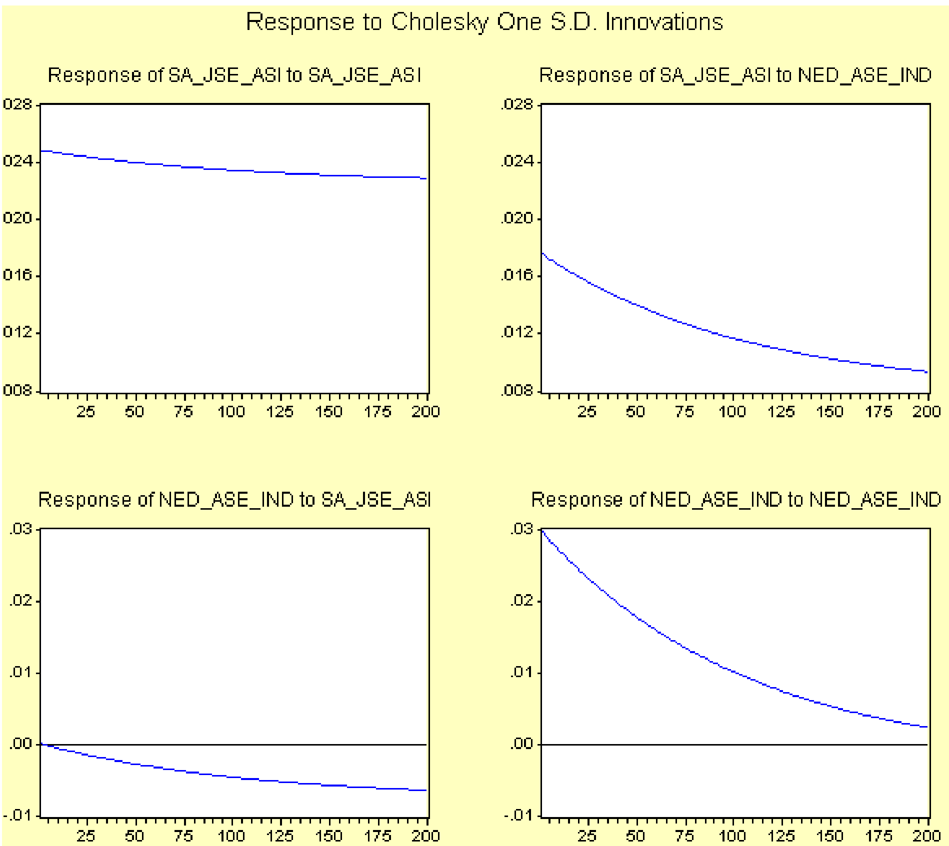
Cholesky ordering Mexico – SA



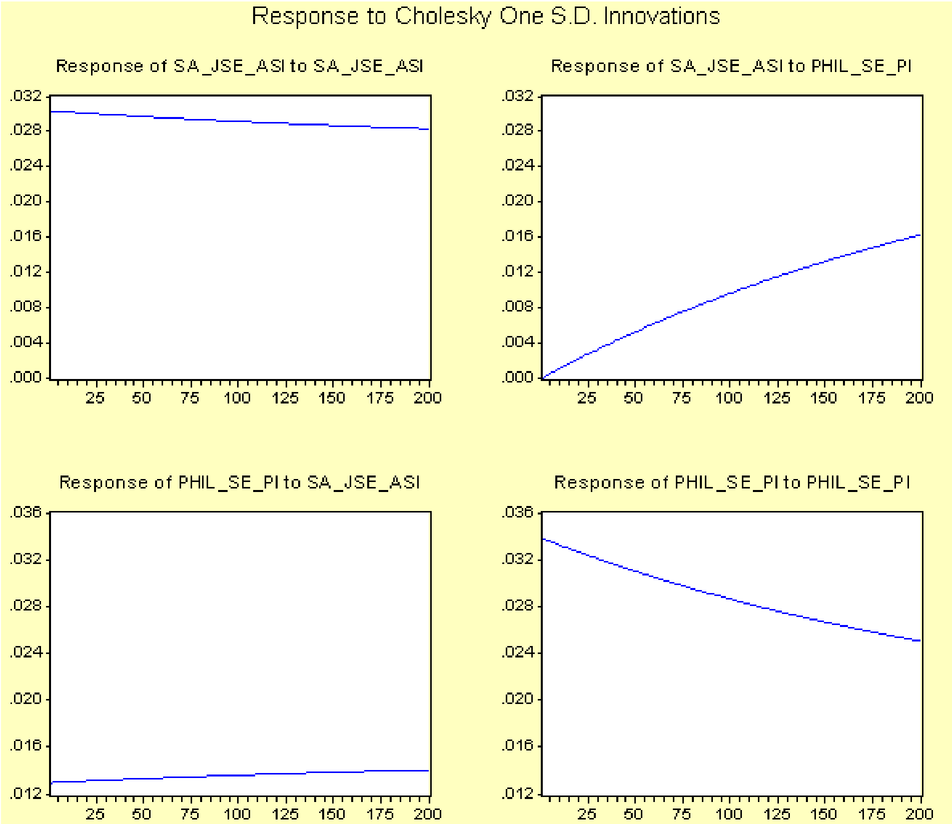
SA – Netherlands, ASE. Cholesky ordering SA – Netherlands



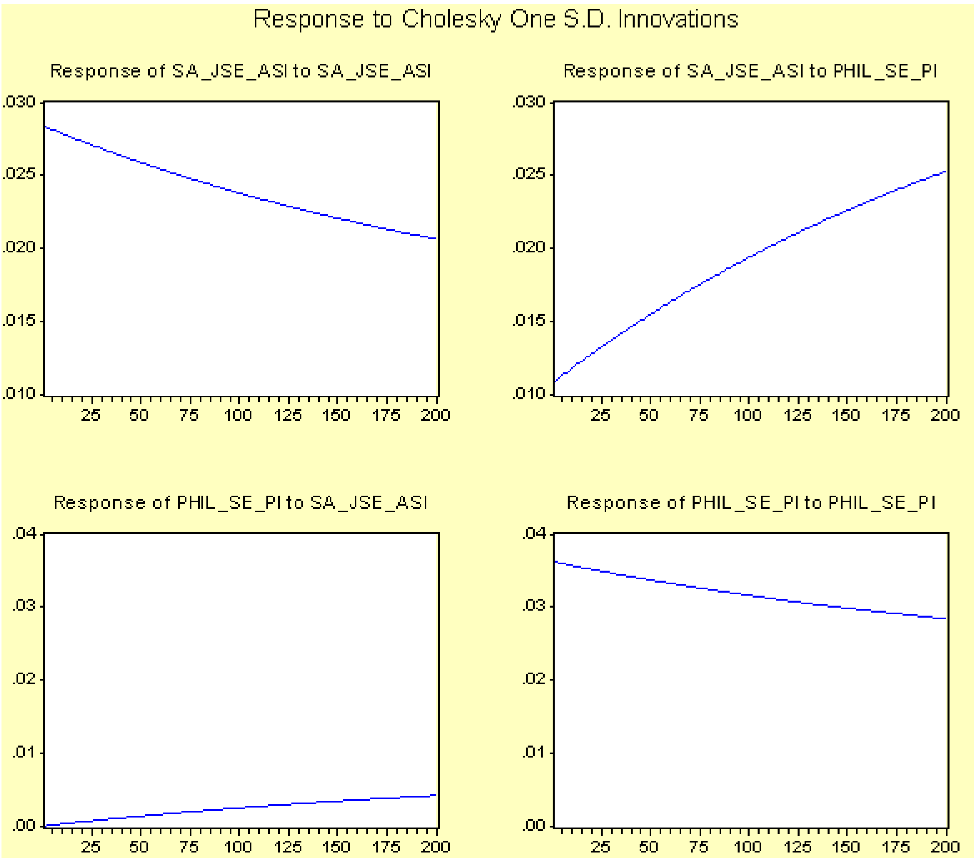
Cholesky ordering Netherlands – SA



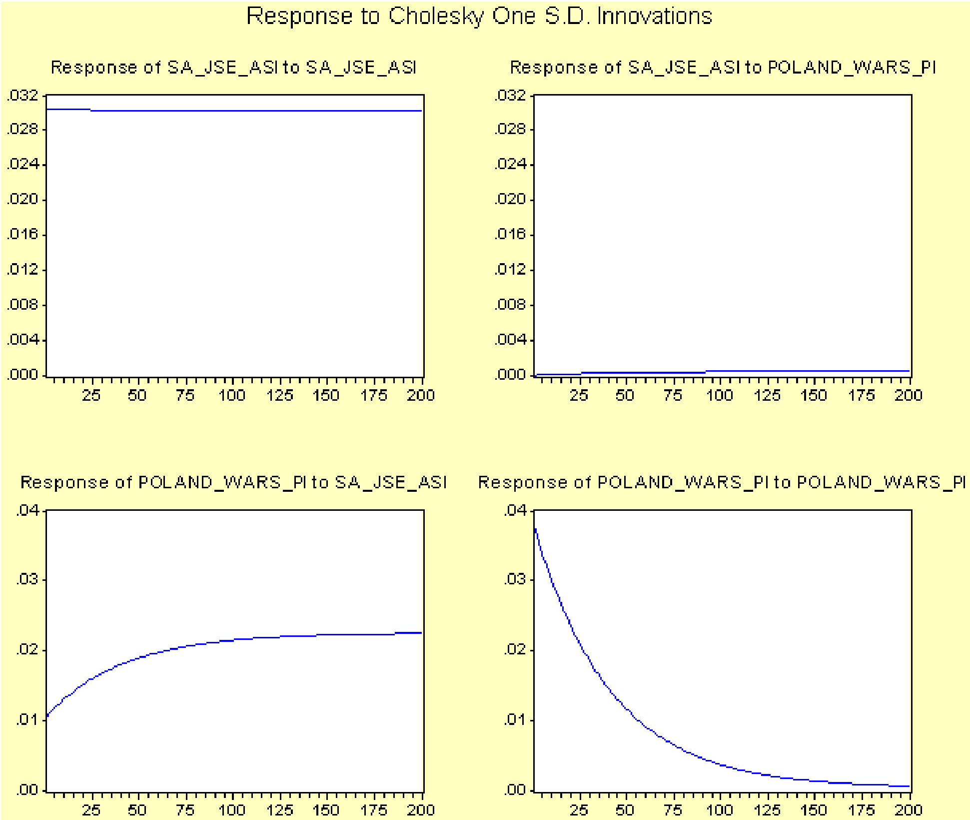
SA – Philippines, PSE. Cholesky ordering SA – Philippines



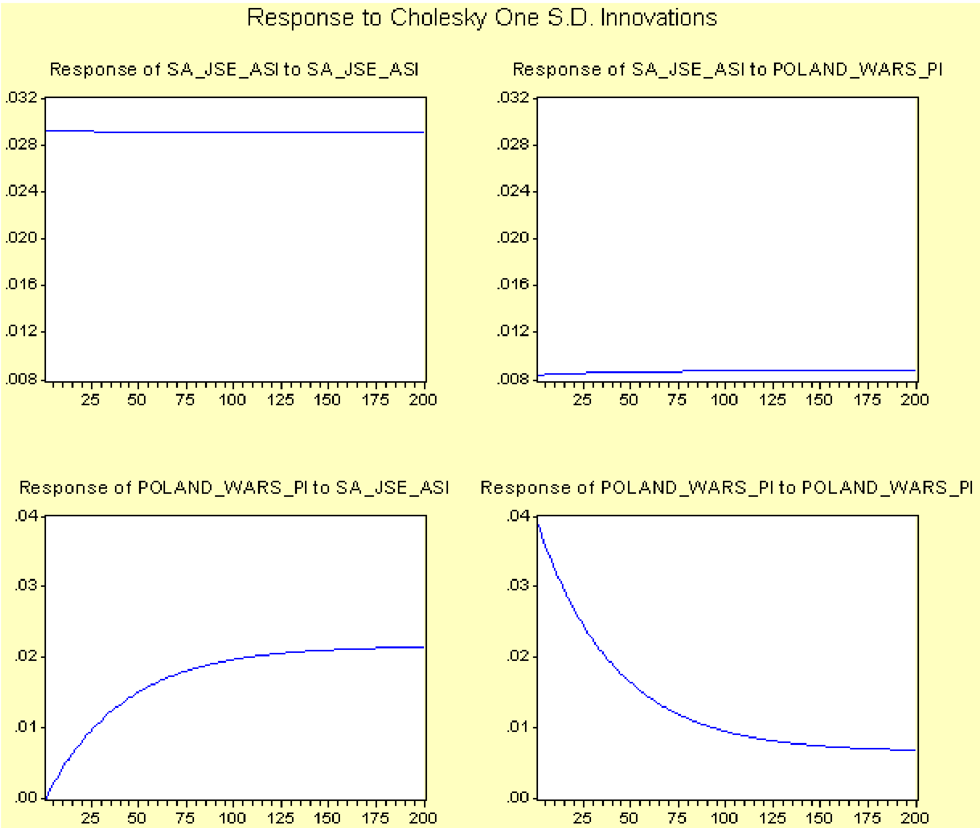
Cholesky ordering Philippines – SA



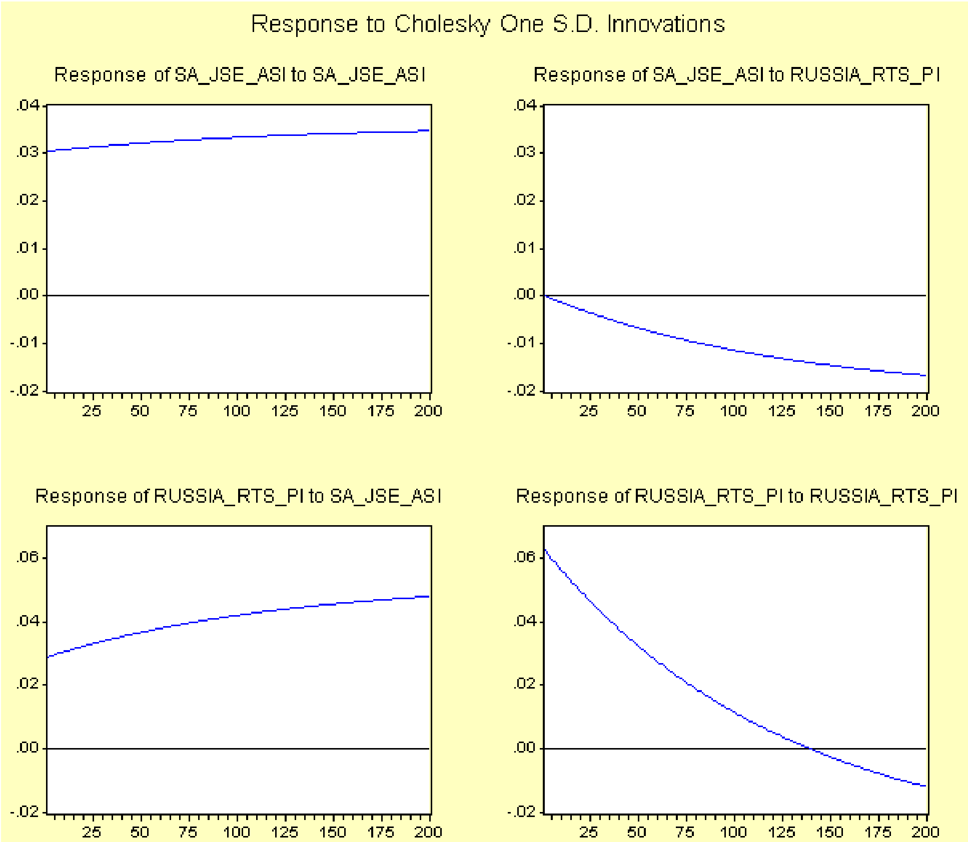
SA – Poland, Warsaw. Cholesky ordering SA – Poland



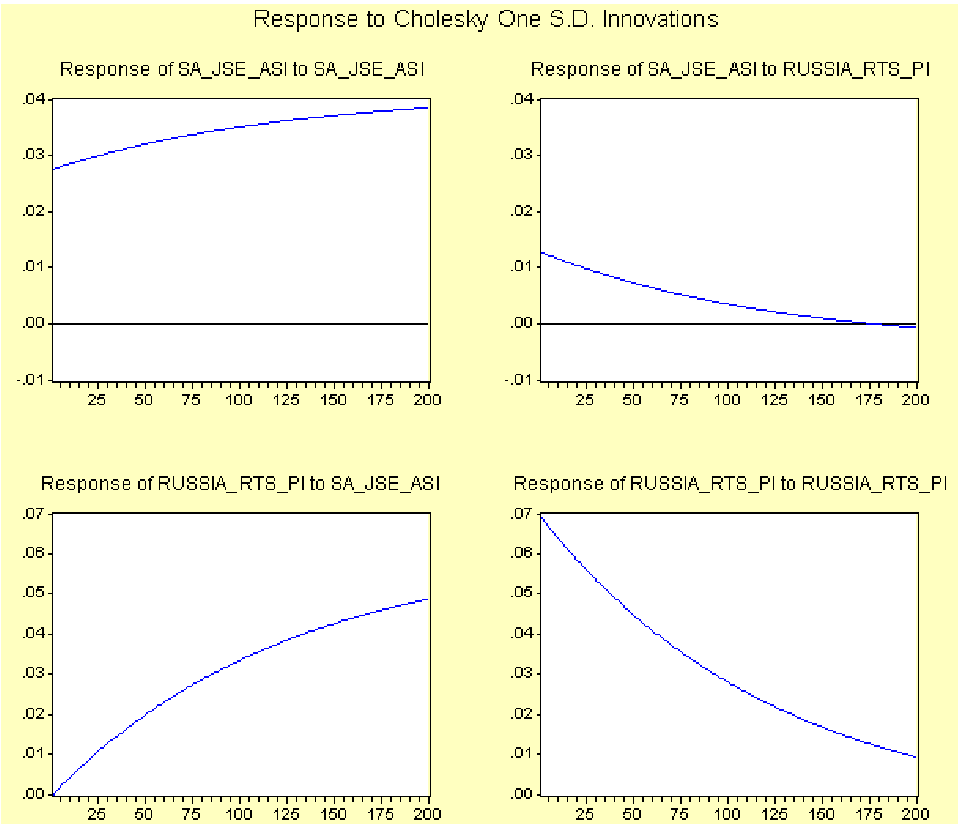
Cholesky ordering Poland – SA



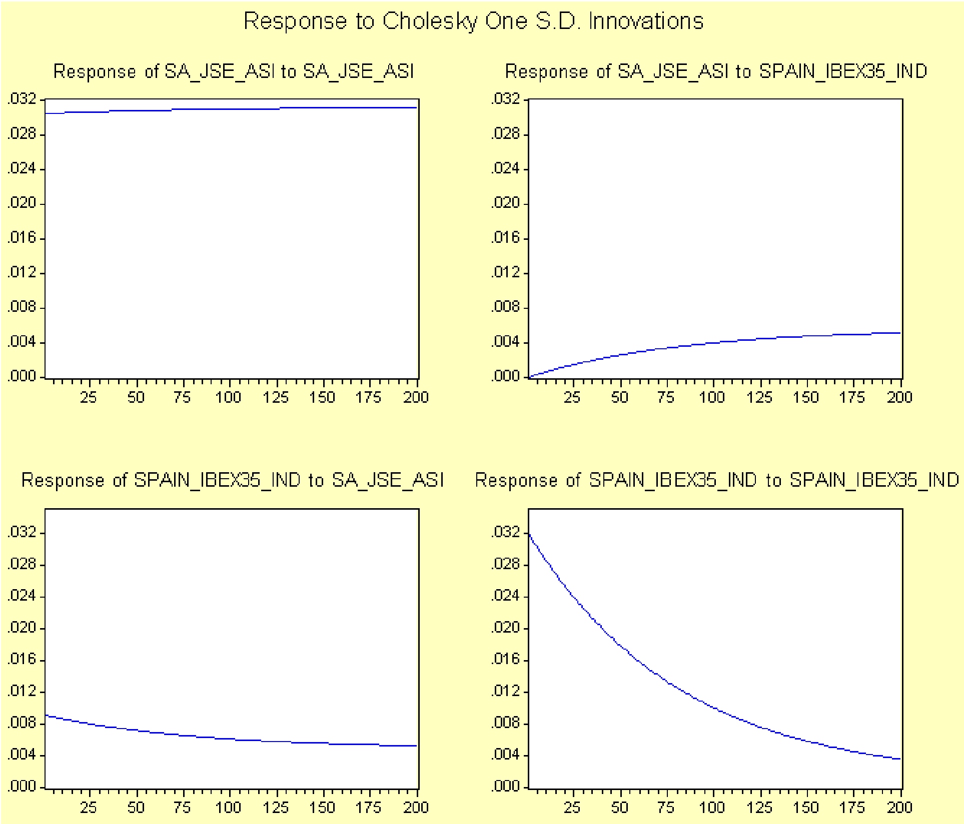
SA – Russia, RTS. Cholesky ordering SA – Russia



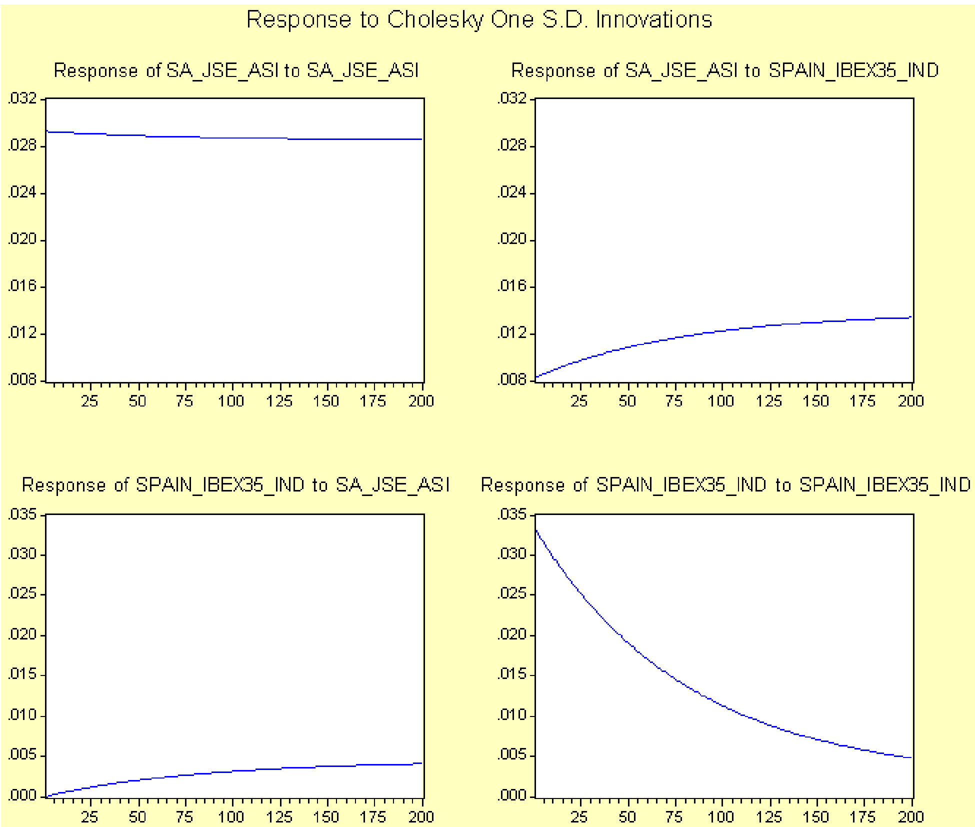
Cholesky ordering Russia – SA



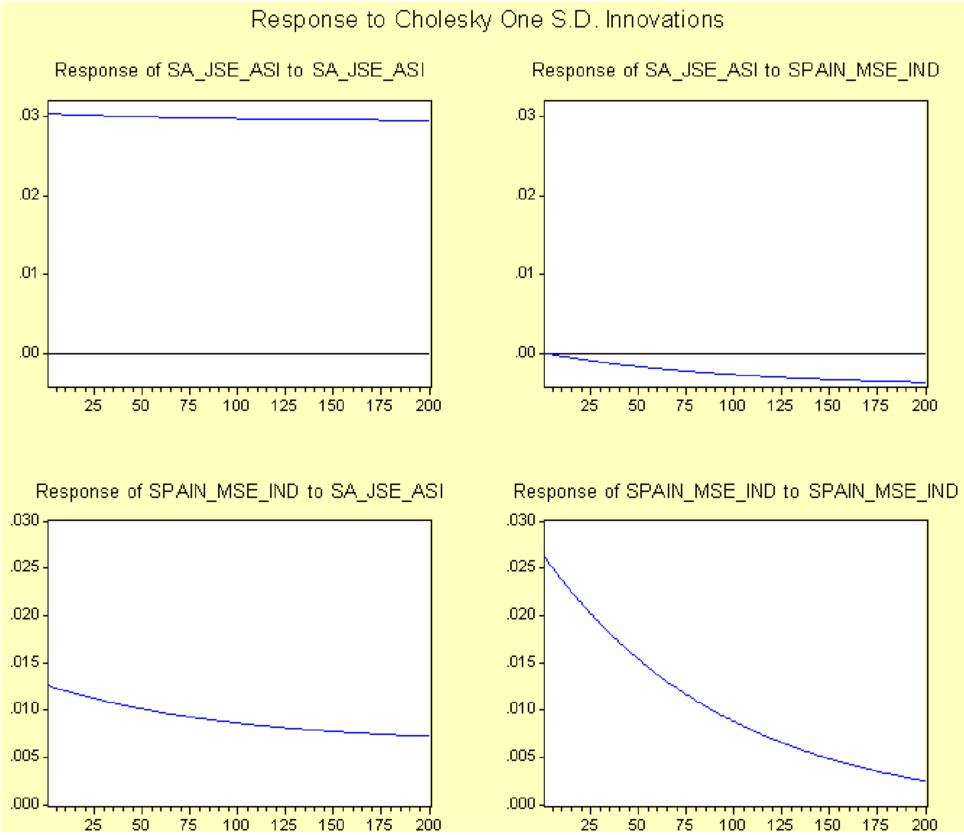
SA – Spain, Ibex35. Cholesky ordering SA – Spain



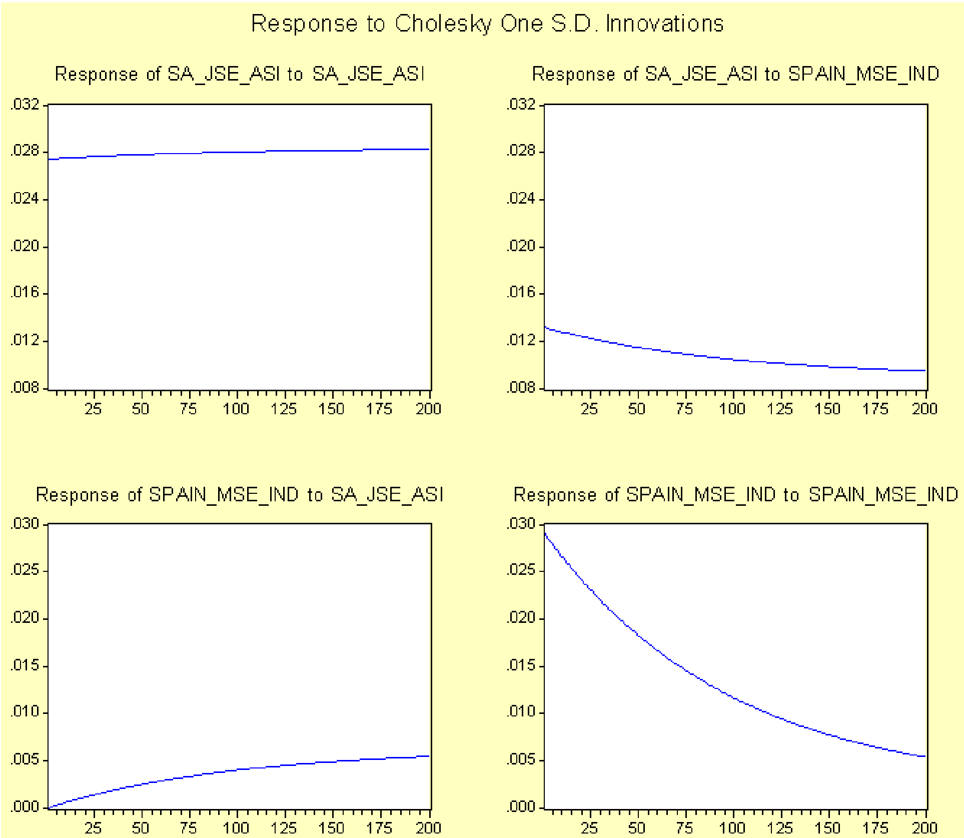
Cholesky ordering Spain – SA



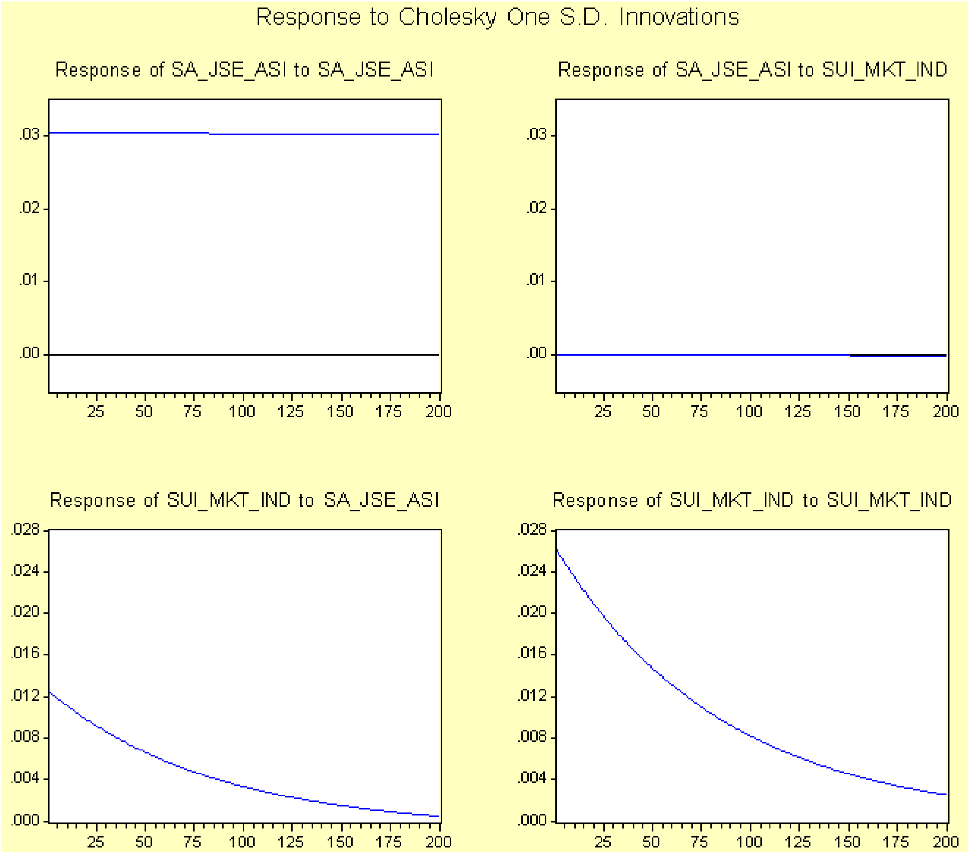
SA – Spain, MSE. Cholesky ordering SA – Spain



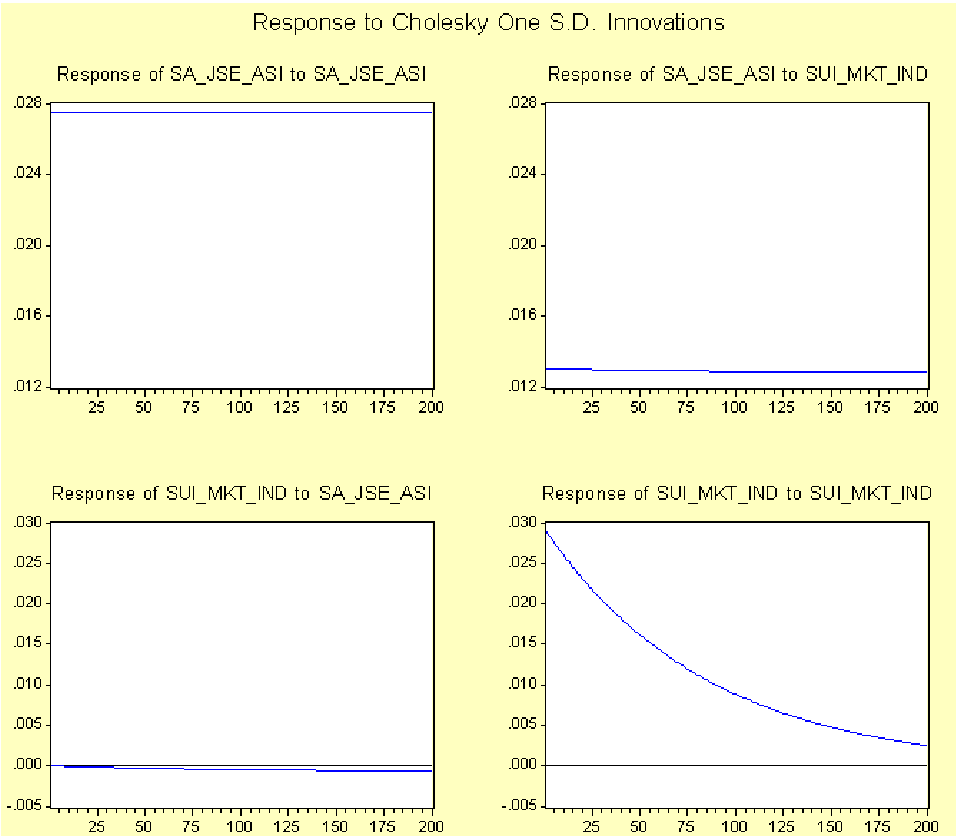
Cholesky ordering Spain – SA



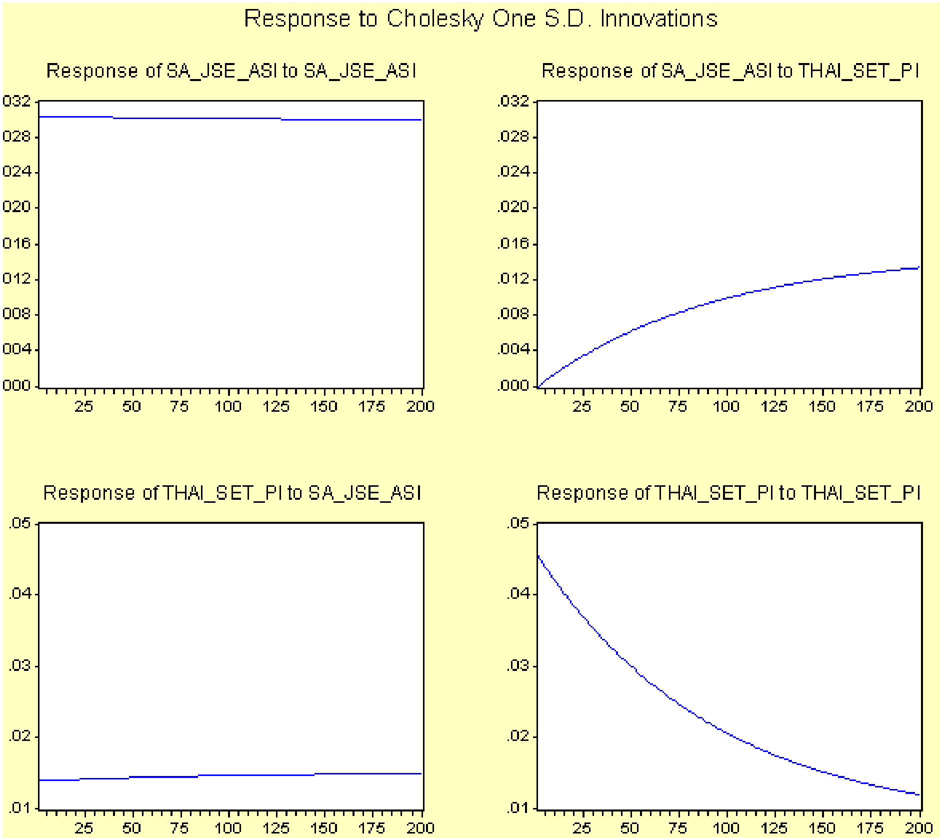
SA – Switzerland, SMkt. Cholesky ordering SA – Switzerland



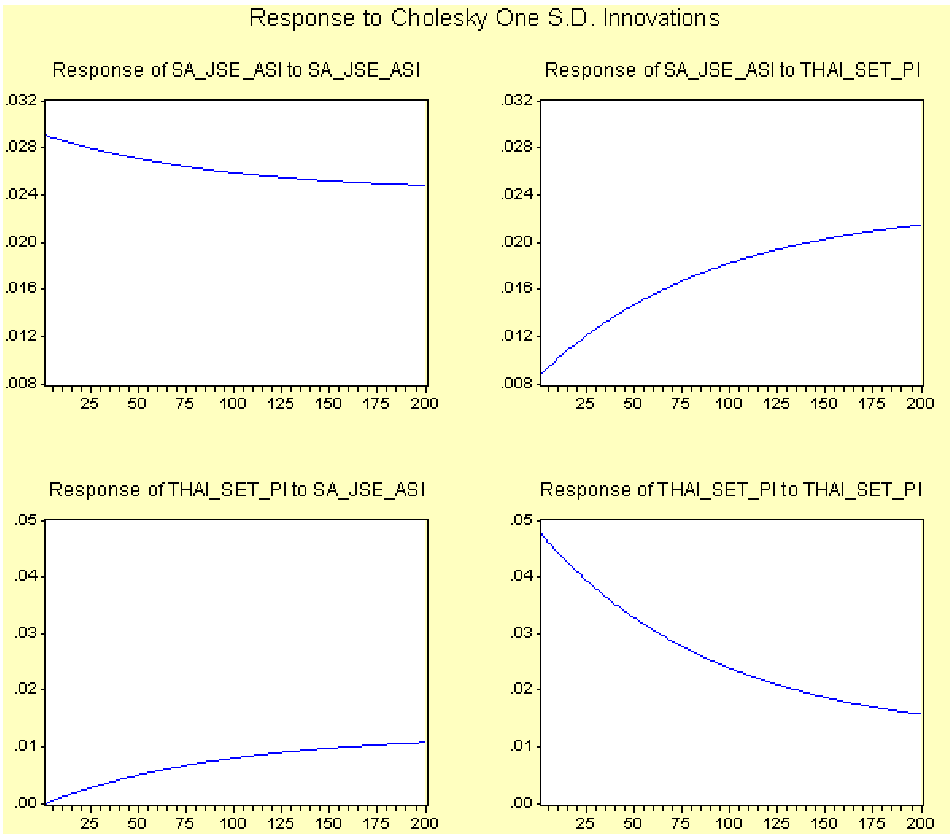
Cholesky ordering Switzerland – SA



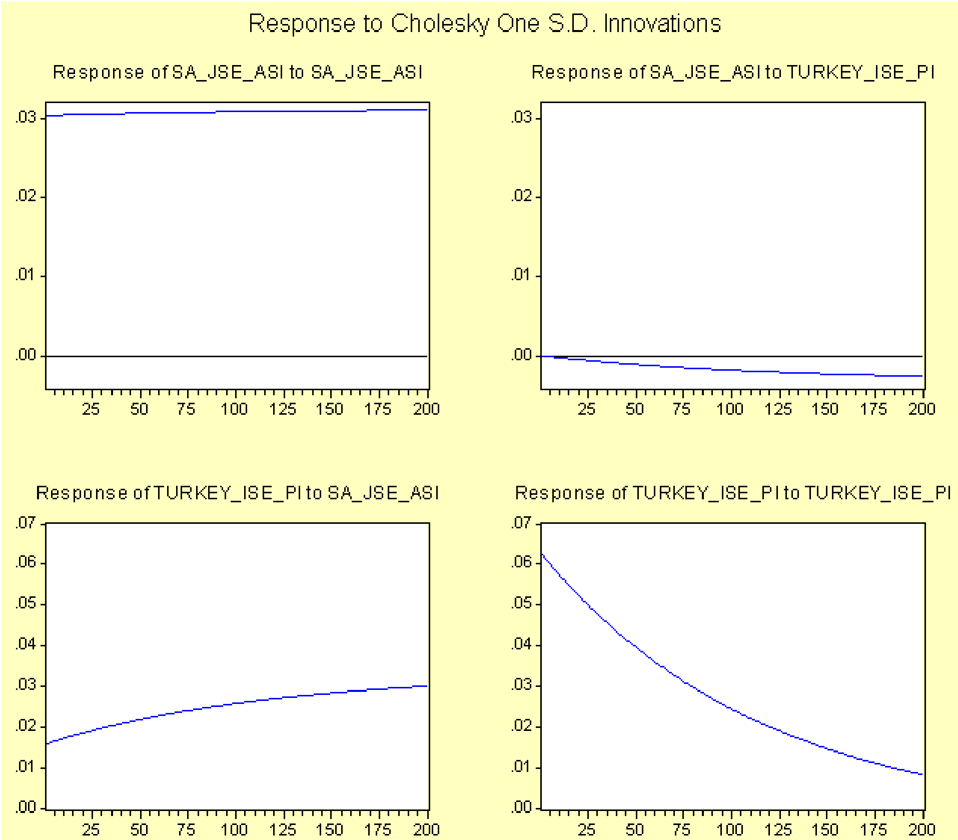
SA – Thailand, SET. Cholesky ordering SA – Thailand



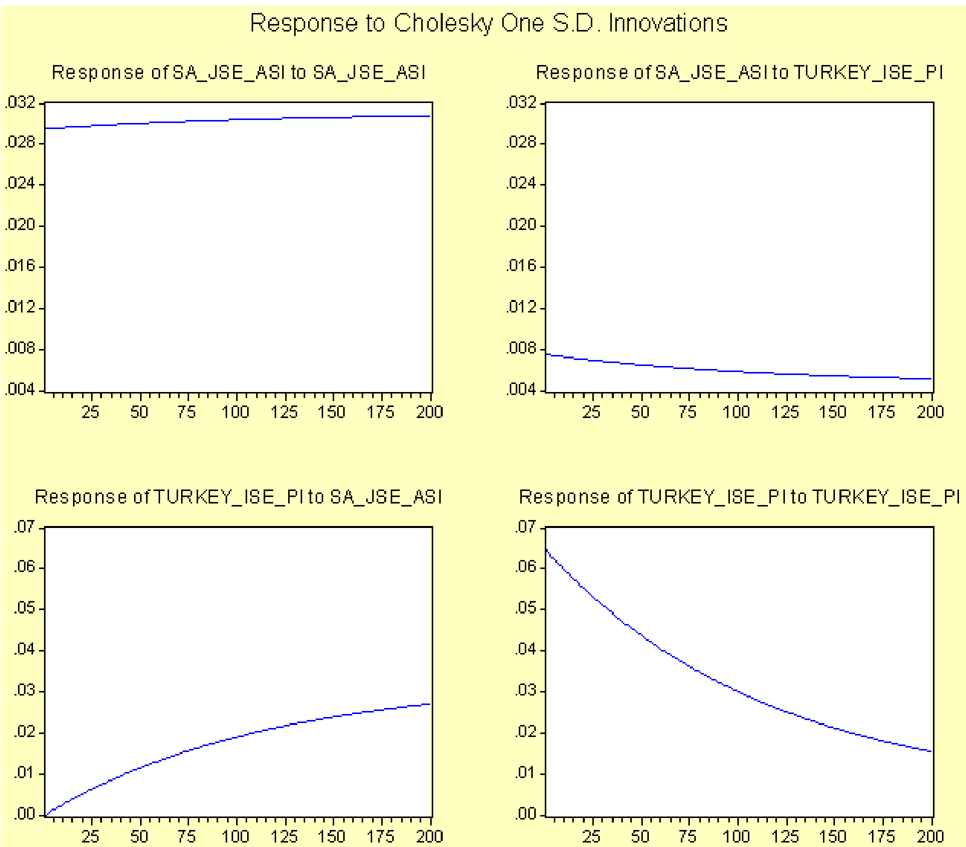
Cholesky ordering Thailand – SA



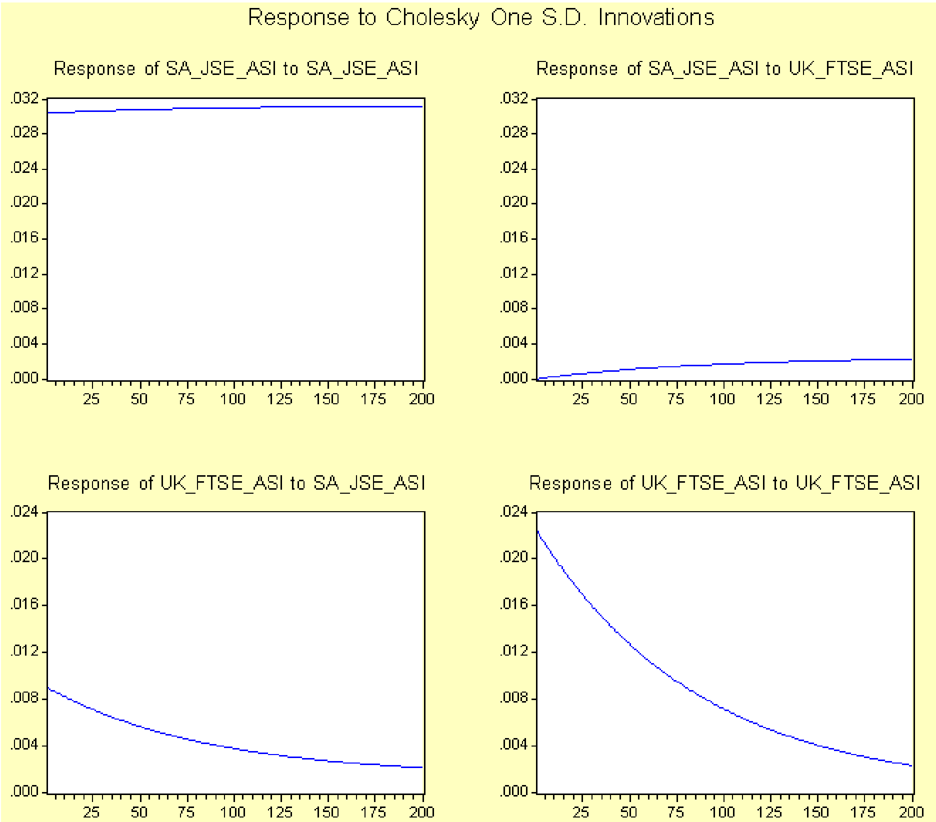
SA – Turkey, ISE. Cholesky ordering SA – Turkey



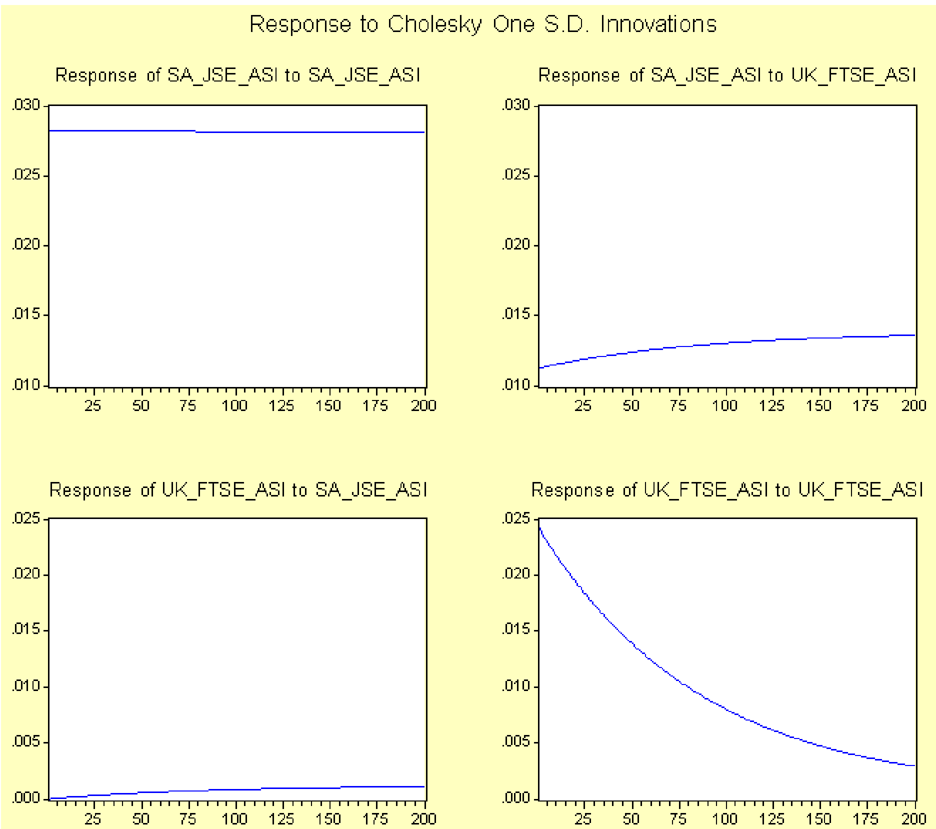
Cholesky ordering Turkey – SA



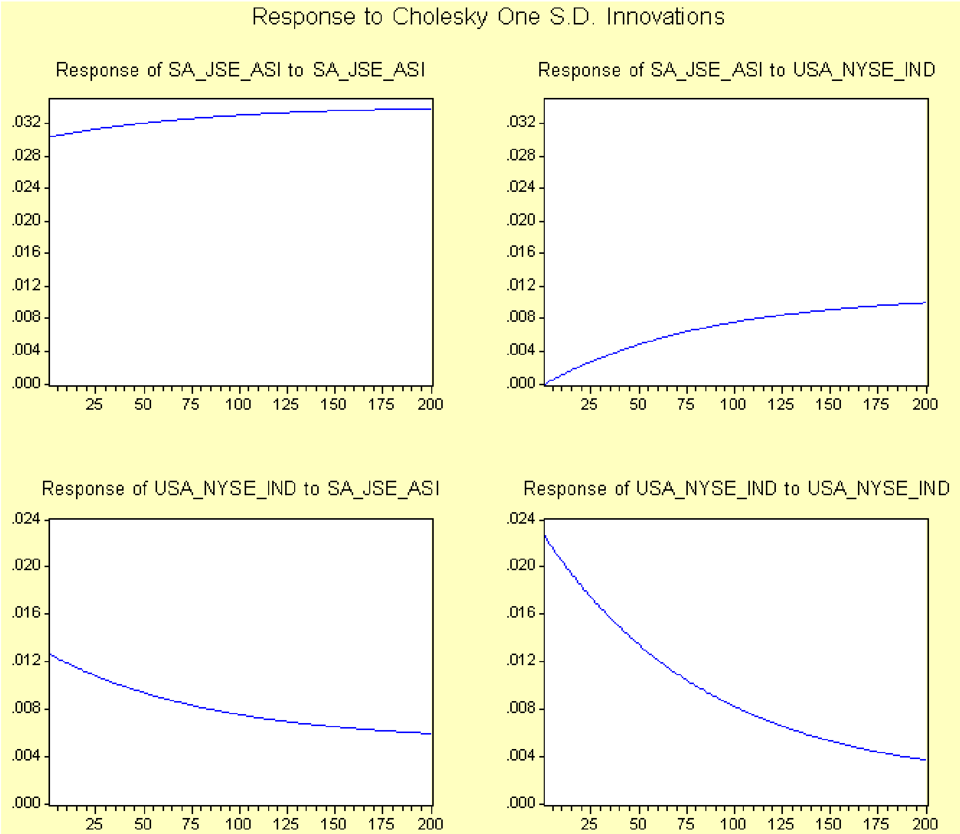
SA – UK, FTSE. Cholesky ordering SA – UK



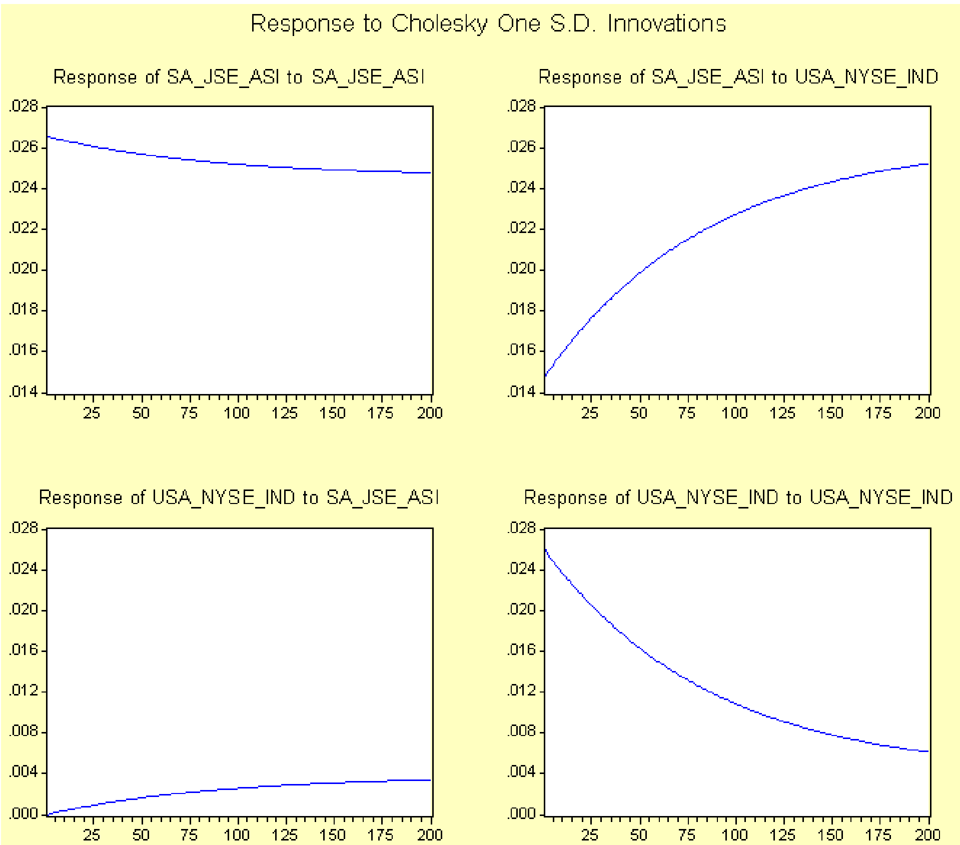
Cholesky ordering UK – SA



SA – USA, NYSE. Cholesky ordering SA – UK

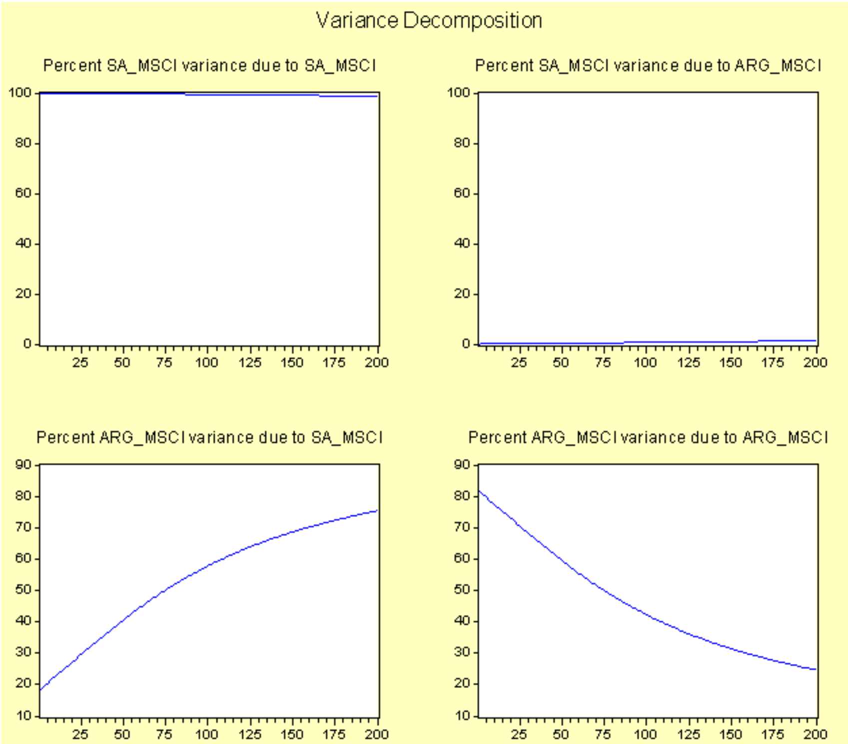


Cholesky ordering UK – SA

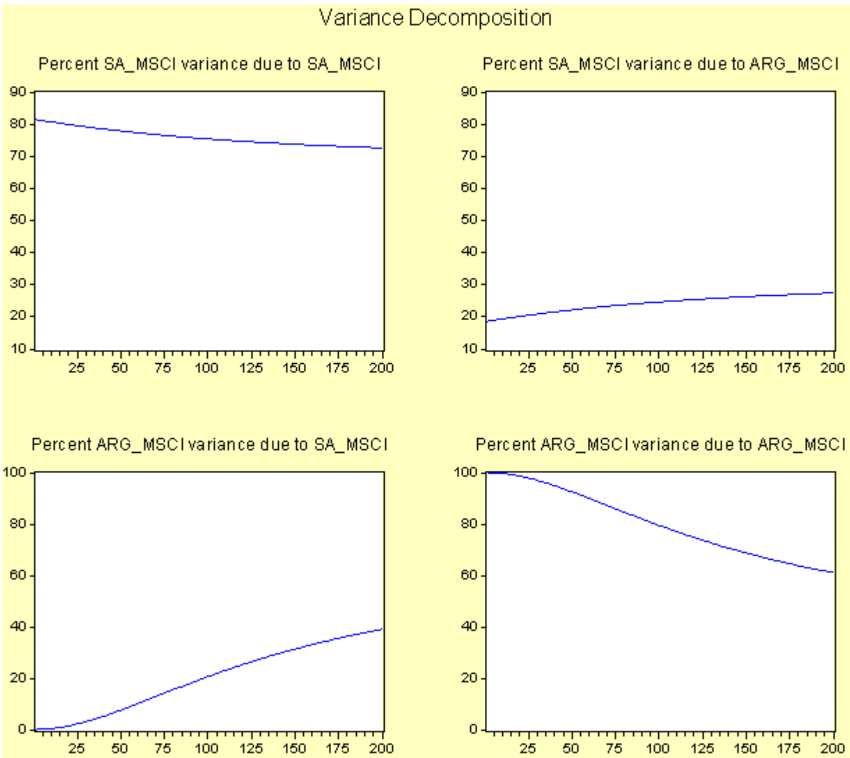


Appendix J – bivariate variance decomposition at 1 lag, using intercept in CE specification, MSCI indices

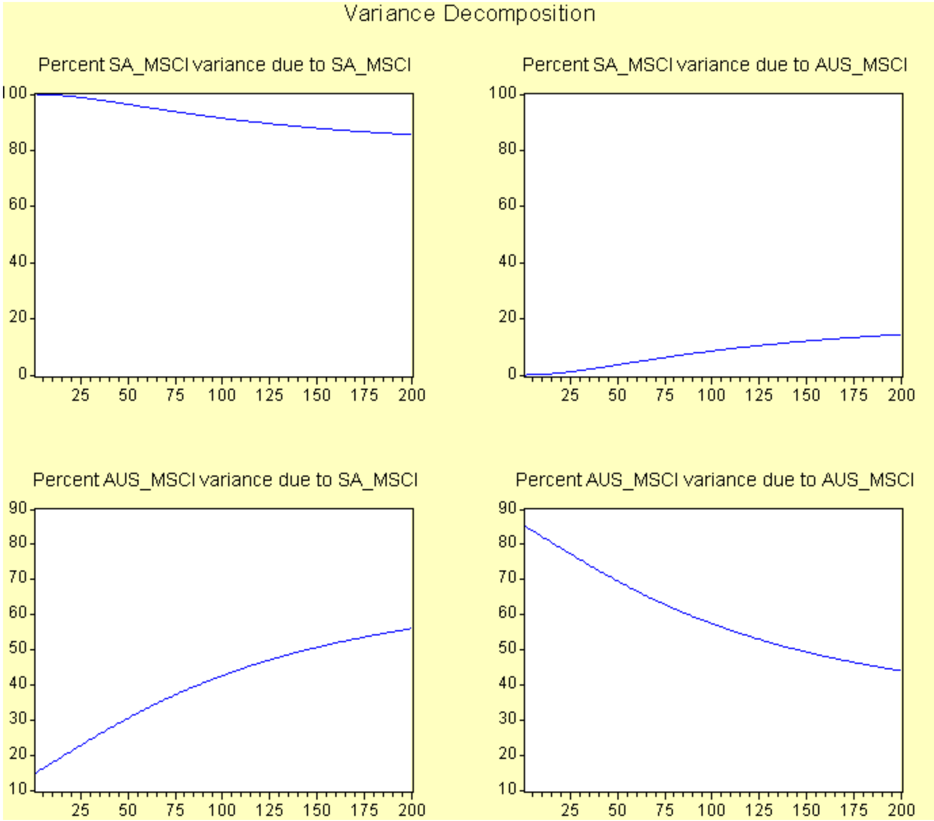
SA – Argentina, Cholesky ordering SA – Argentina



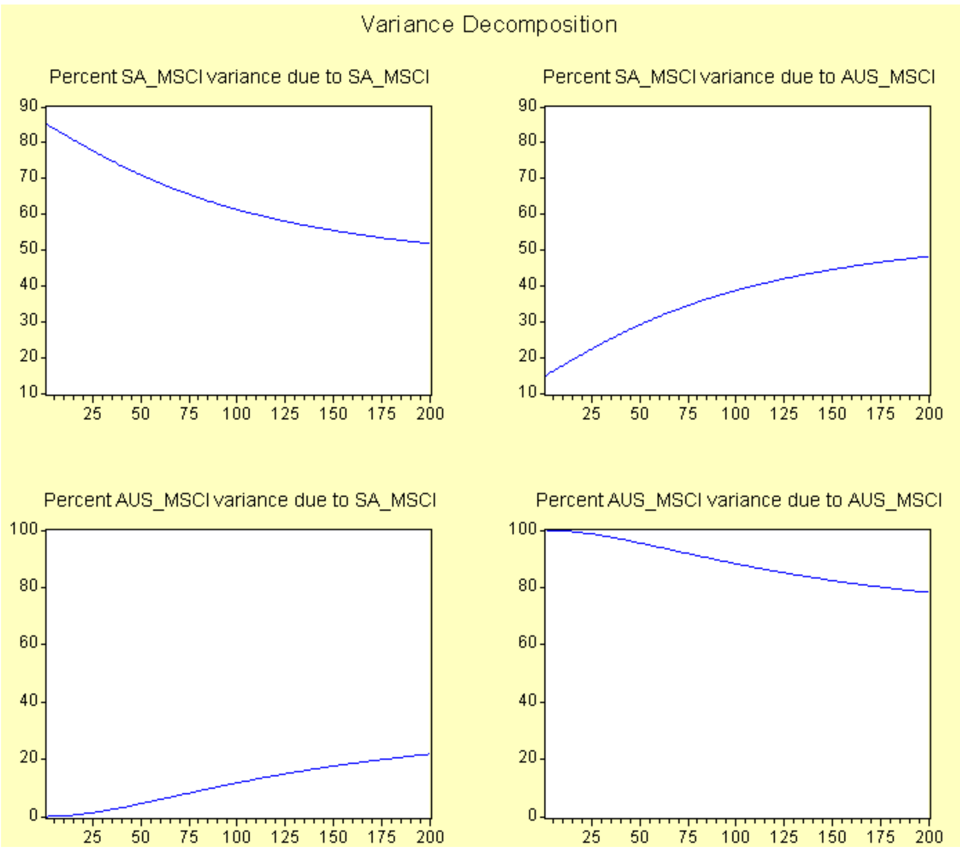
Cholesky ordering Argentina – SA



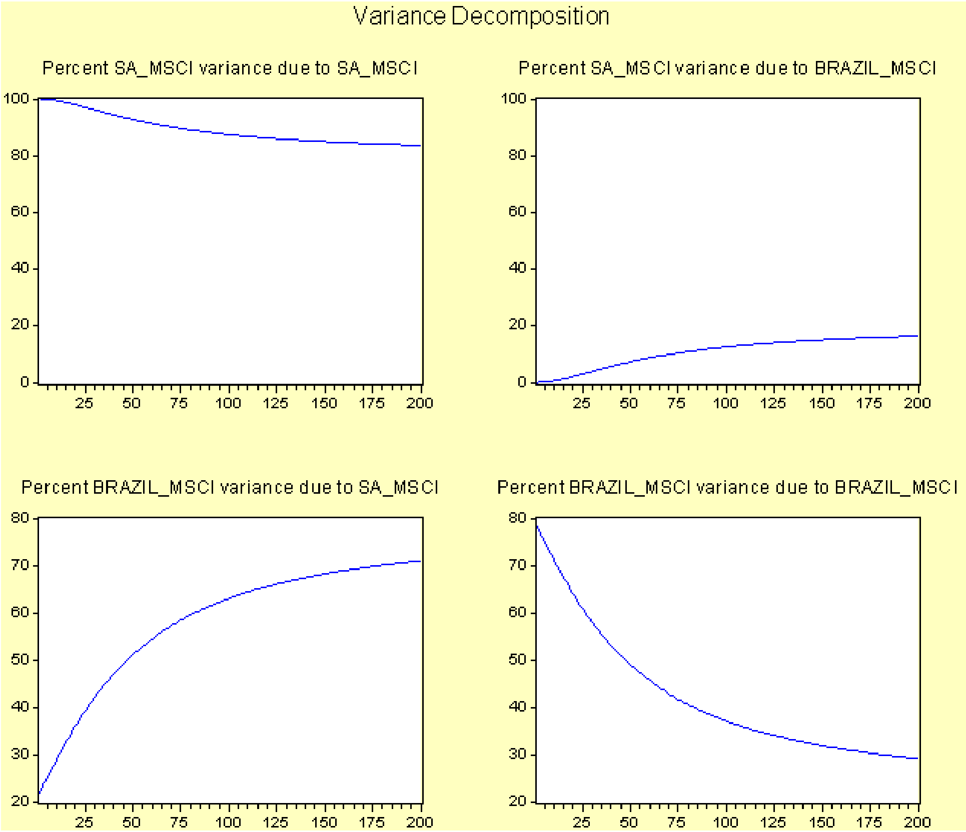
SA – Australia. Cholesky ordering SA – Australia



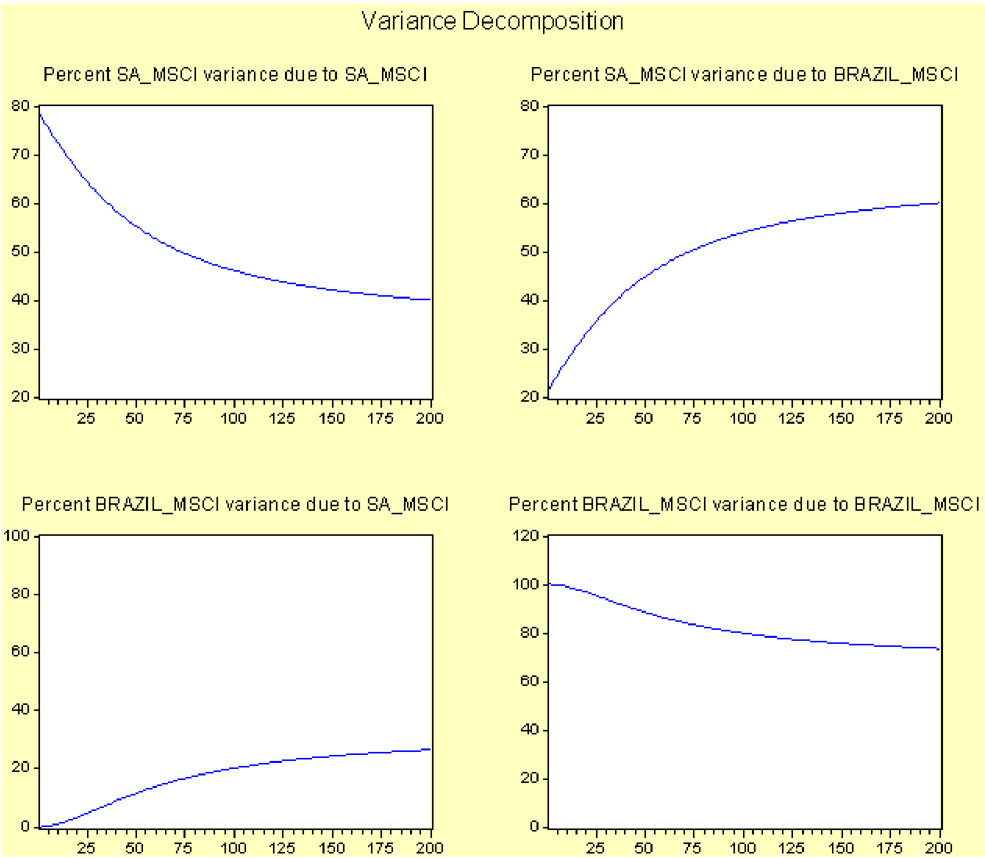
Cholesky ordering Australia – SA



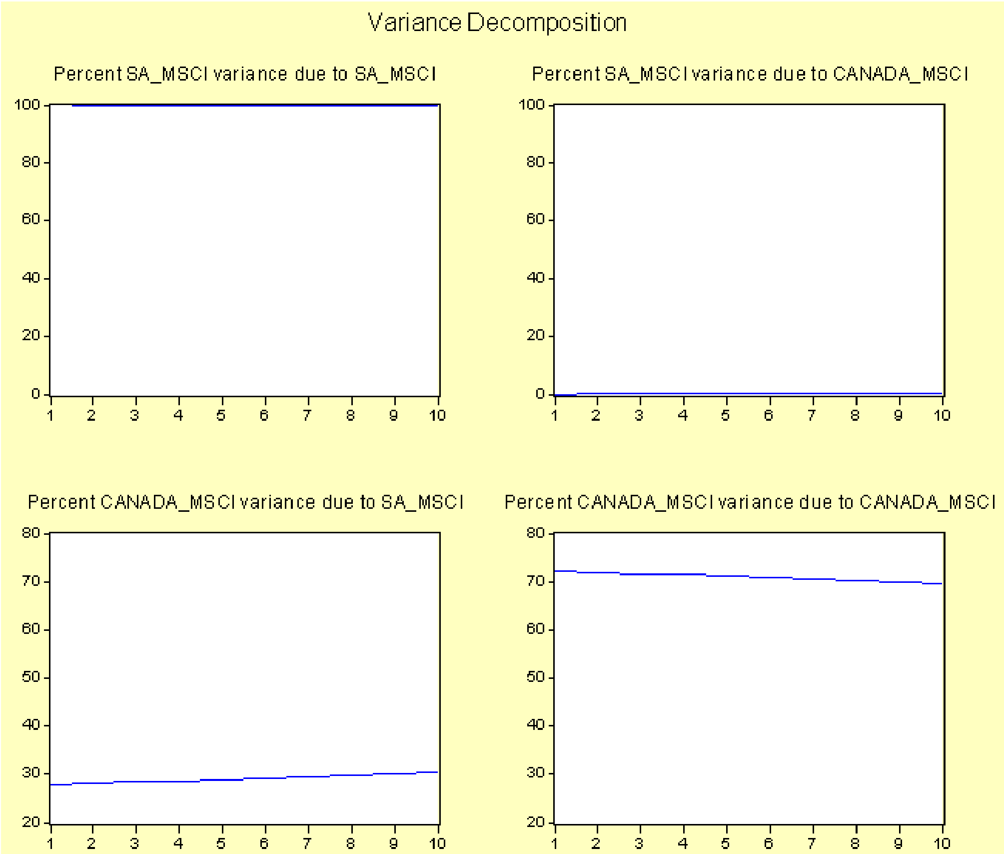
SA – Brazil. Cholesky ordering SA – Brazil



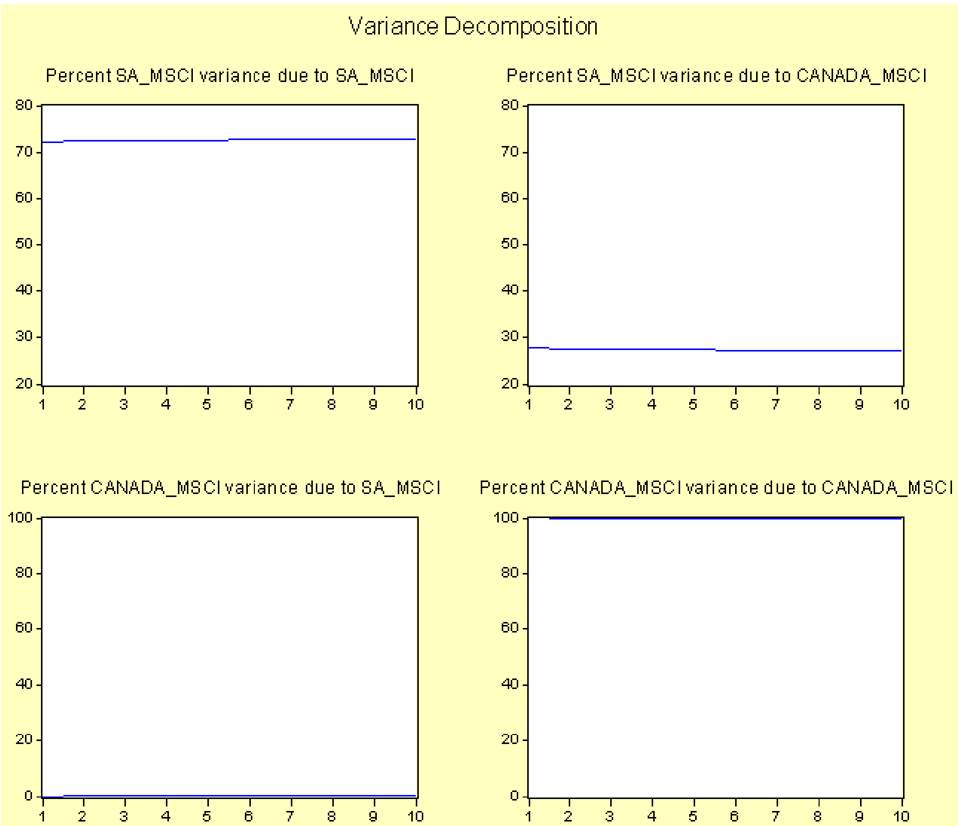
Cholesky ordering Brazil – SA



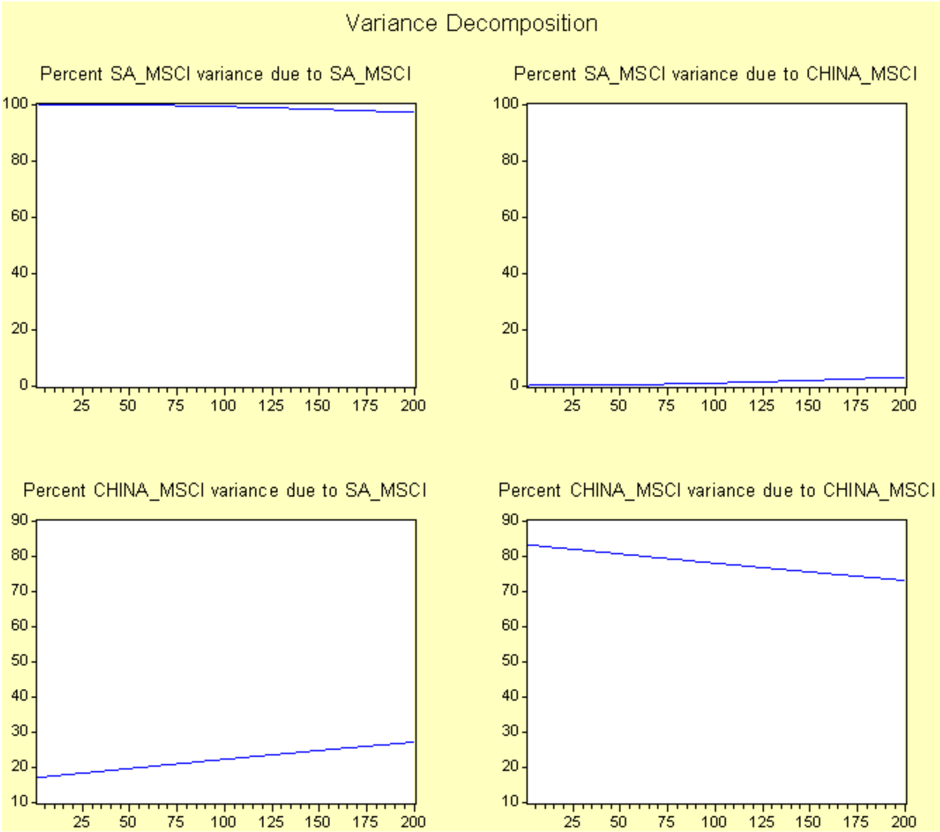
SA – Canada. Cholesky ordering SA – Canada



Cholesky ordering Canada – SA

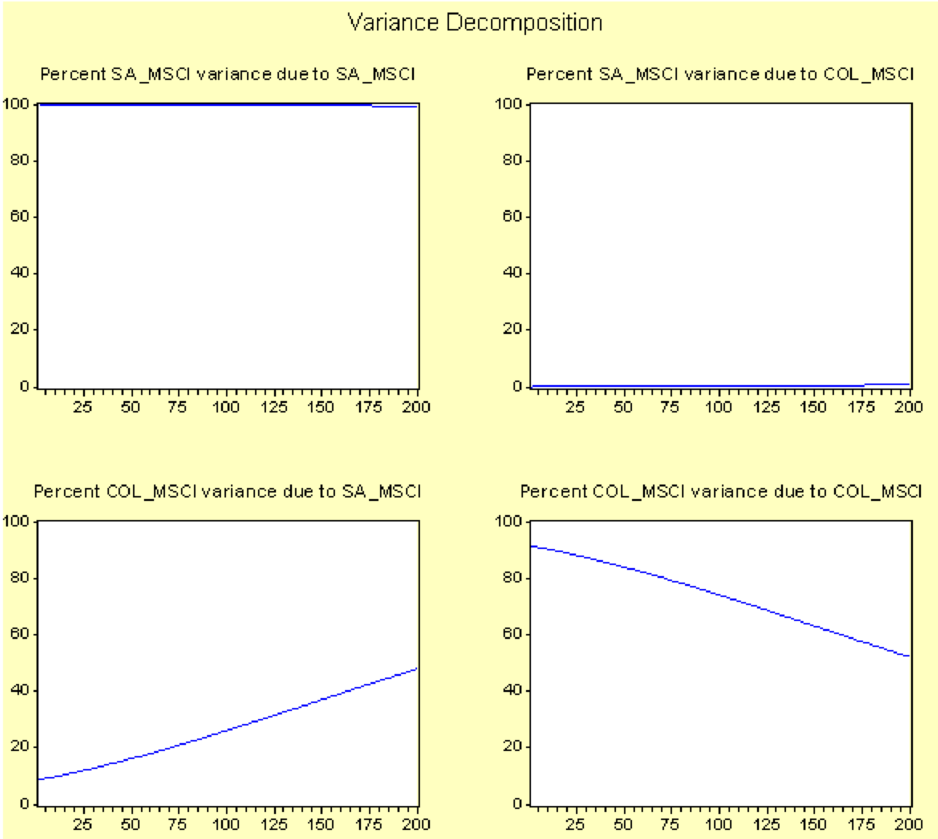


SA – China, Cholesky ordering SA – China

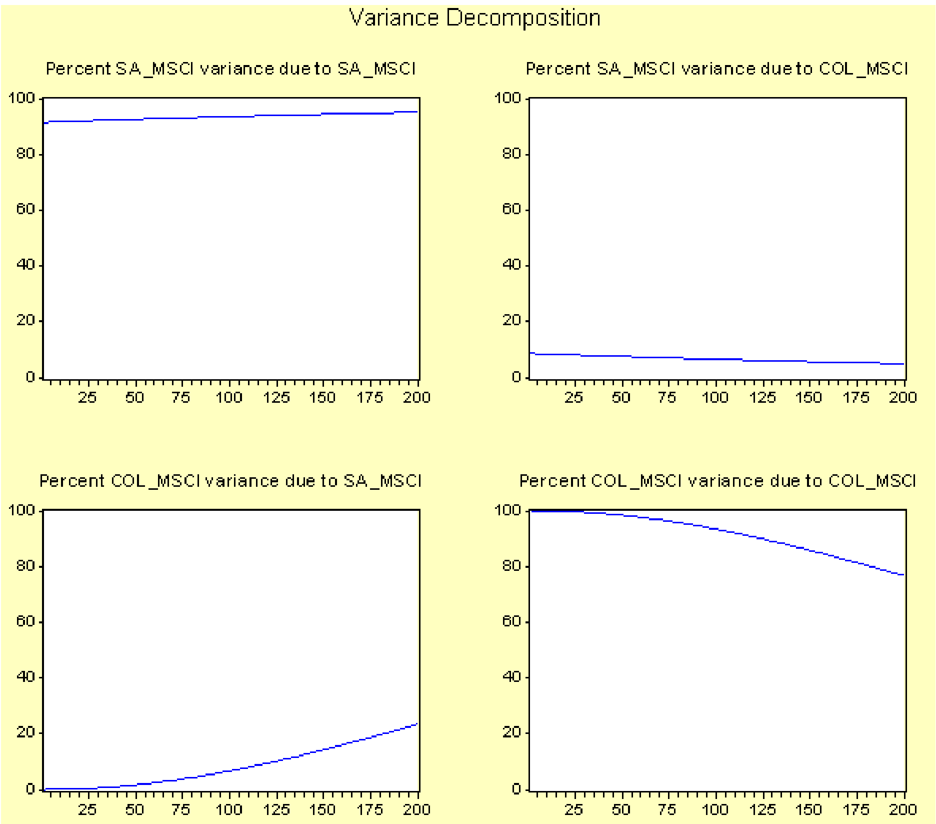


Cholesky ordering China – SA

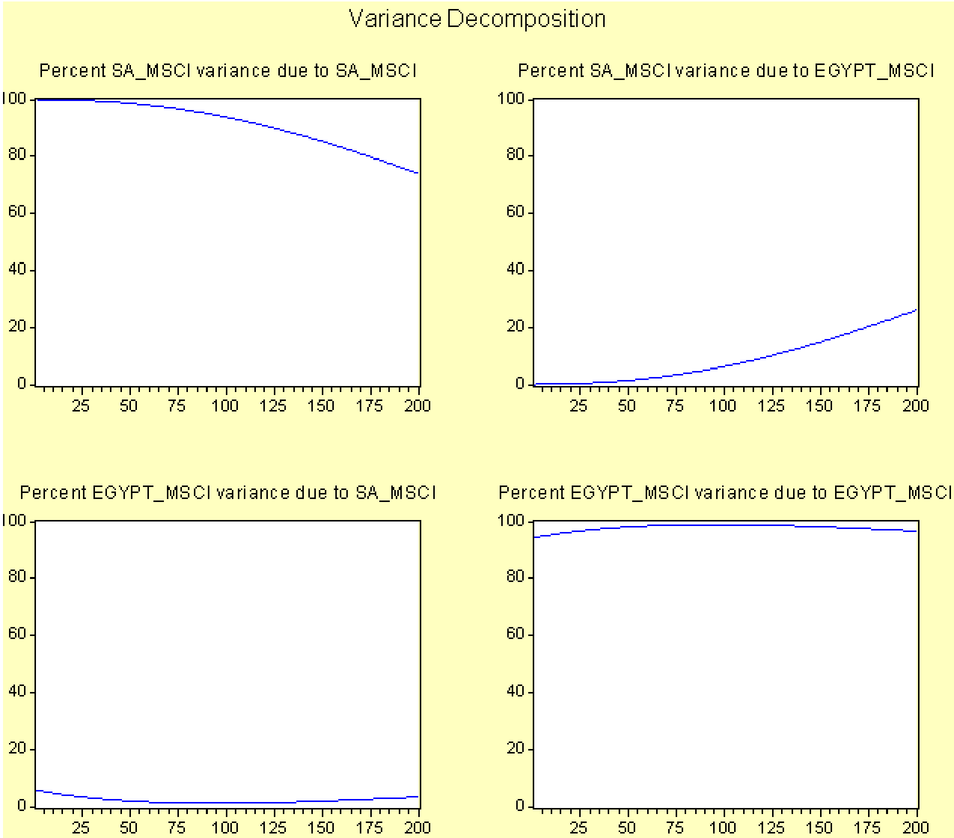
SA – Colombia. Cholesky ordering SA – Colombia



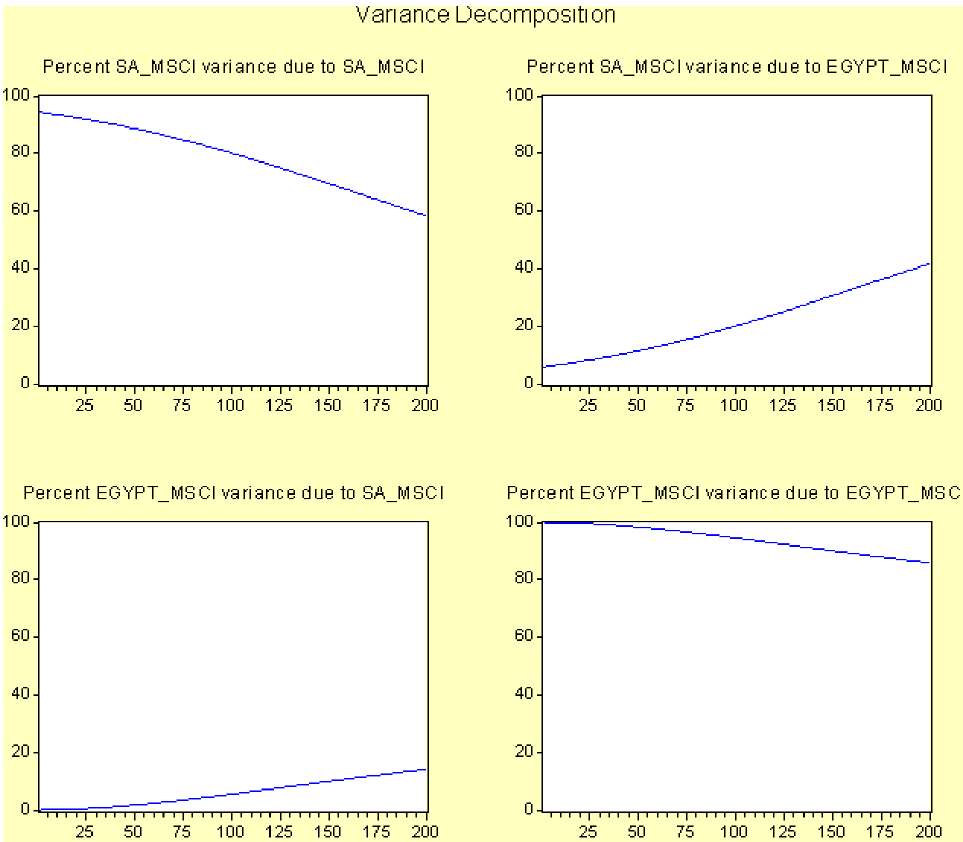
Cholesky ordering Colombia – SA



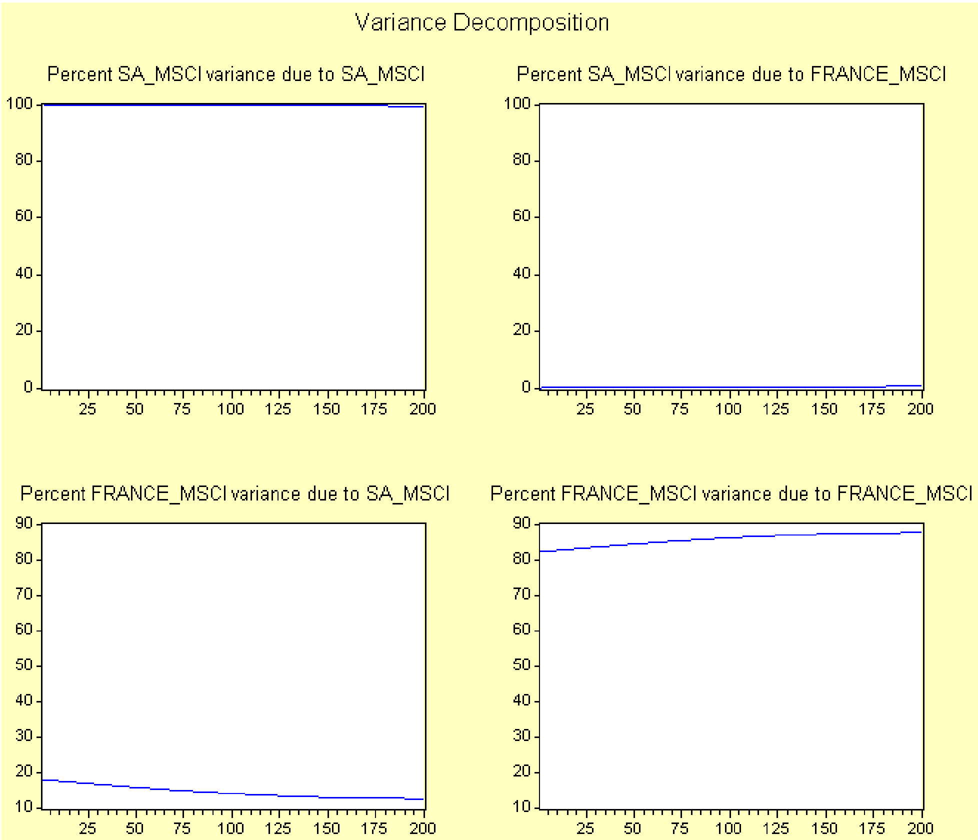
SA – Egypt. Cholesky ordering SA – Egypt



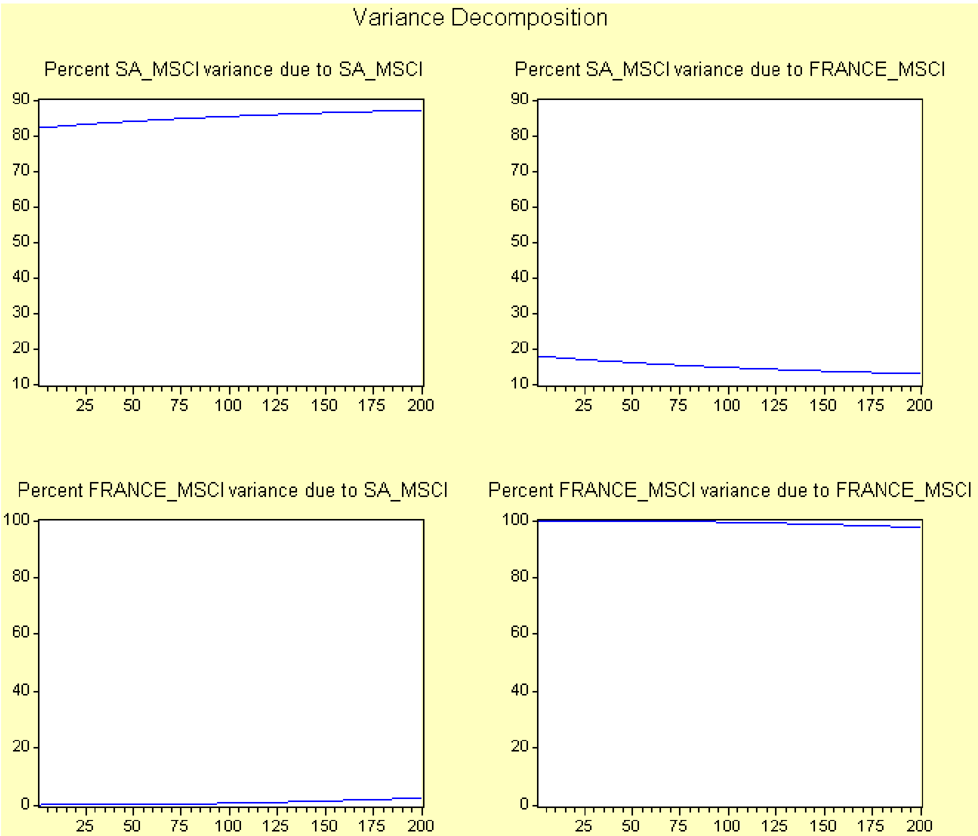
Cholesky ordering Egypt – SA



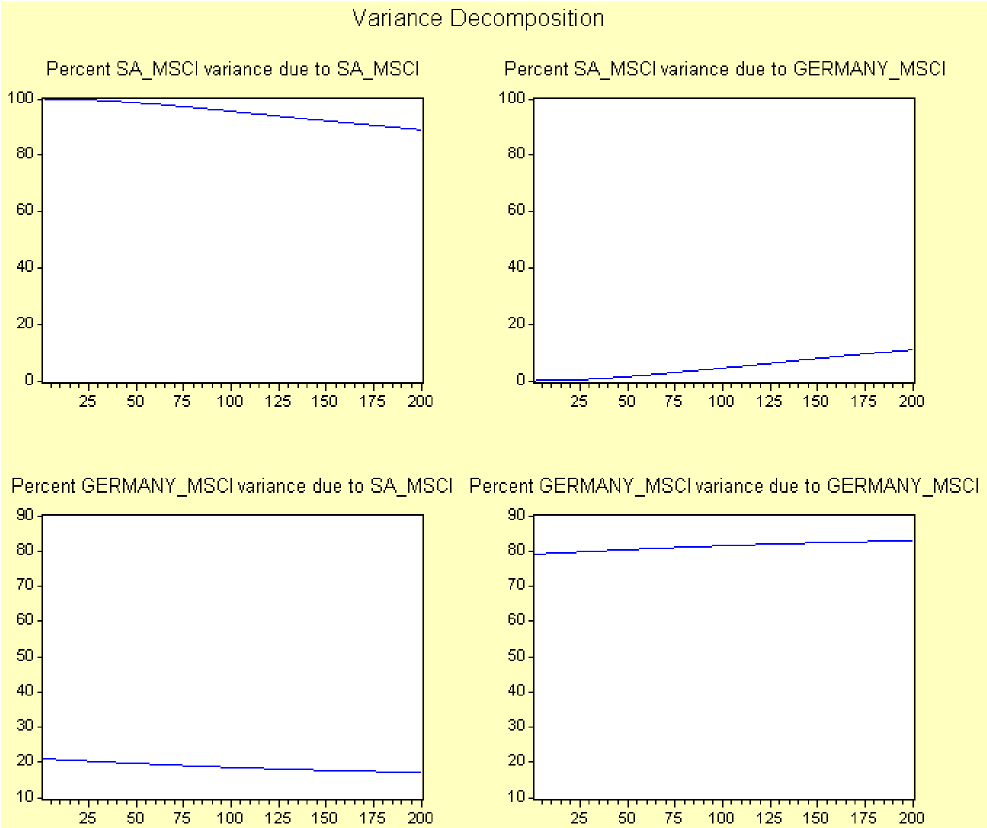
SA – France, Cholesky ordering SA – France



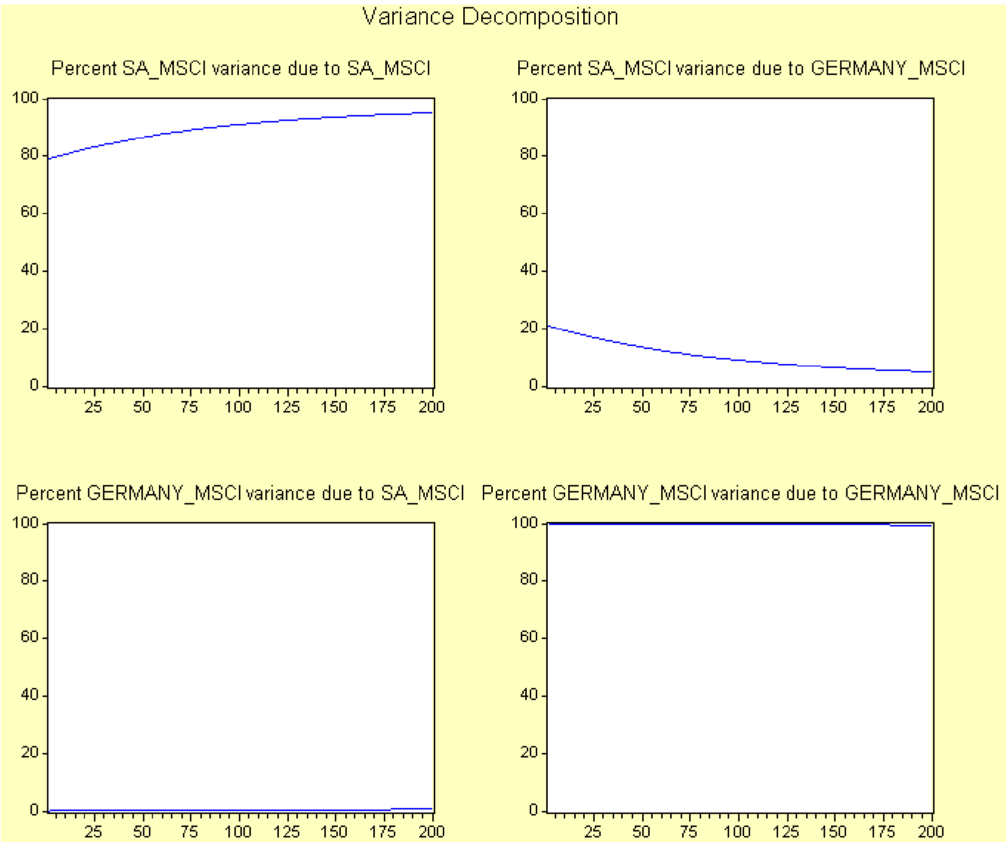
Cholesky ordering France – SA



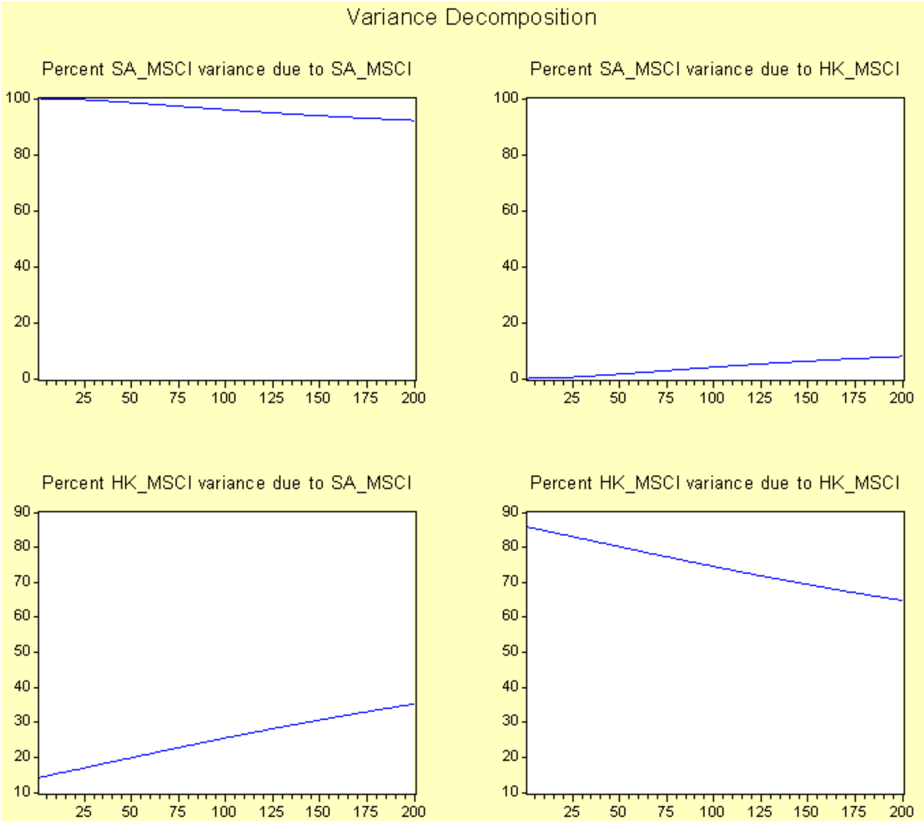
SA – Germany. Cholesky ordering SA – Germany



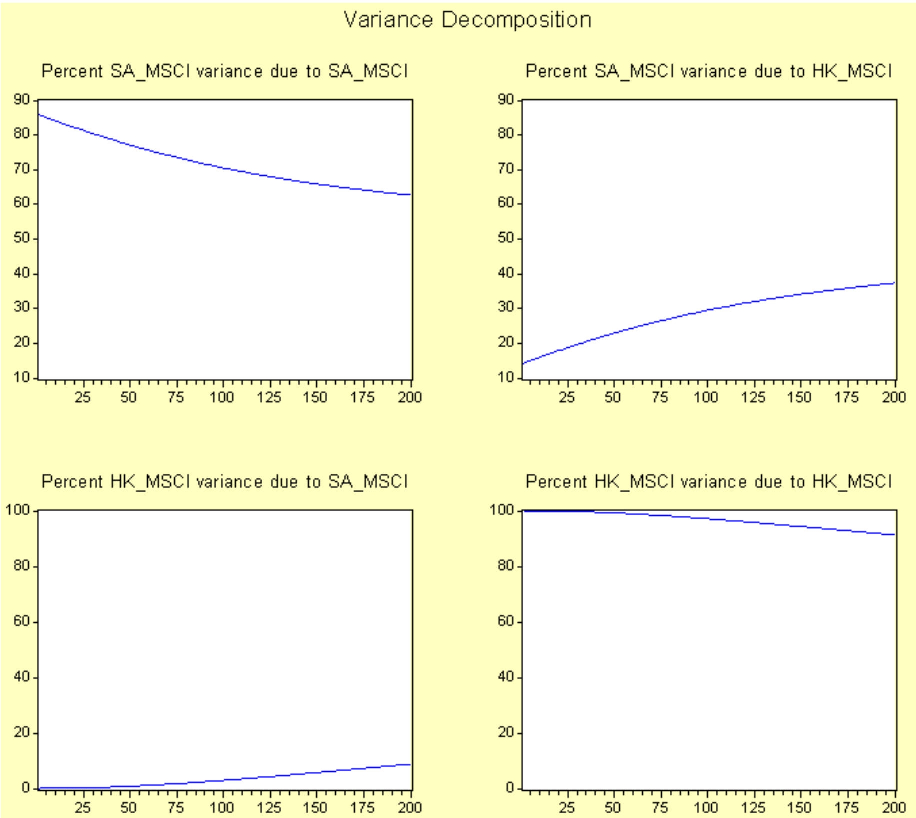
Cholesky ordering Germany – SA



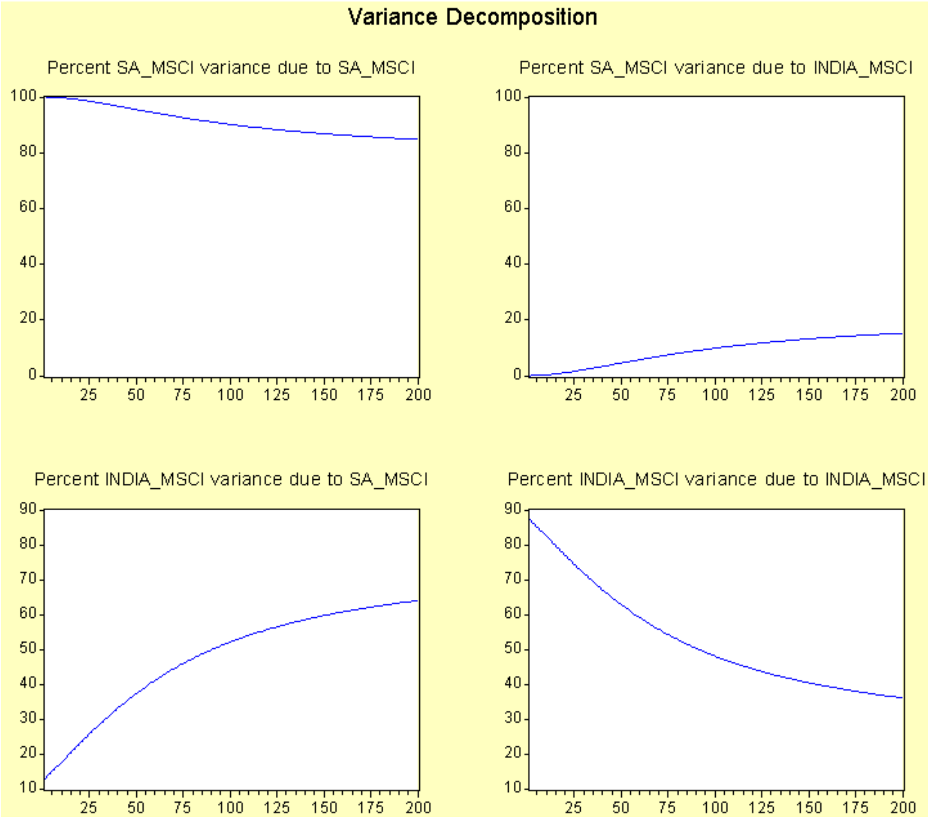
SA – Hong Kong. Cholesky ordering SA – HK



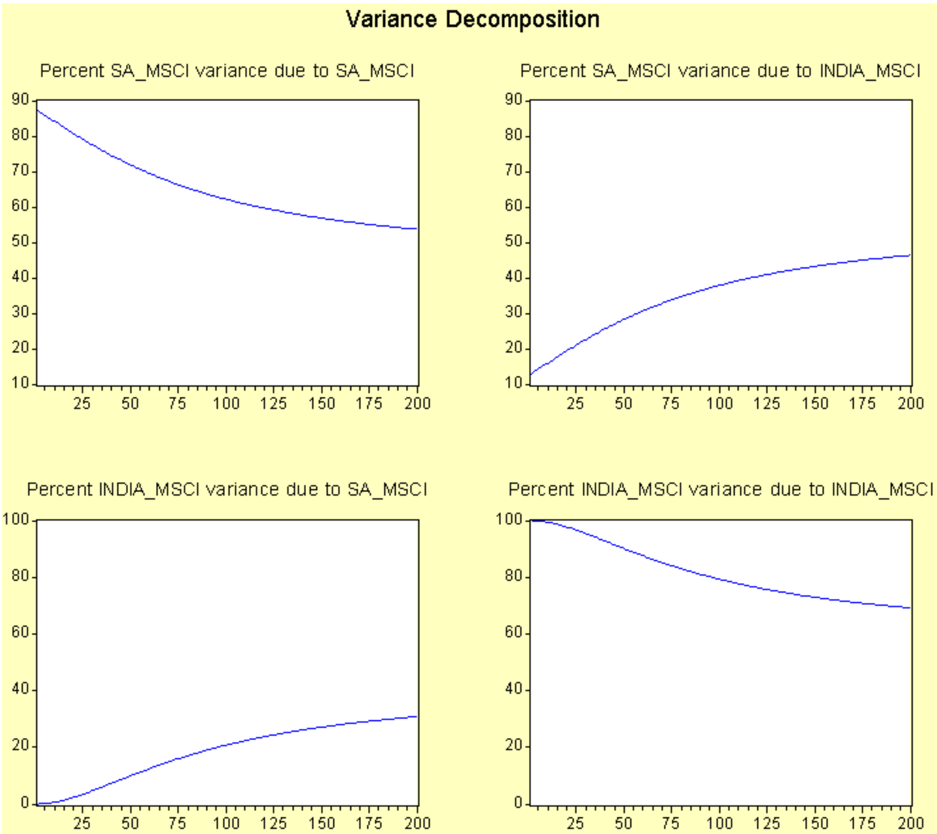
Cholesky ordering HK – SA



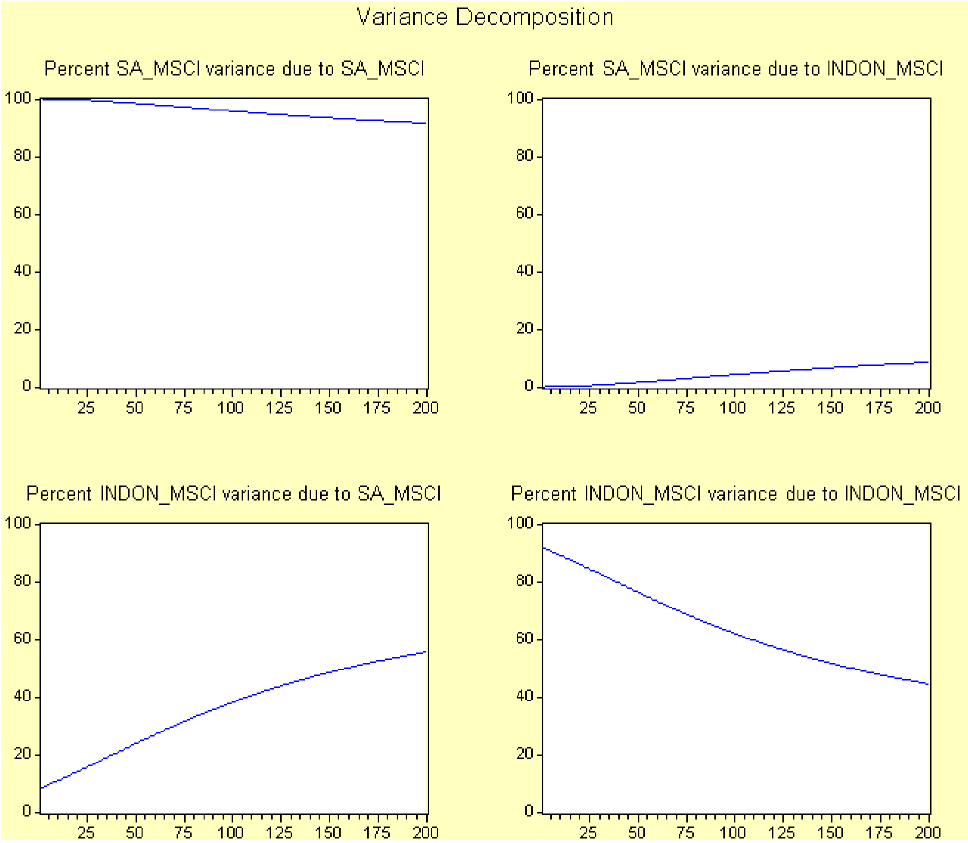
SA – India. Cholesky ordering SA – India



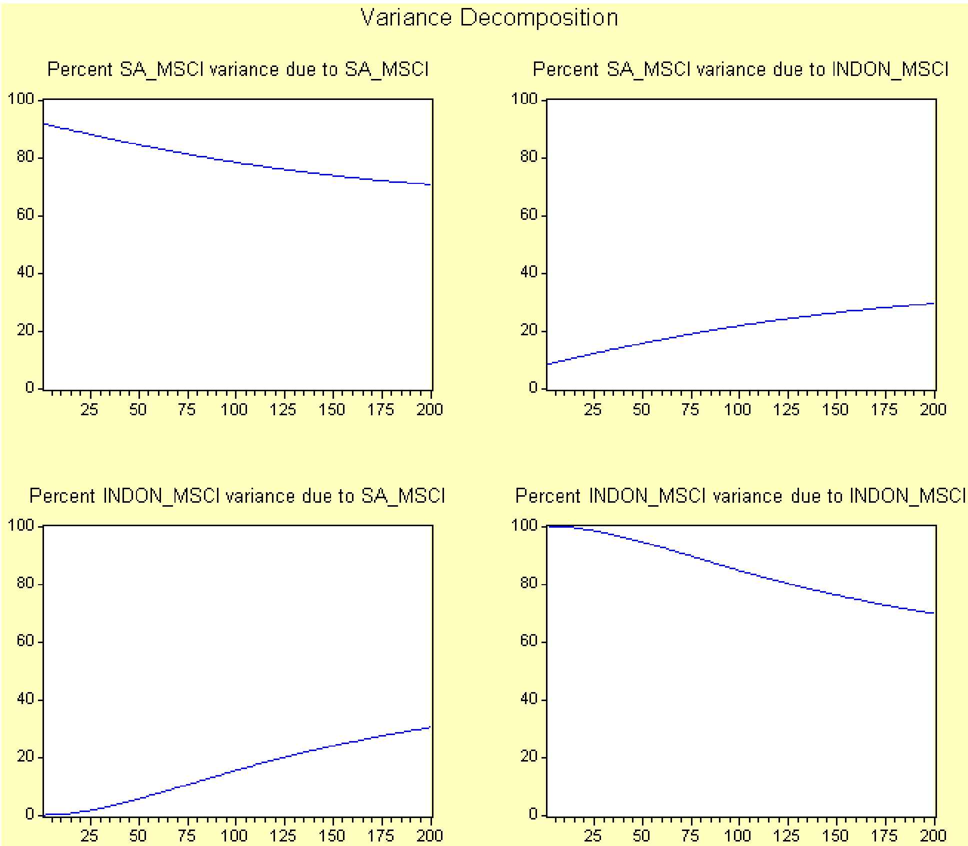
Cholesky ordering India – SA



SA – Indonesia. Cholesky ordering SA – Indonesia



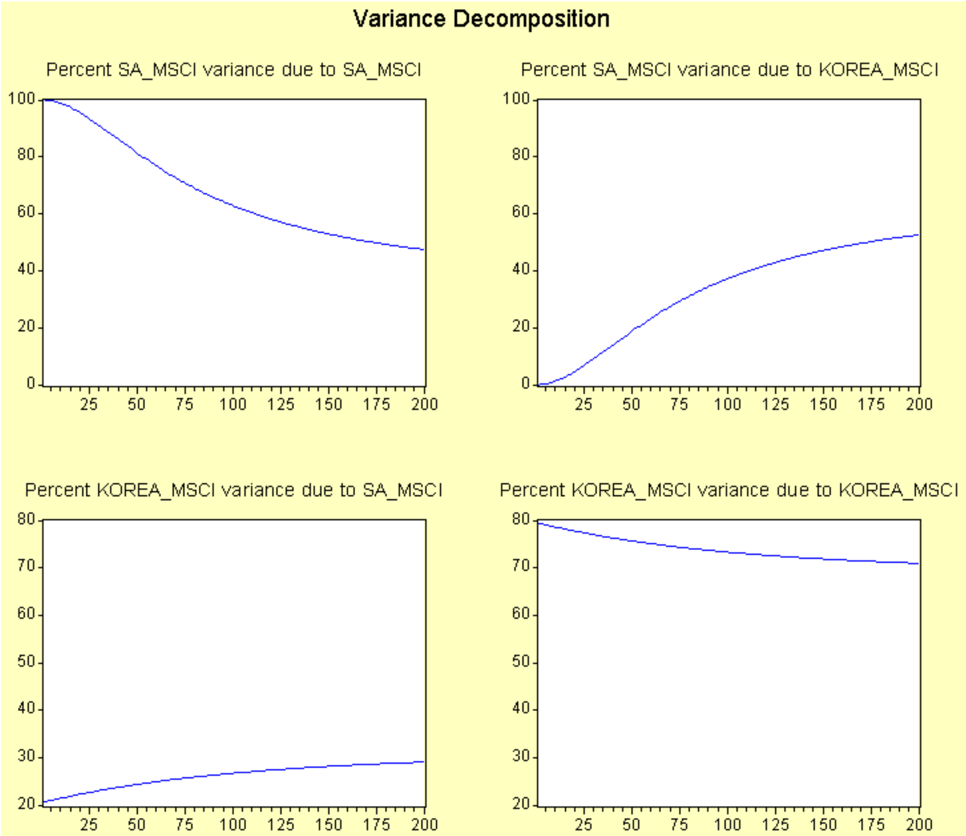
Cholesky ordering Indonesia – SA



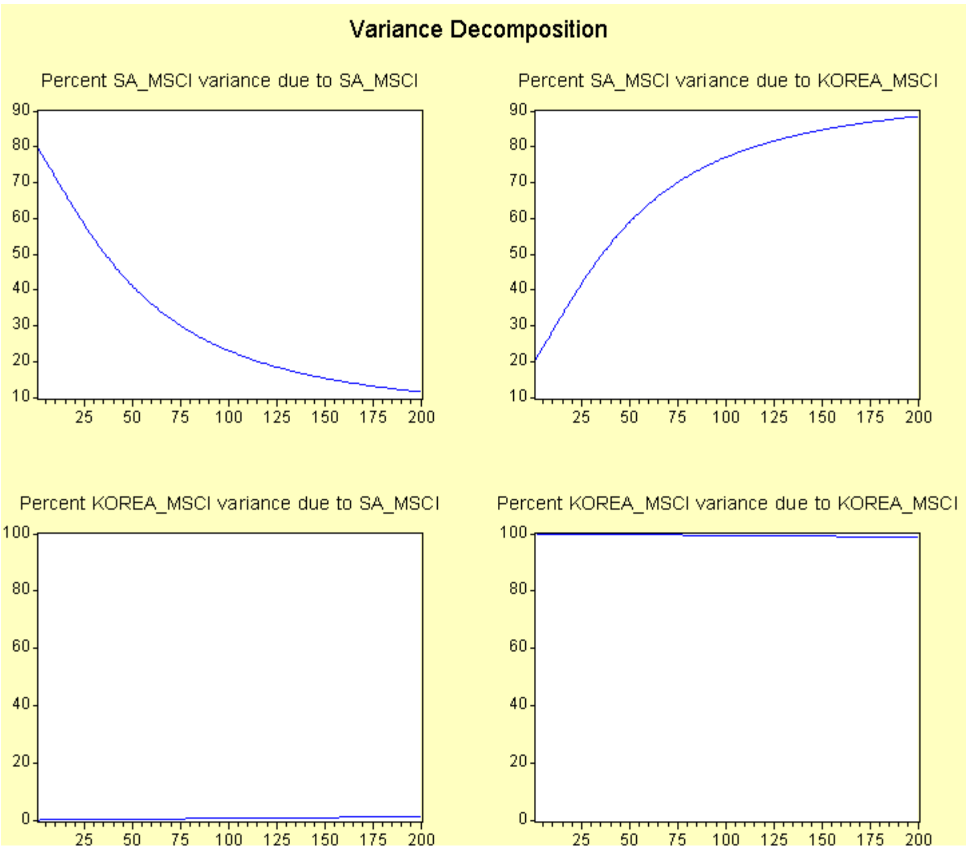
SA – Japan. Cholesky ordering SA – Japan.

Cholesky ordering Japan – SA

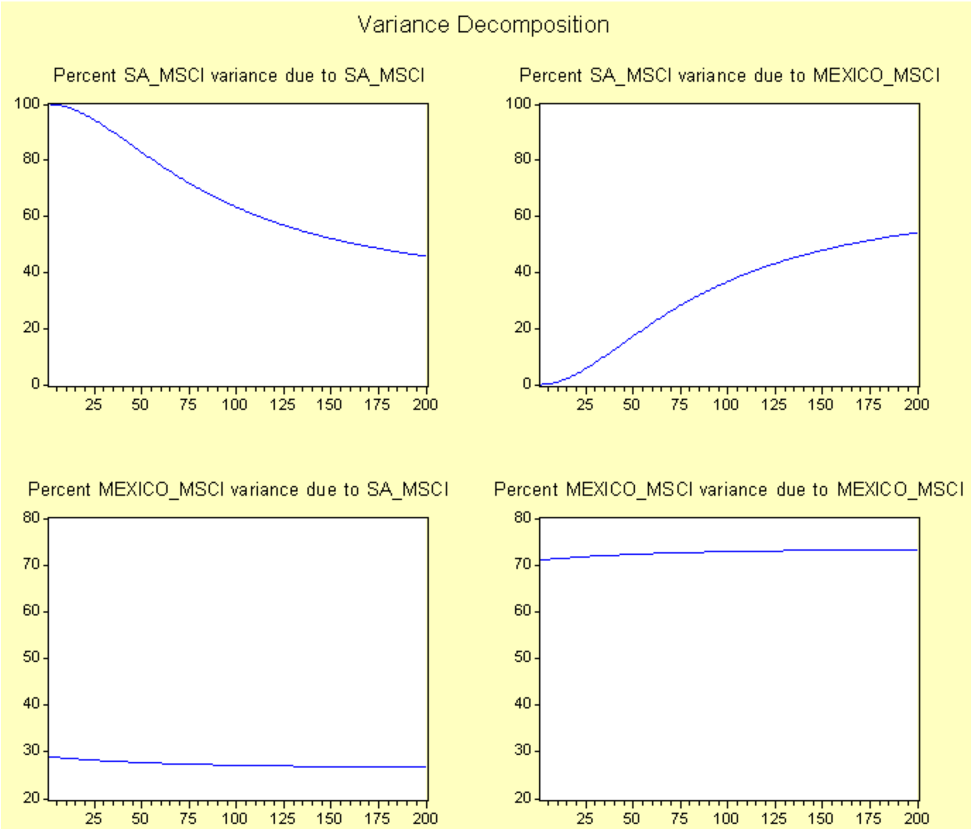
SA – Korea. Cholesky ordering SA – Korea



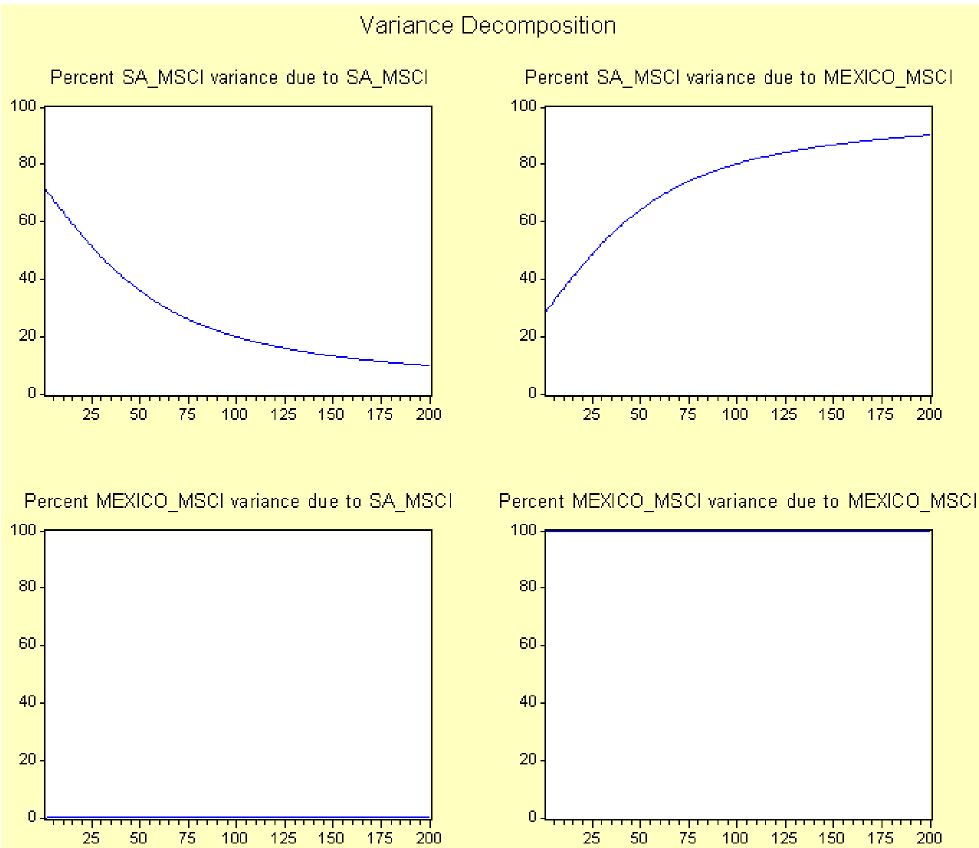
Cholesky ordering Korea – SA



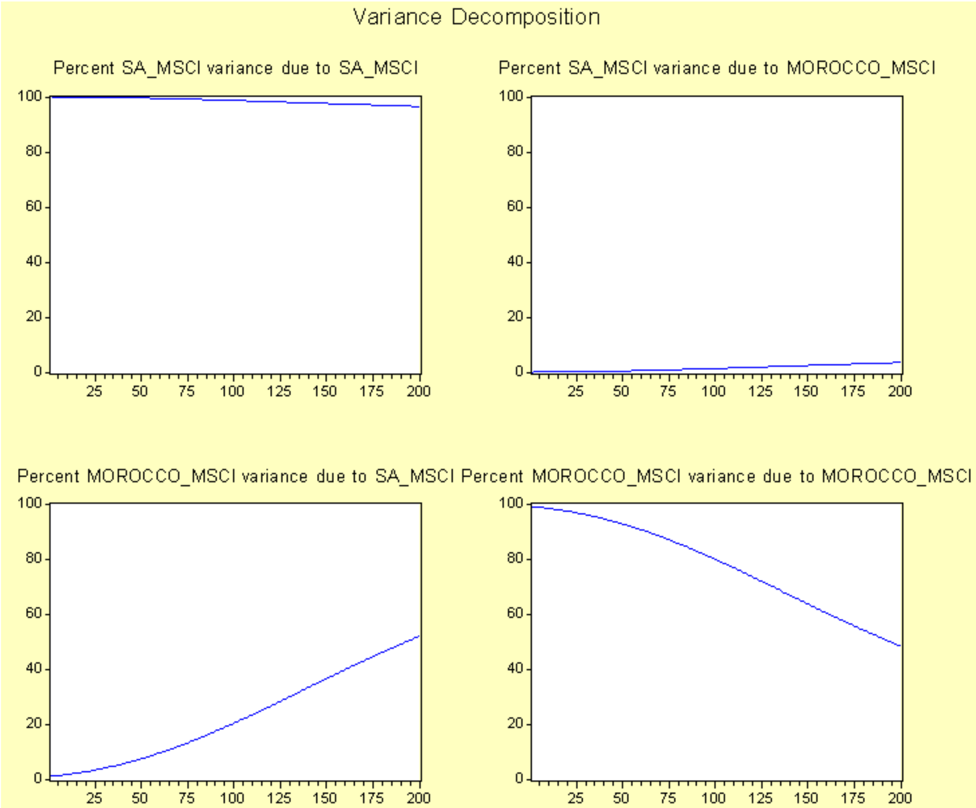
SA – Mexico. Cholesky ordering SA – Mexico



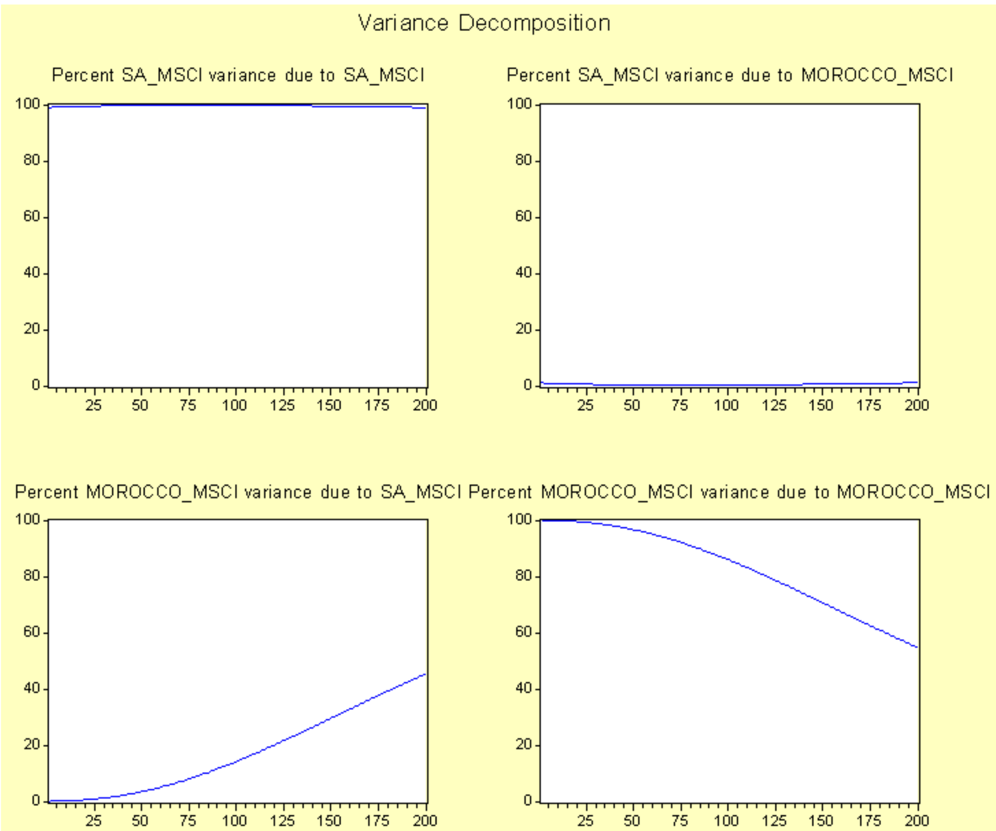
Cholesky ordering Mexico – SA



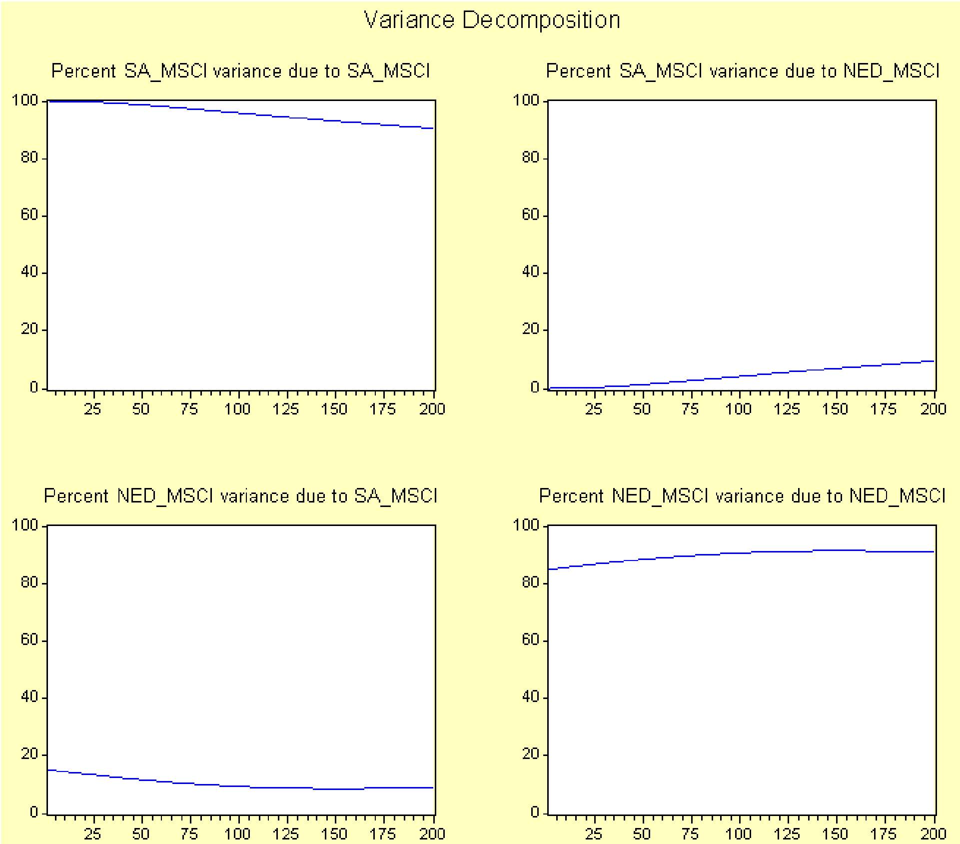
SA – Morocco. Cholesky ordering SA – Morocco



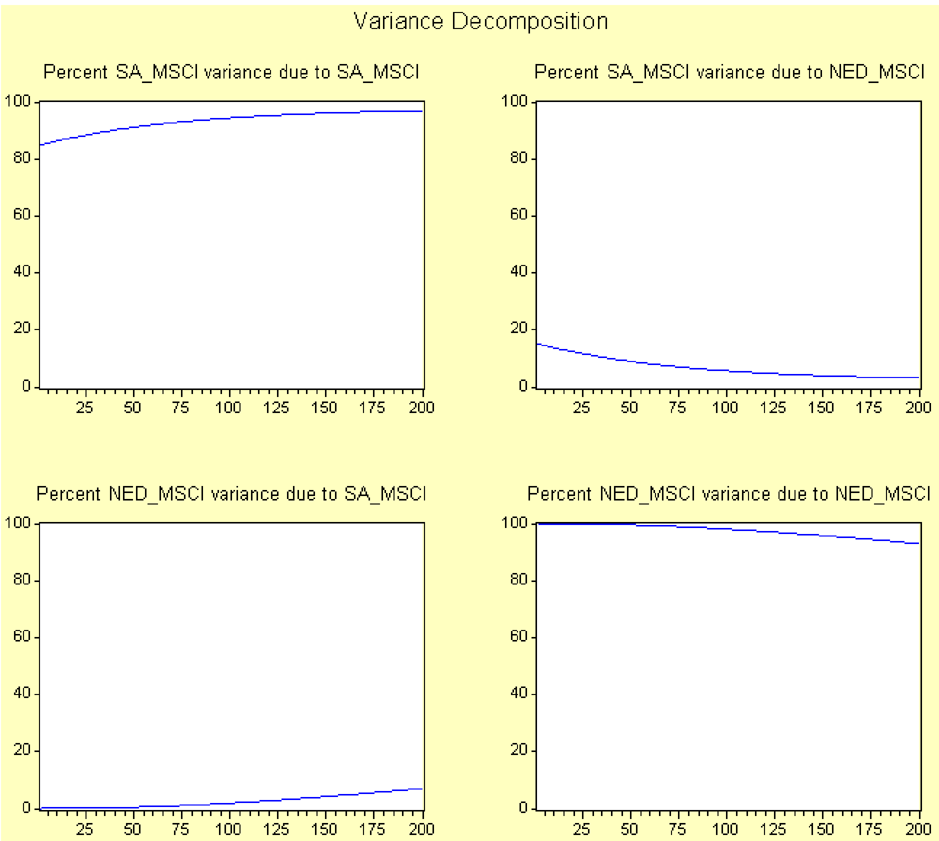
Cholesky ordering Morocco – SA



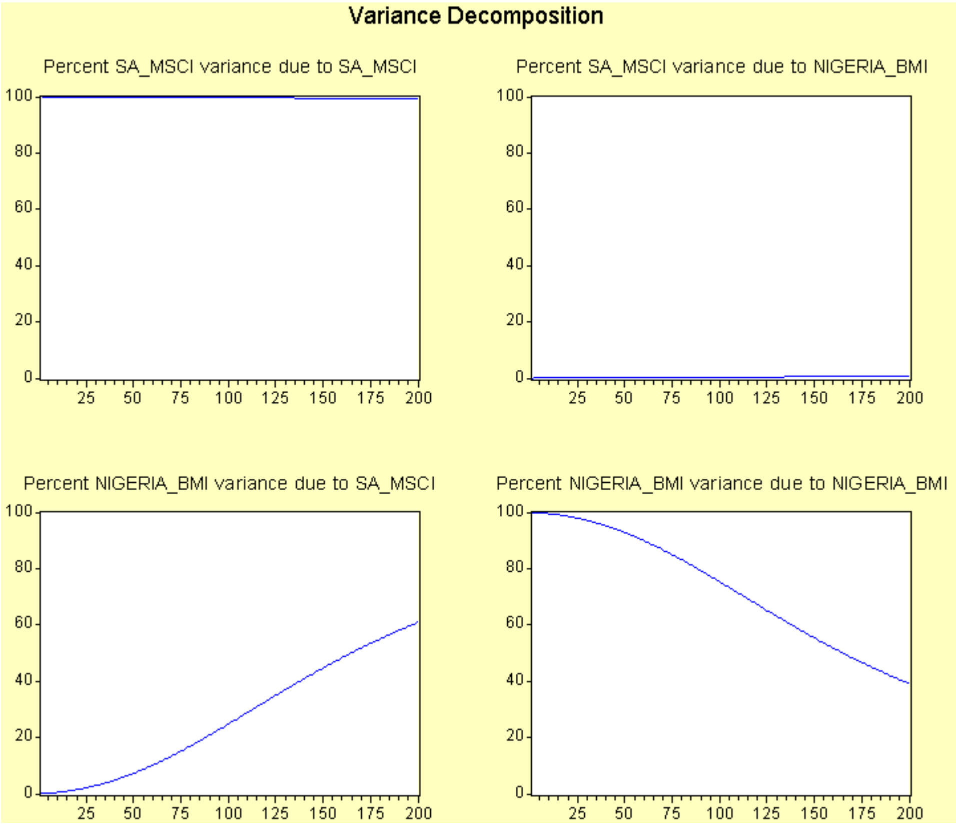
SA – Netherlands. Cholesky ordering SA – Netherlands



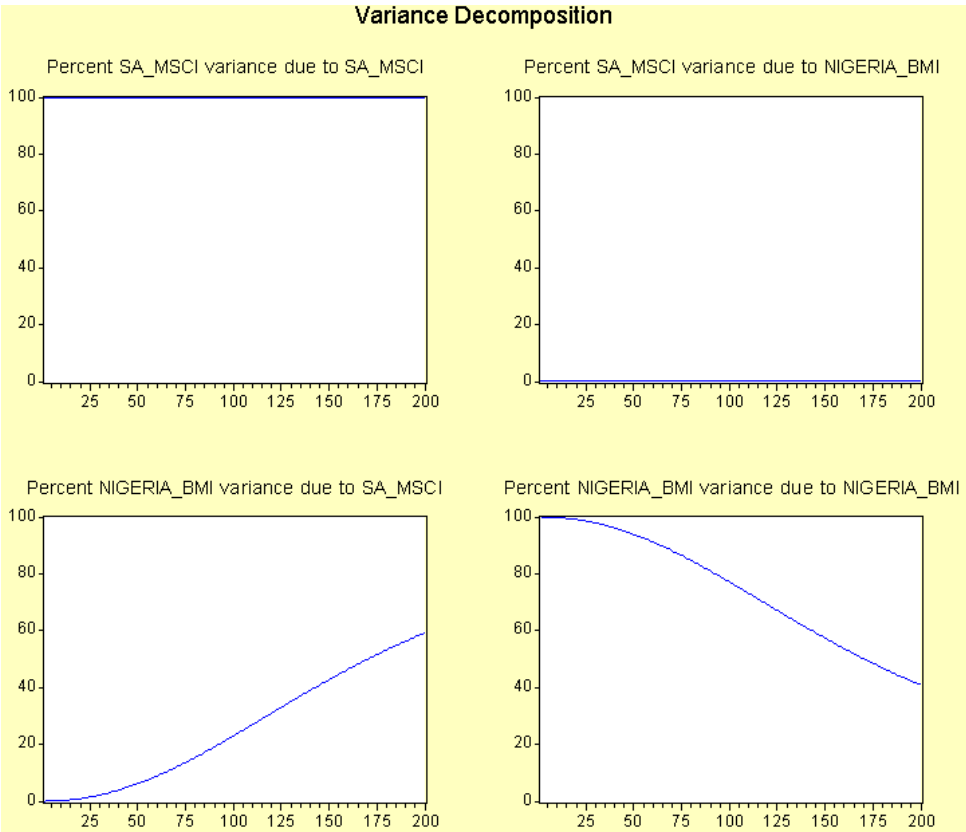
Cholesky ordering Netherlands – SA



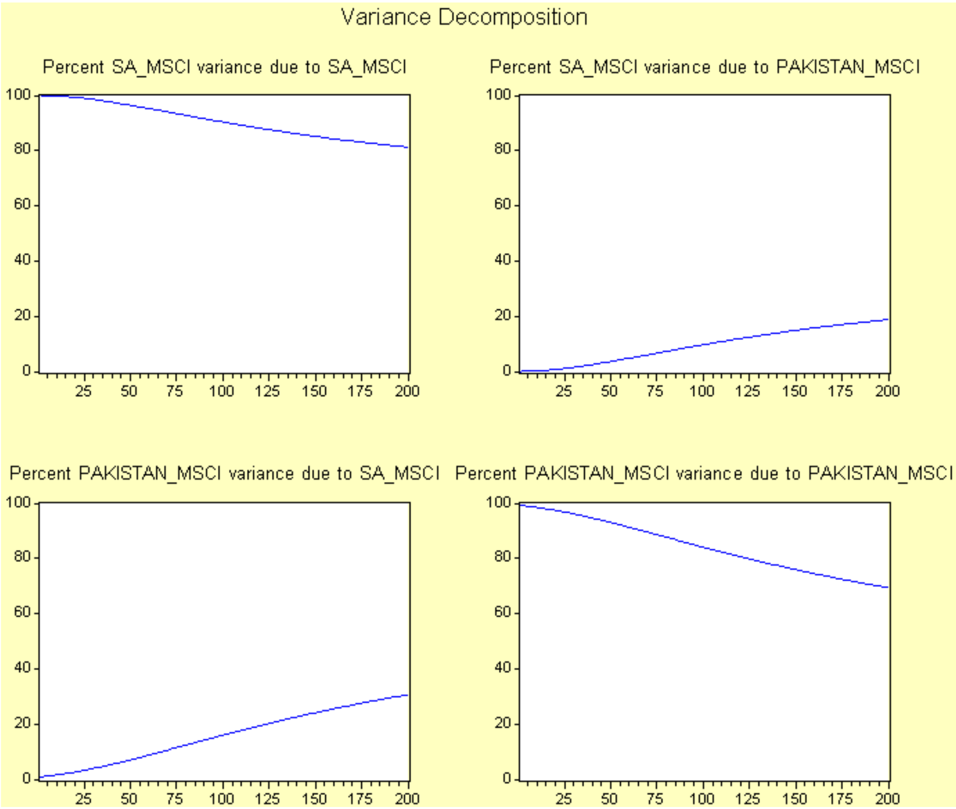
SA – Nigeria. Cholesky ordering SA – Nigeria



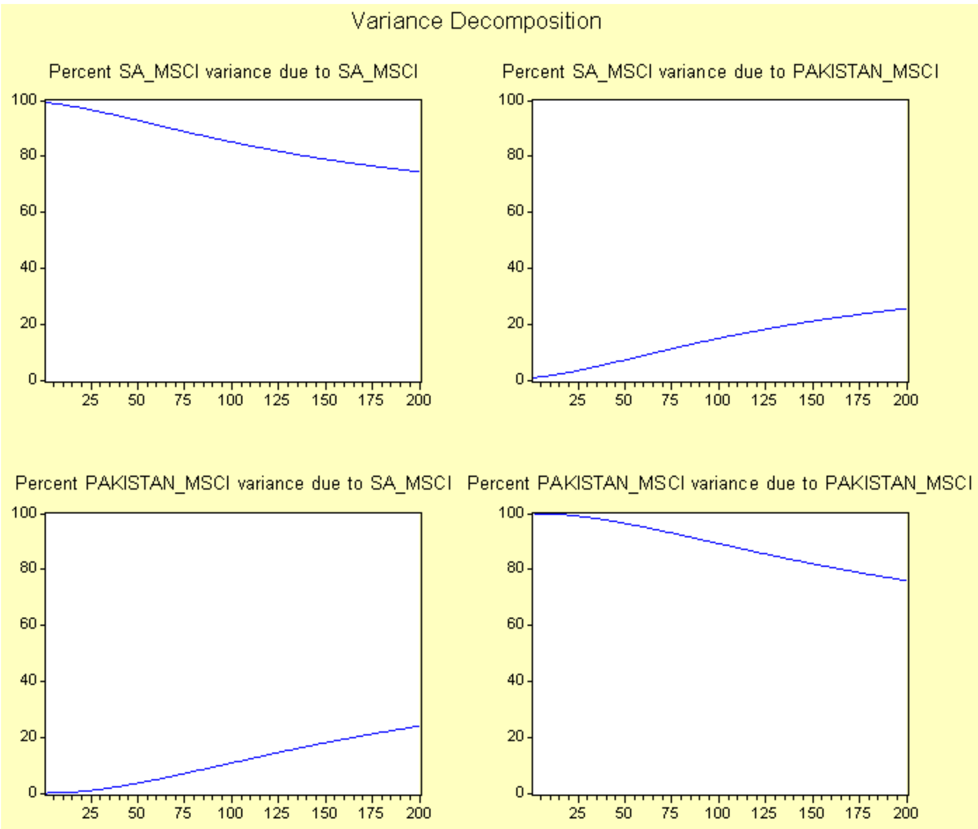
Cholesky ordering Nigeria – SA



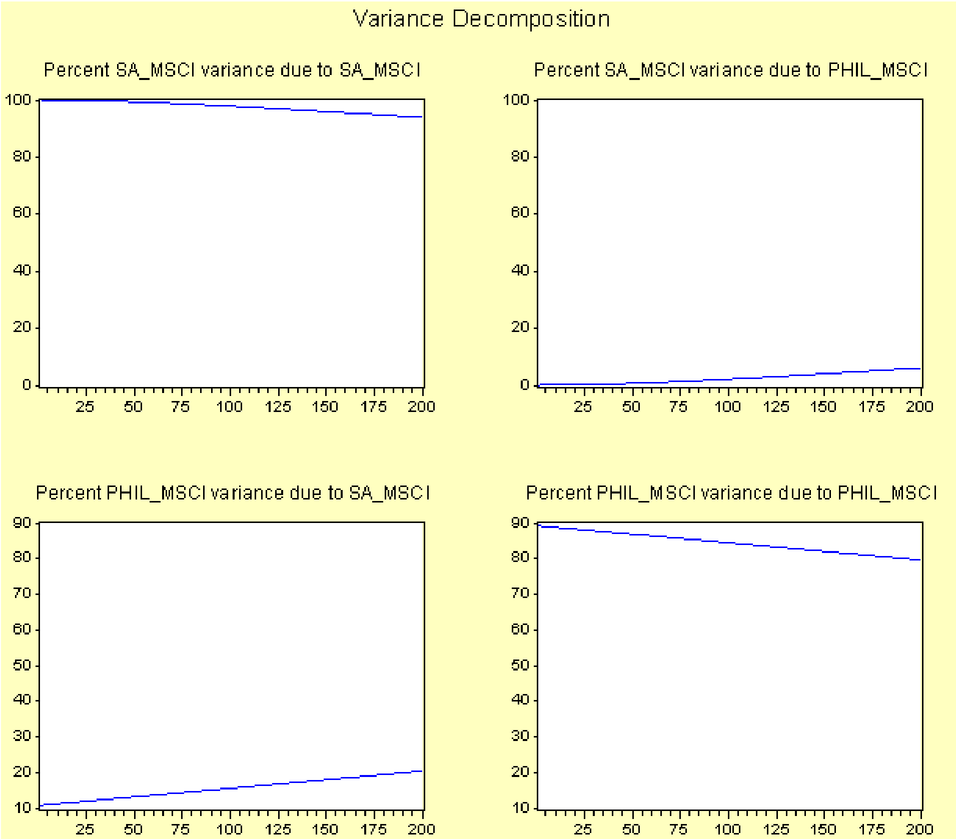
SA – Pakistan. Cholesky ordering SA – Pakistan



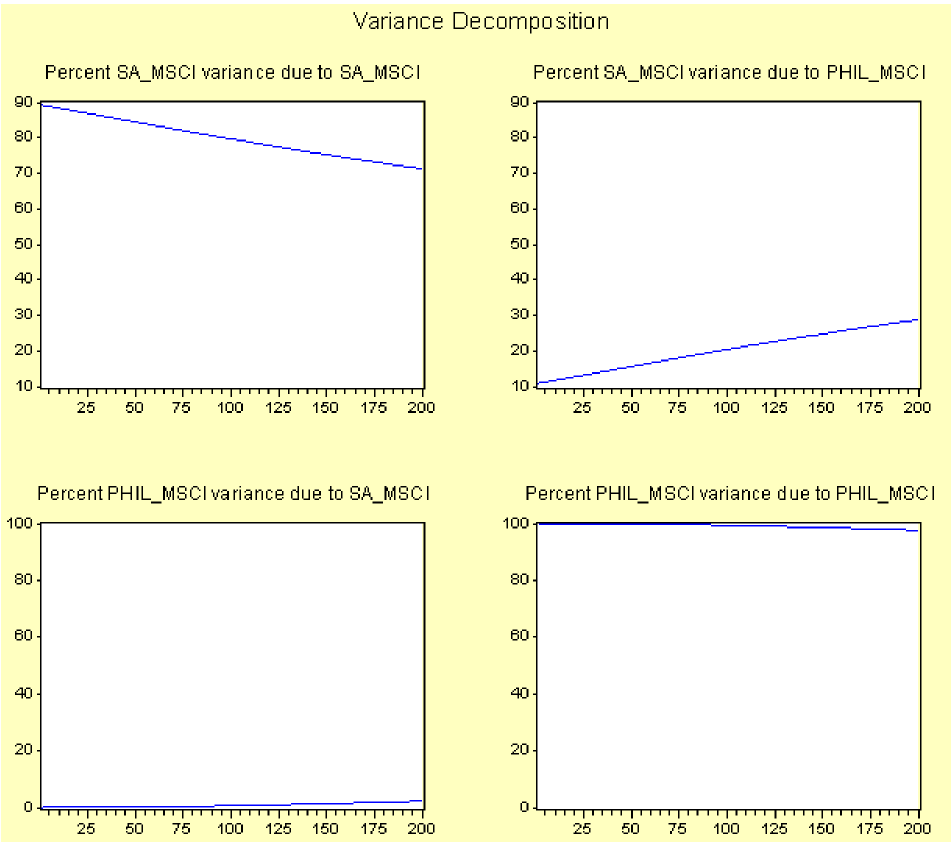
Cholesky ordering Pakistan – SA



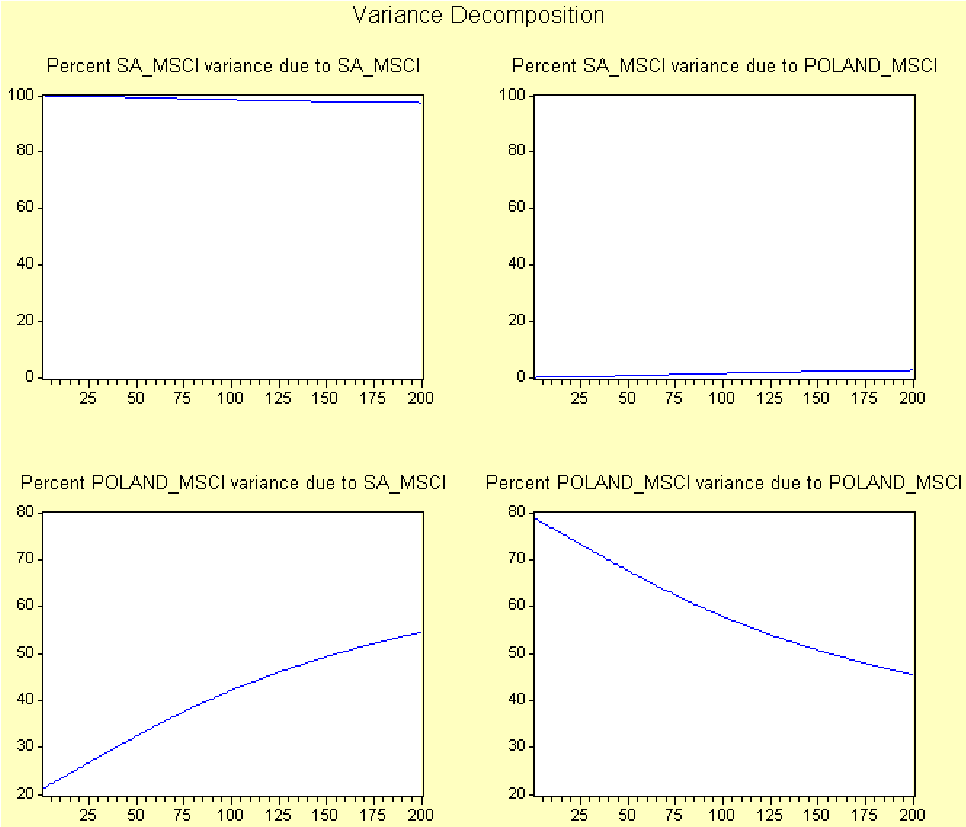
SA – Philippines. Cholesky ordering SA – Philippines



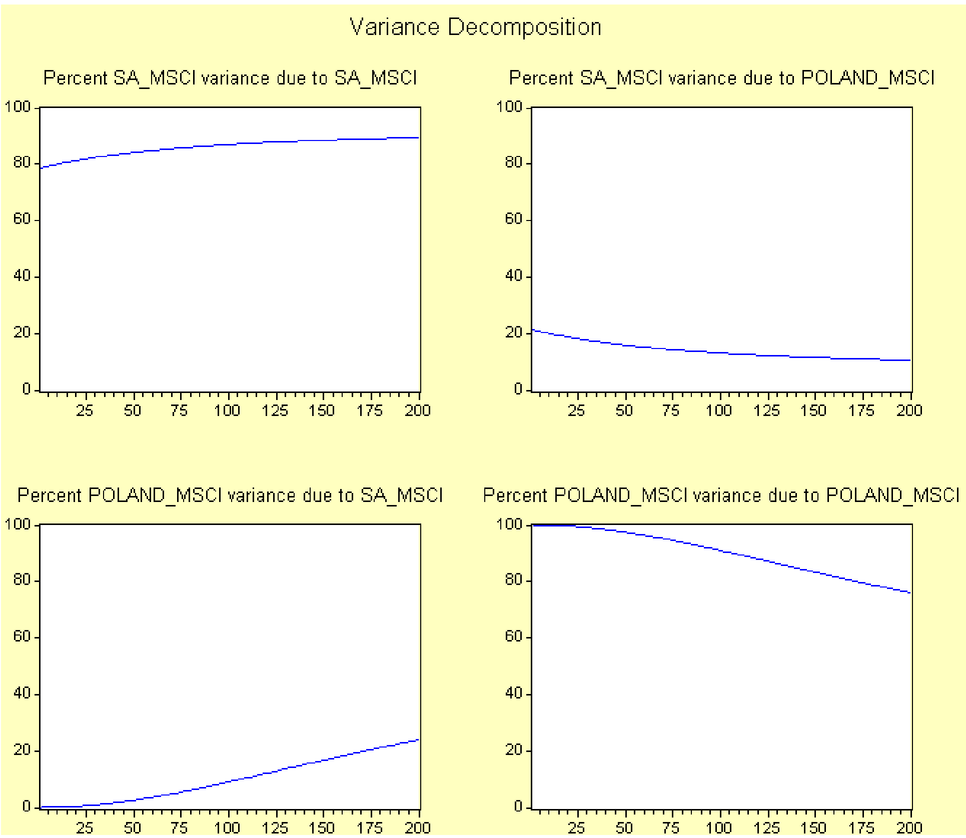
Cholesky ordering Philippines – SA



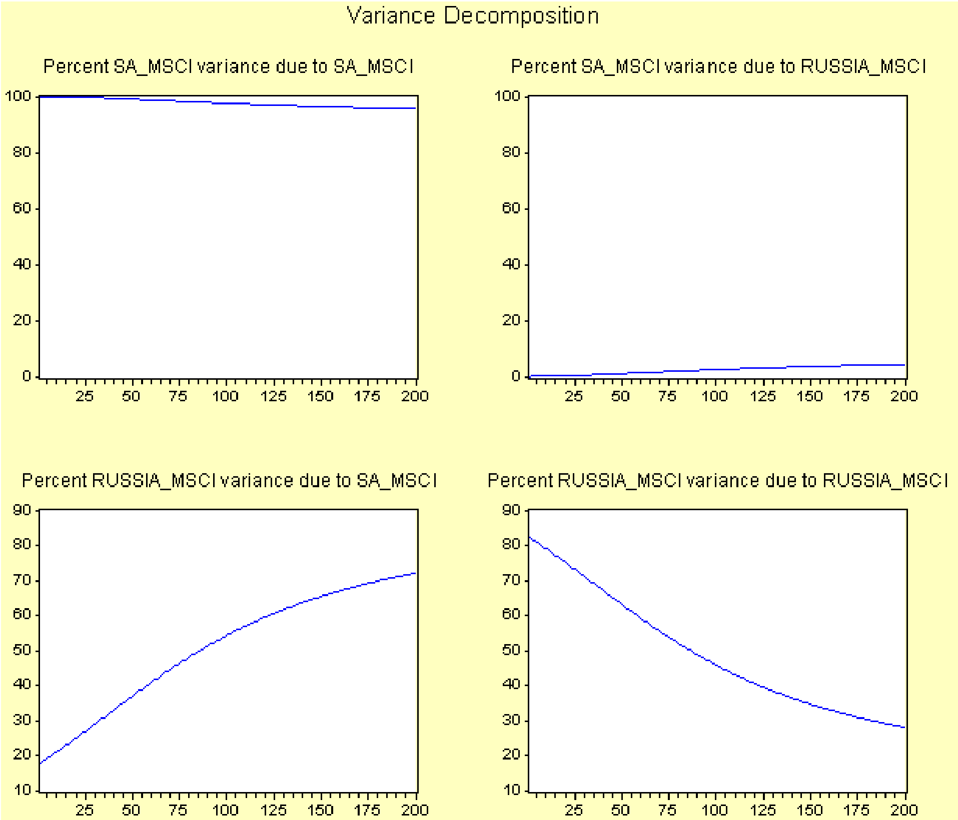
SA – Poland. Cholesky ordering SA – Poland



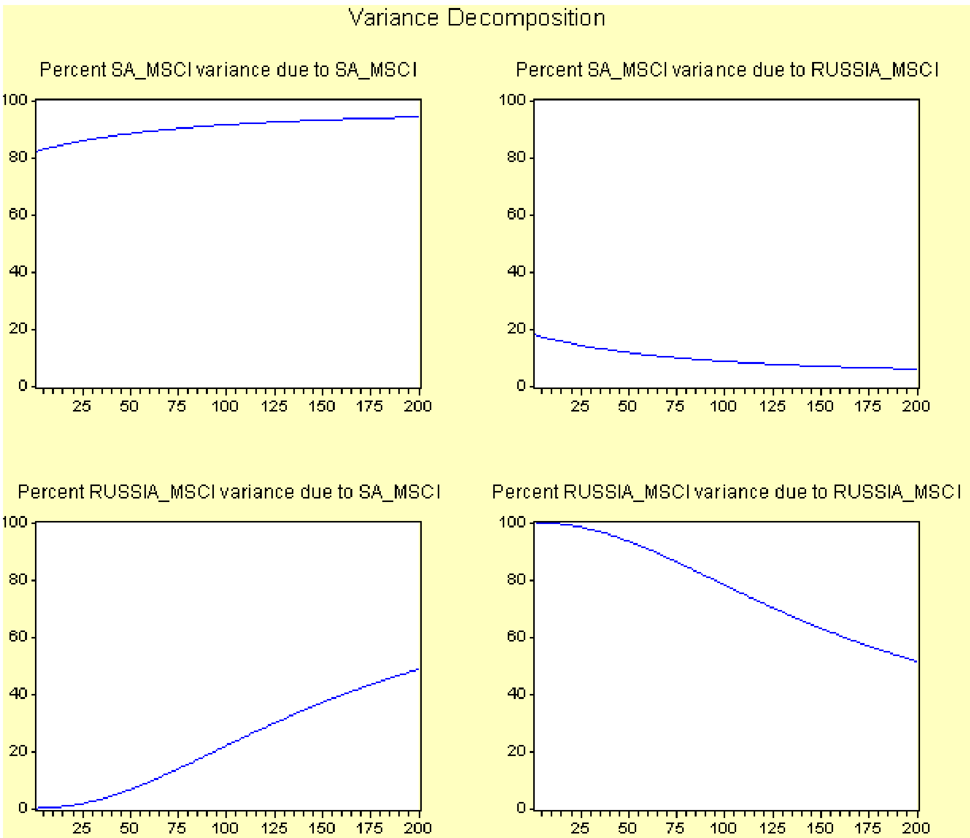
Cholesky ordering Poland – SA



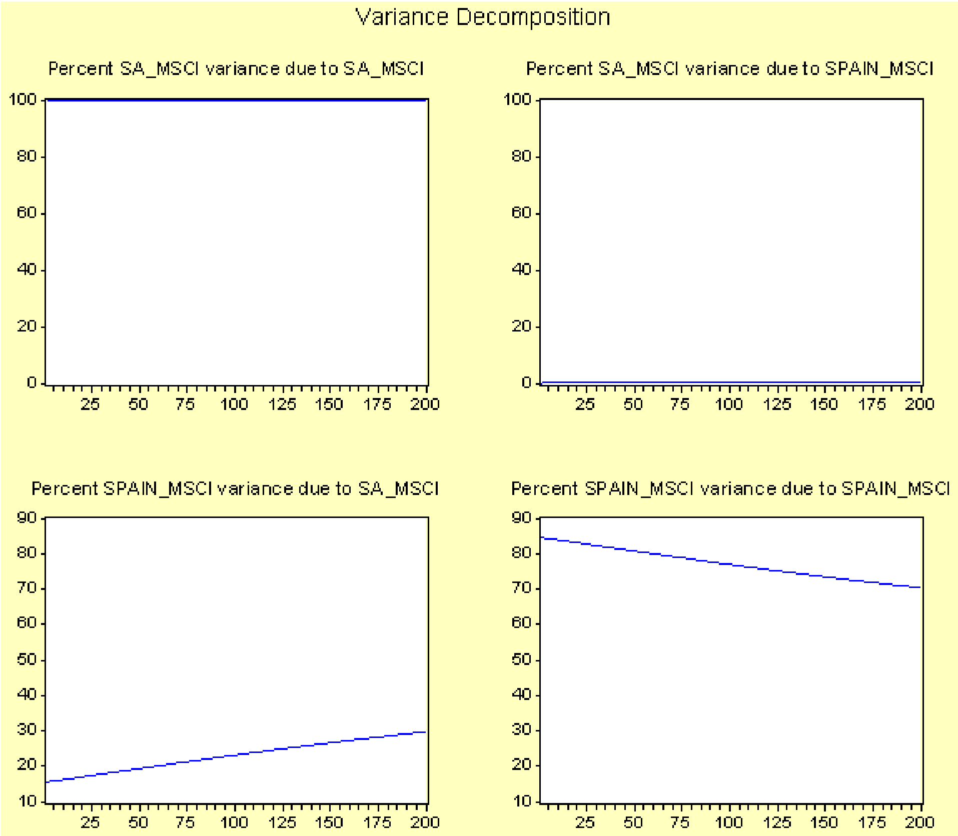
SA – Russia. Cholesky ordering SA – Russia



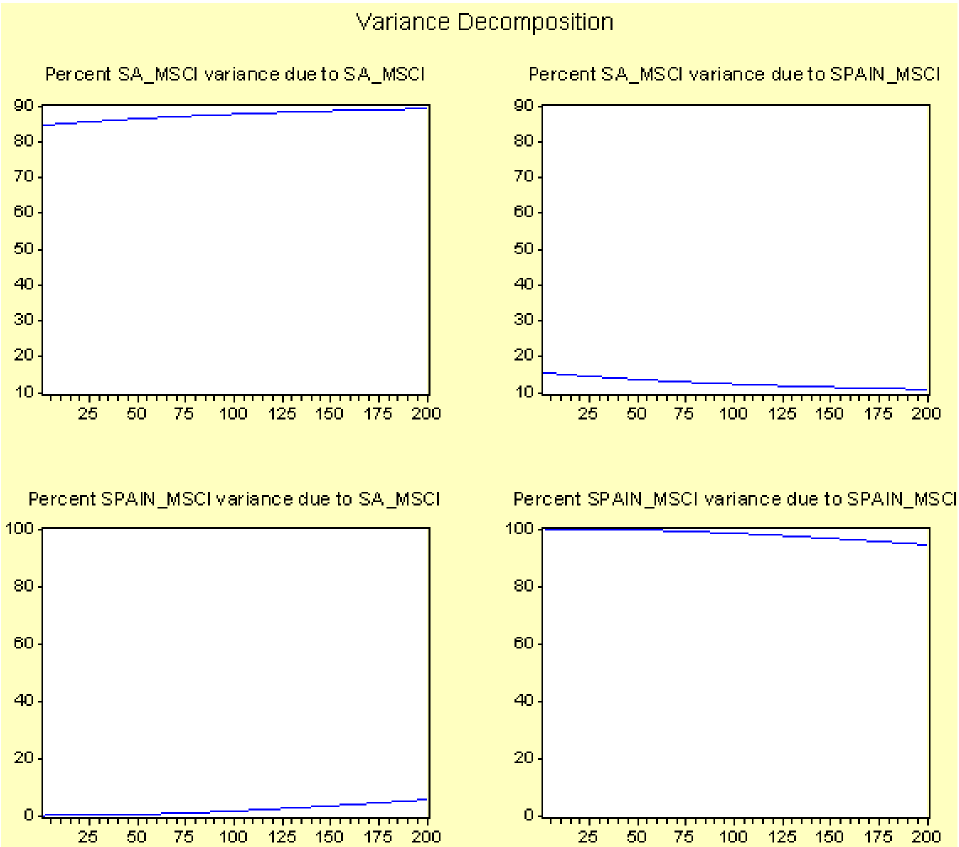
Cholesky ordering Russia – SA



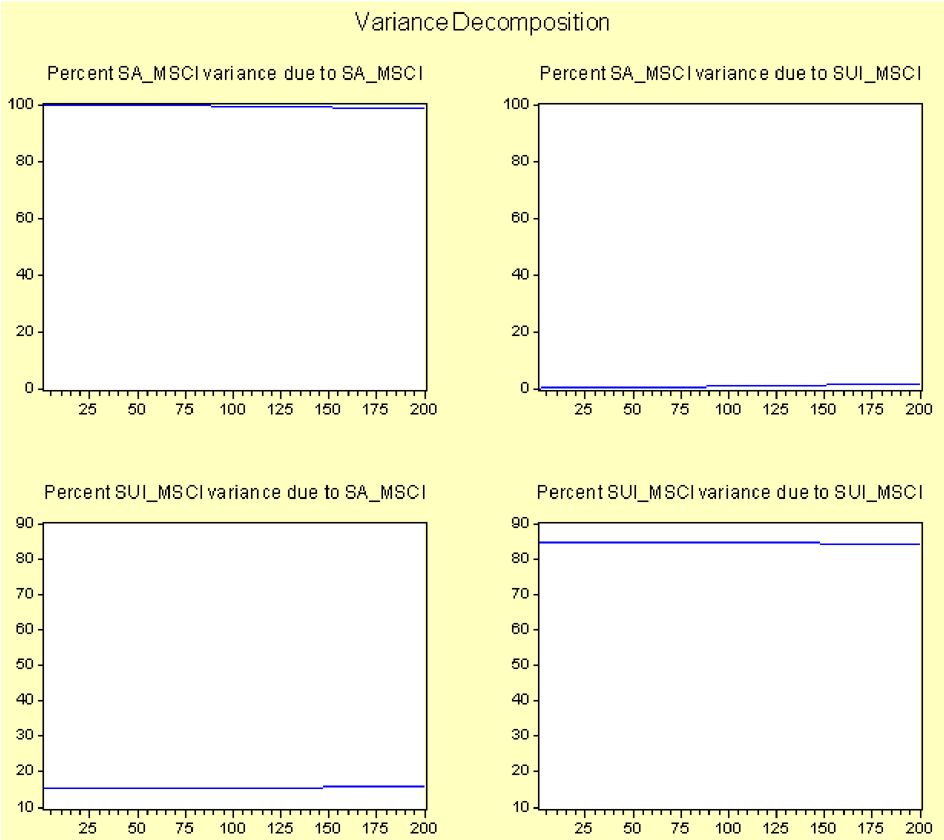
SA – Spain. Cholesky ordering SA – Spain



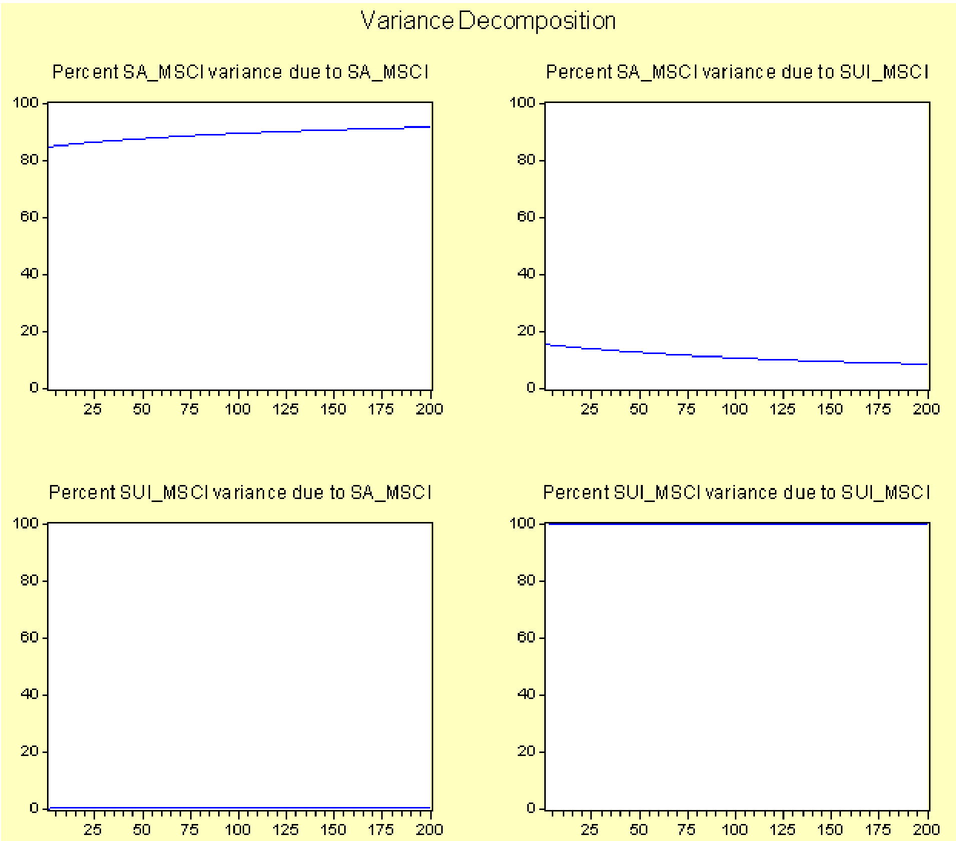
Cholesky ordering Spain – SA



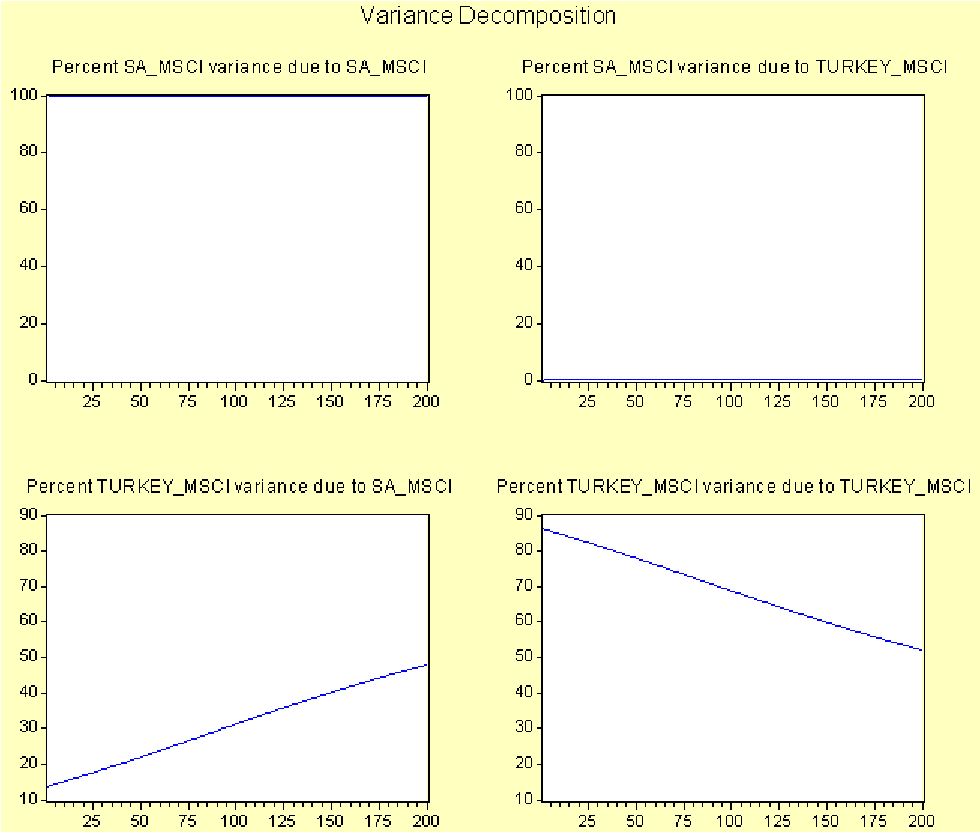
SA – Switzerland. Cholesky ordering SA – Switzerland



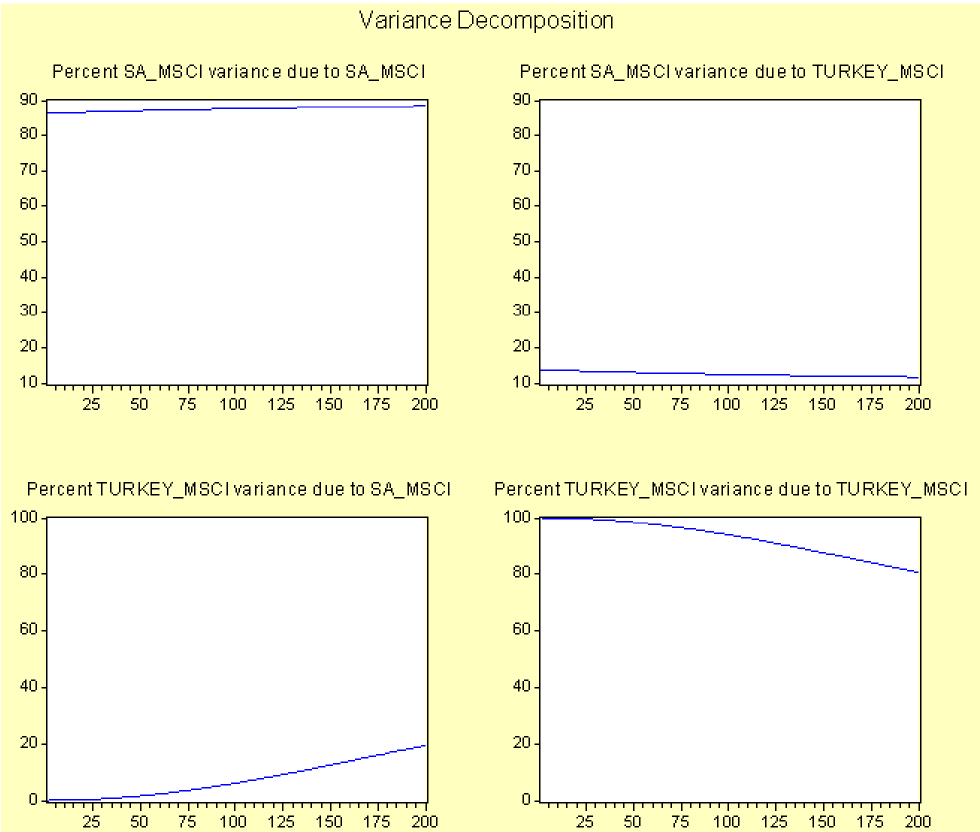
Cholesky ordering Switzerland – SA



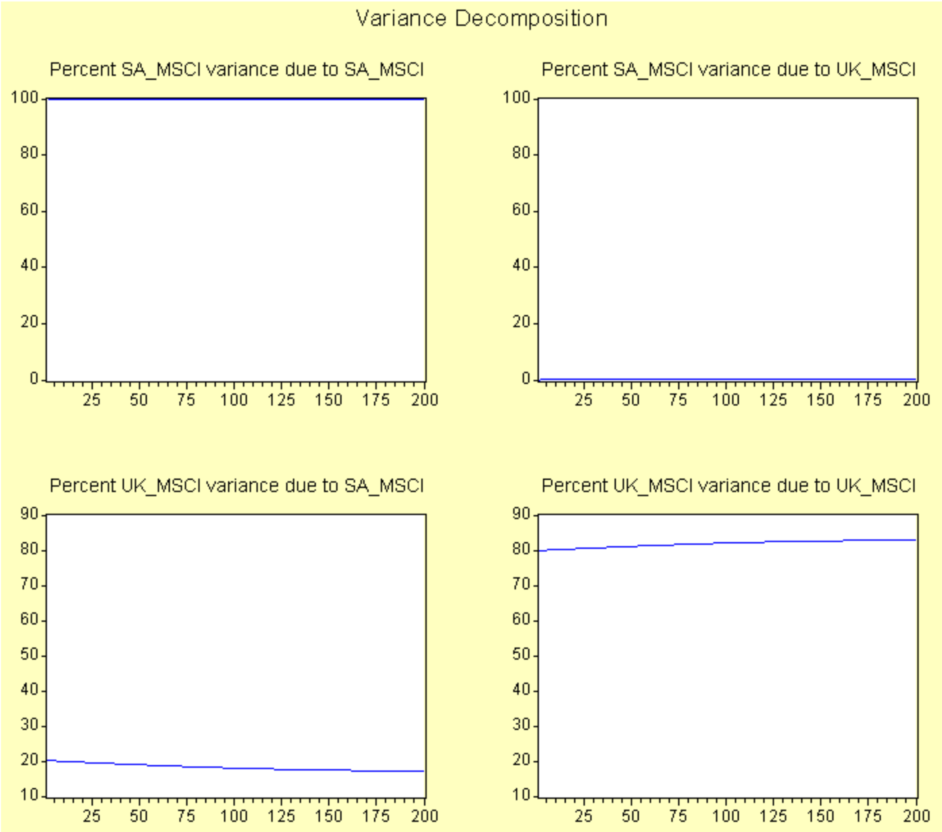
SA – Turkey. Cholesky ordering SA – Turkey



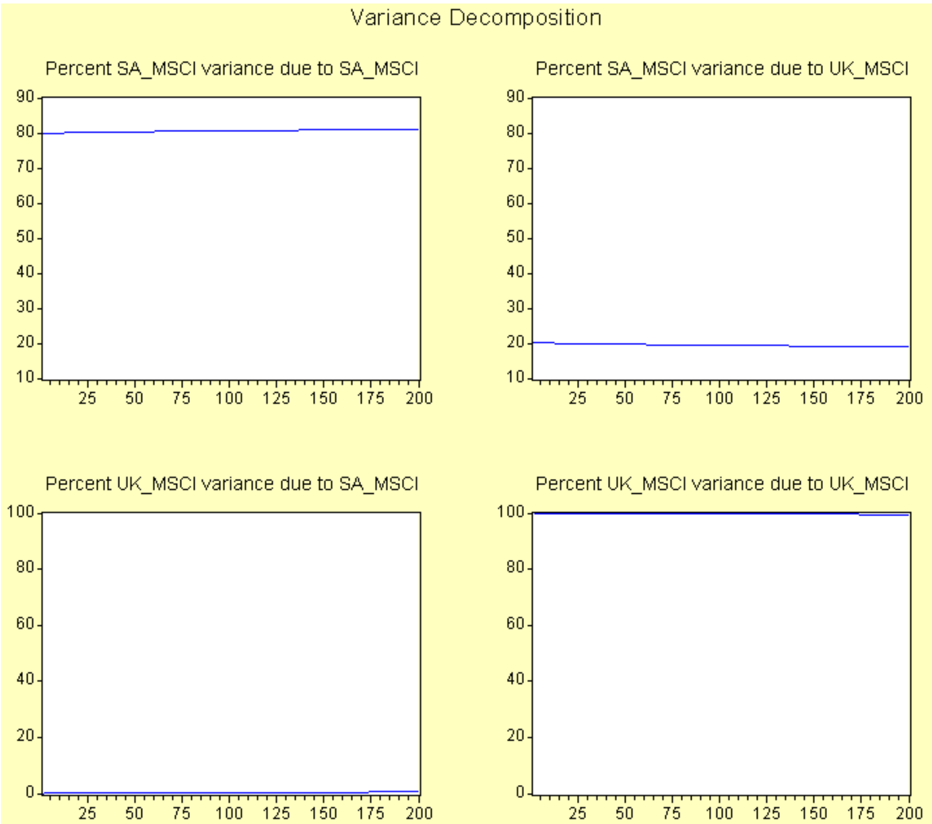
Cholesky ordering Turkey – SA



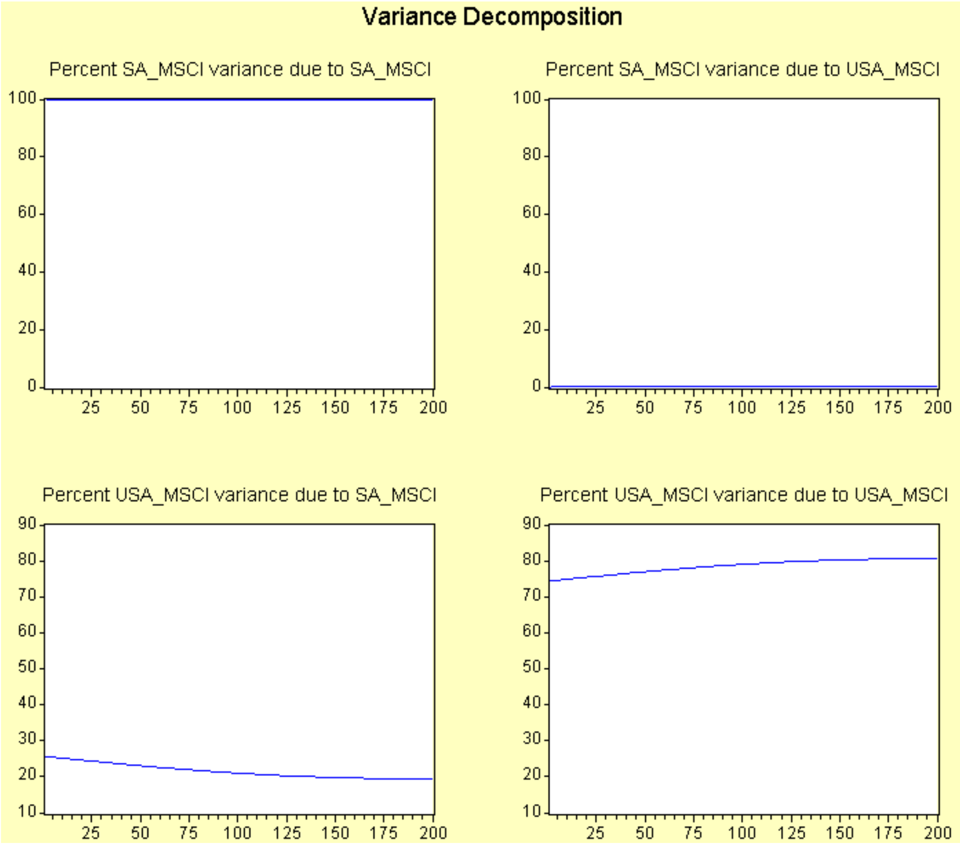
SA – UK. Cholesky ordering SA – UK



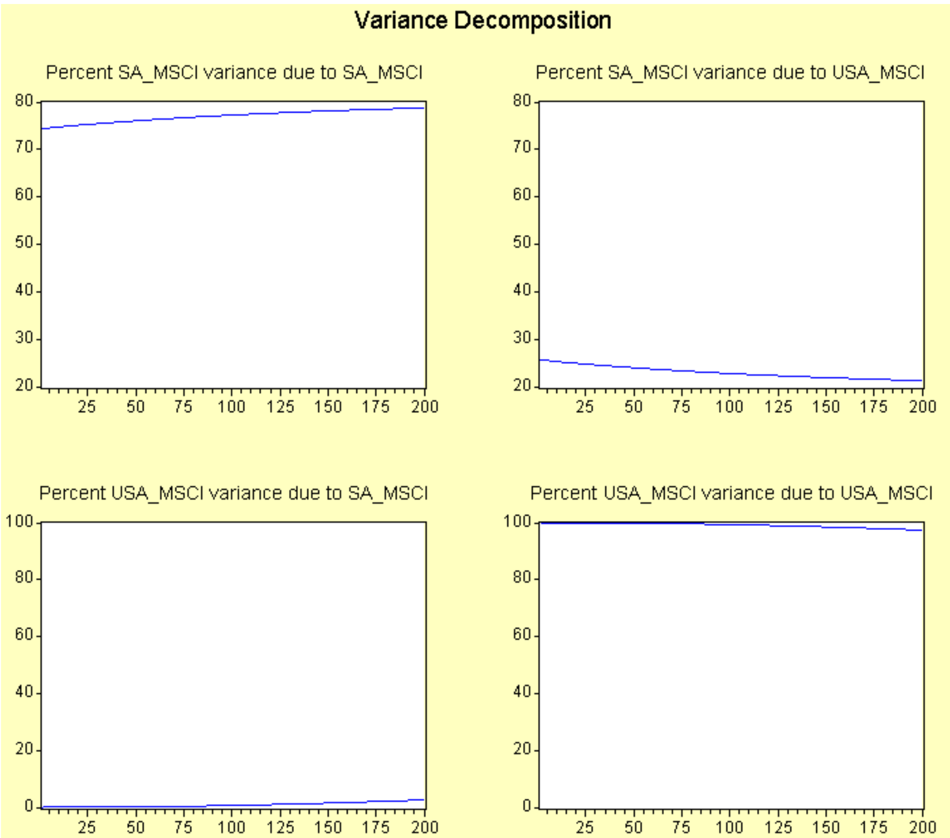
Cholesky ordering UK – SA



SA – USA. Cholesky ordering SA – USA

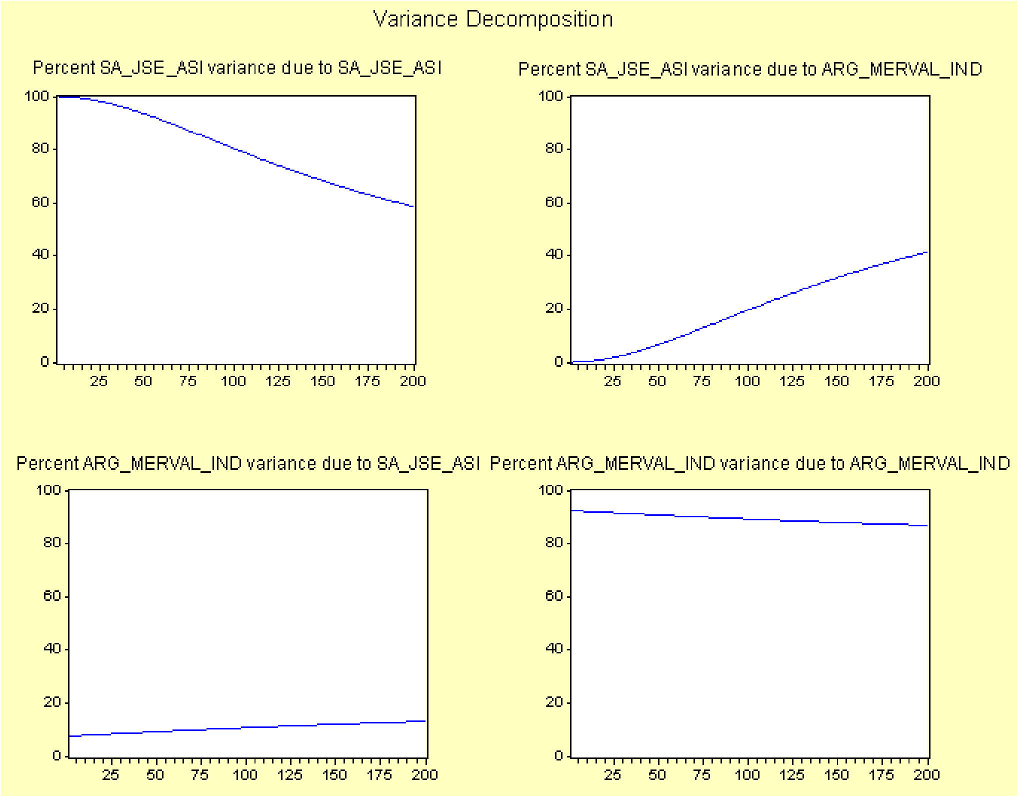


Cholesky ordering USA – SA

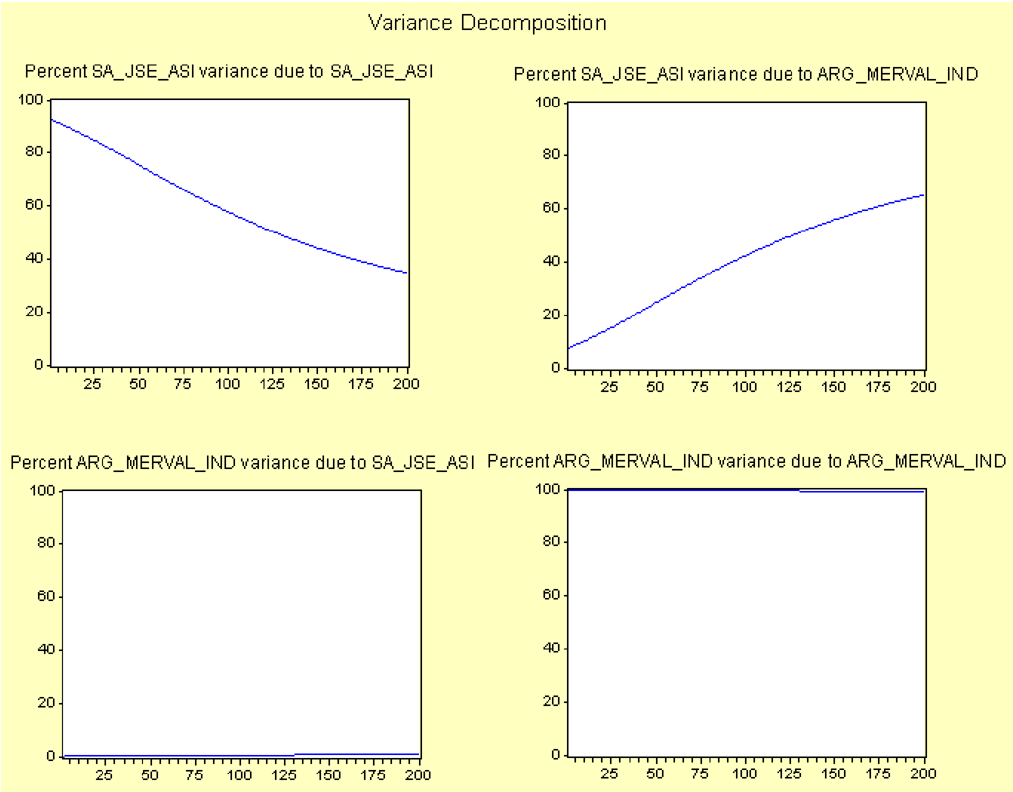


Appendix K – bivariate variance decomposition at 1 lag, using intercept in CE specification, price indices

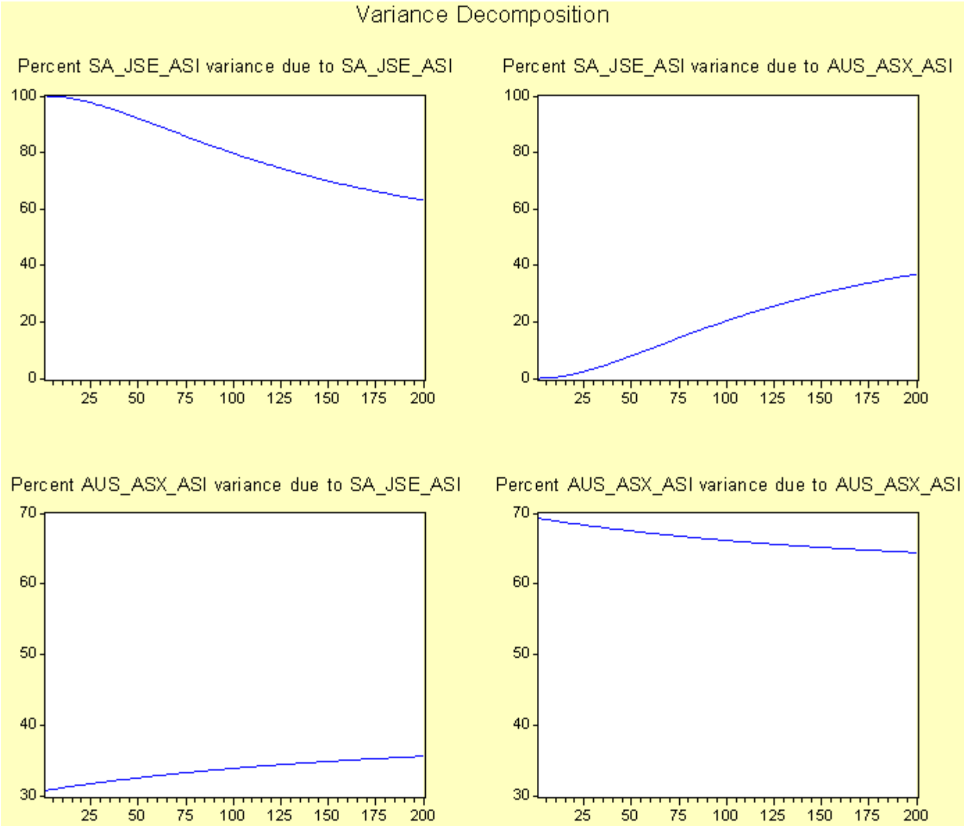
SA – Argentina, Merval. Cholesky ordering SA – Argentina



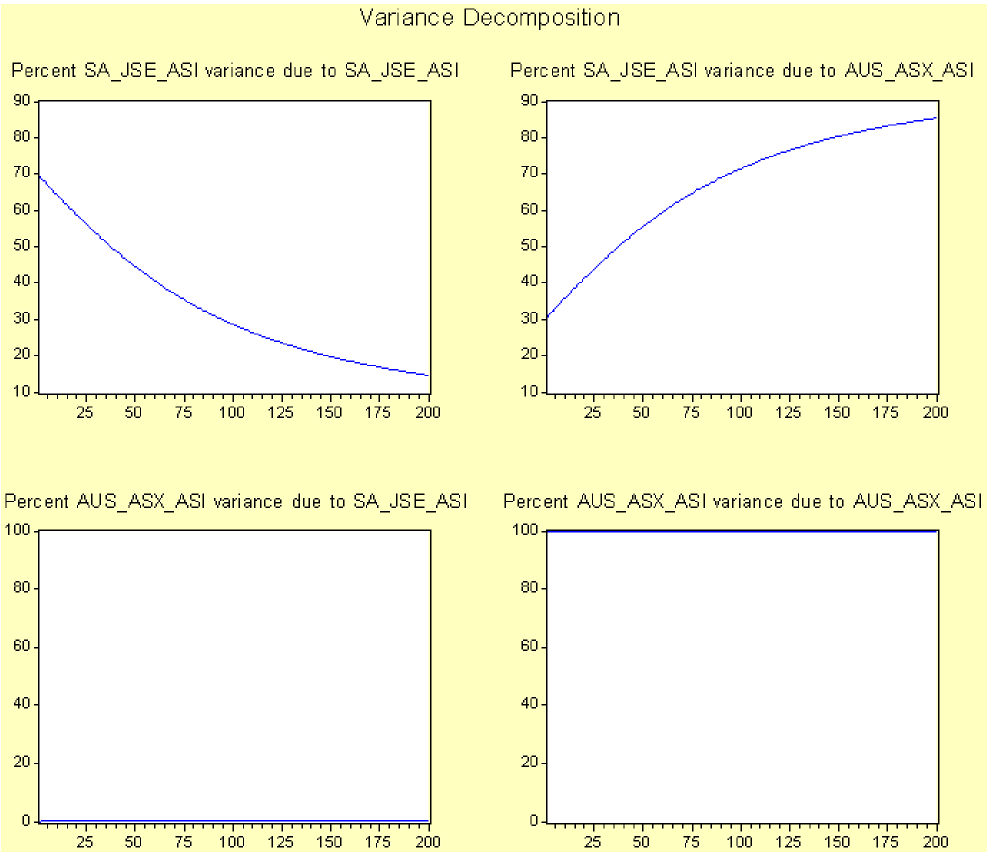
Cholesky ordering Argentina – SA



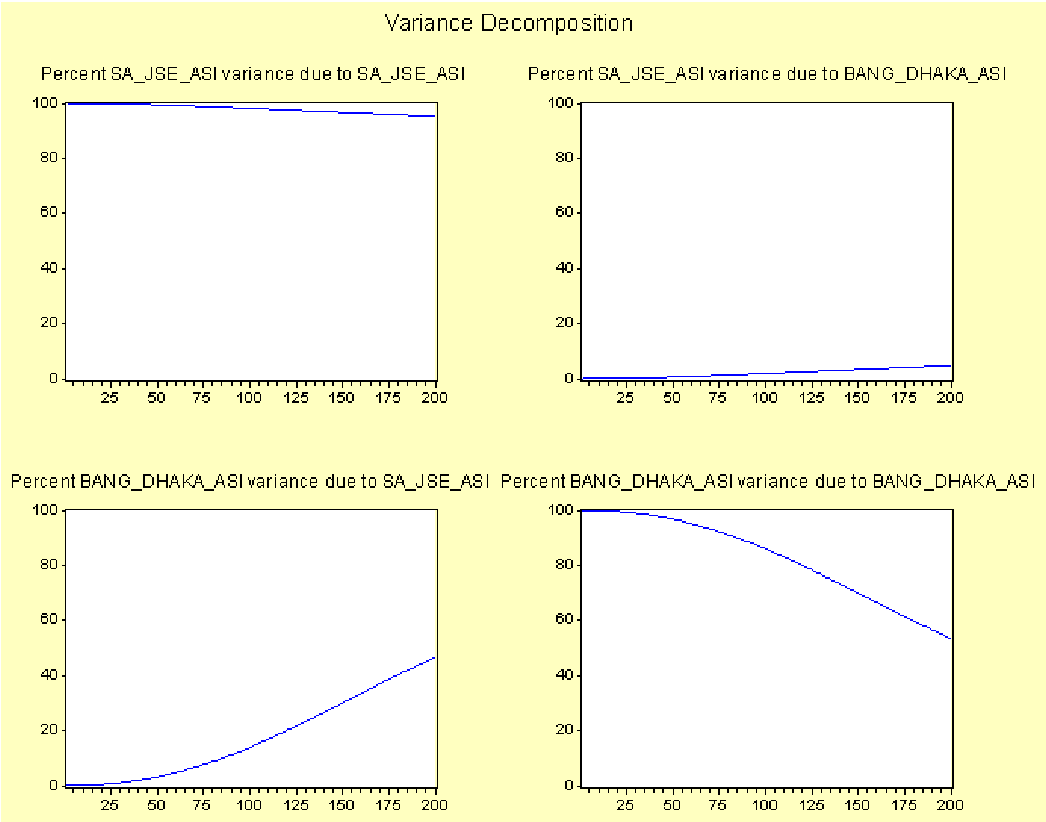
SA – Australia, ASX. Cholesky ordering SA – Australia



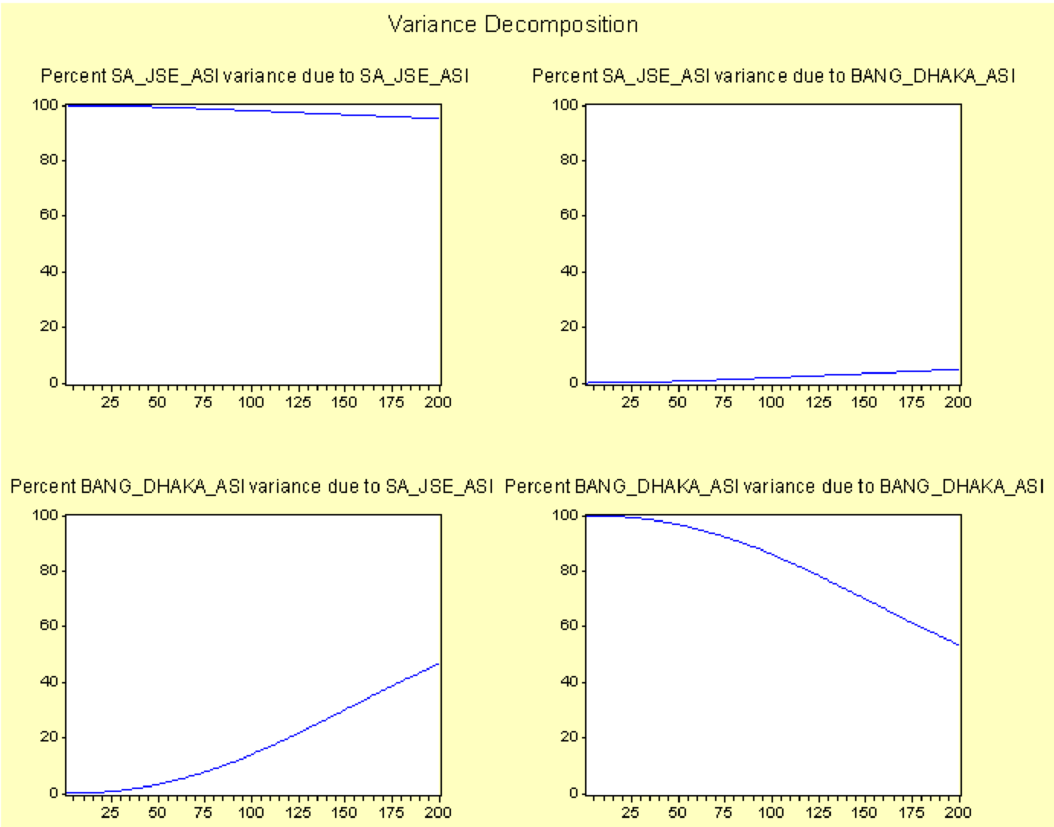
Cholesky ordering Australia – SA



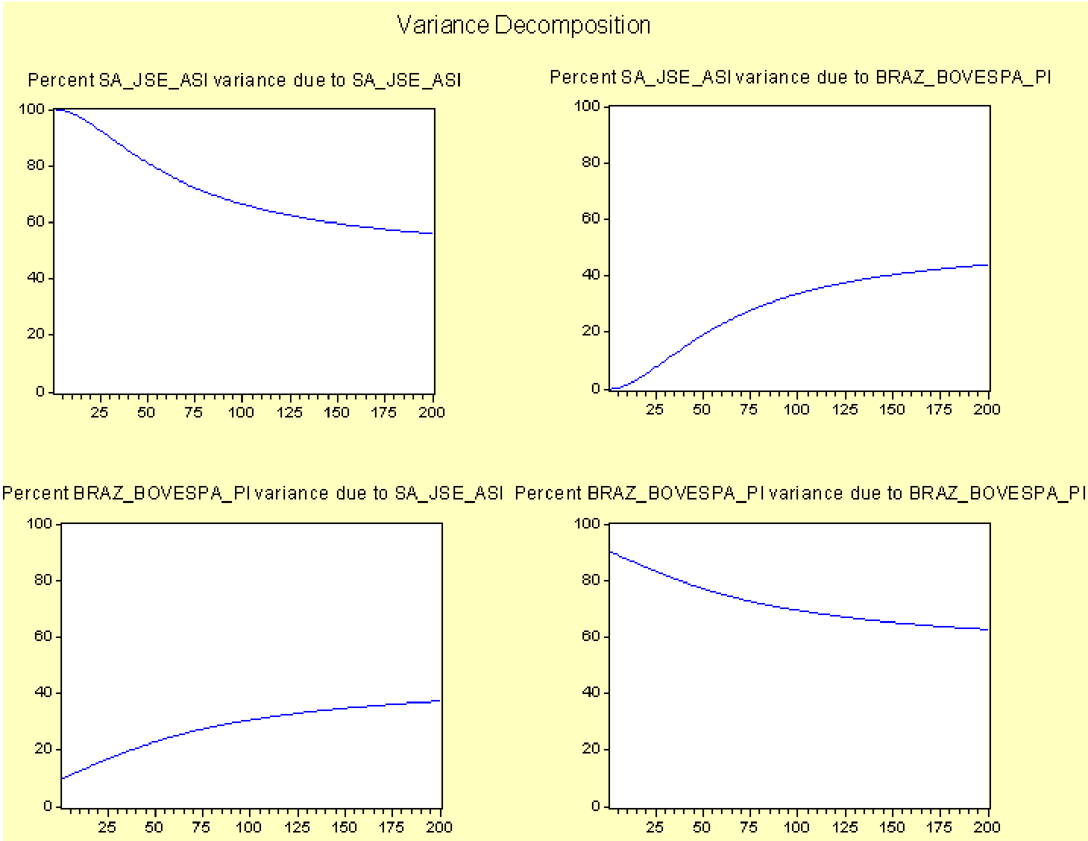
SA – Bangladesh, Dhaka. Cholesky ordering SA – Bangladesh



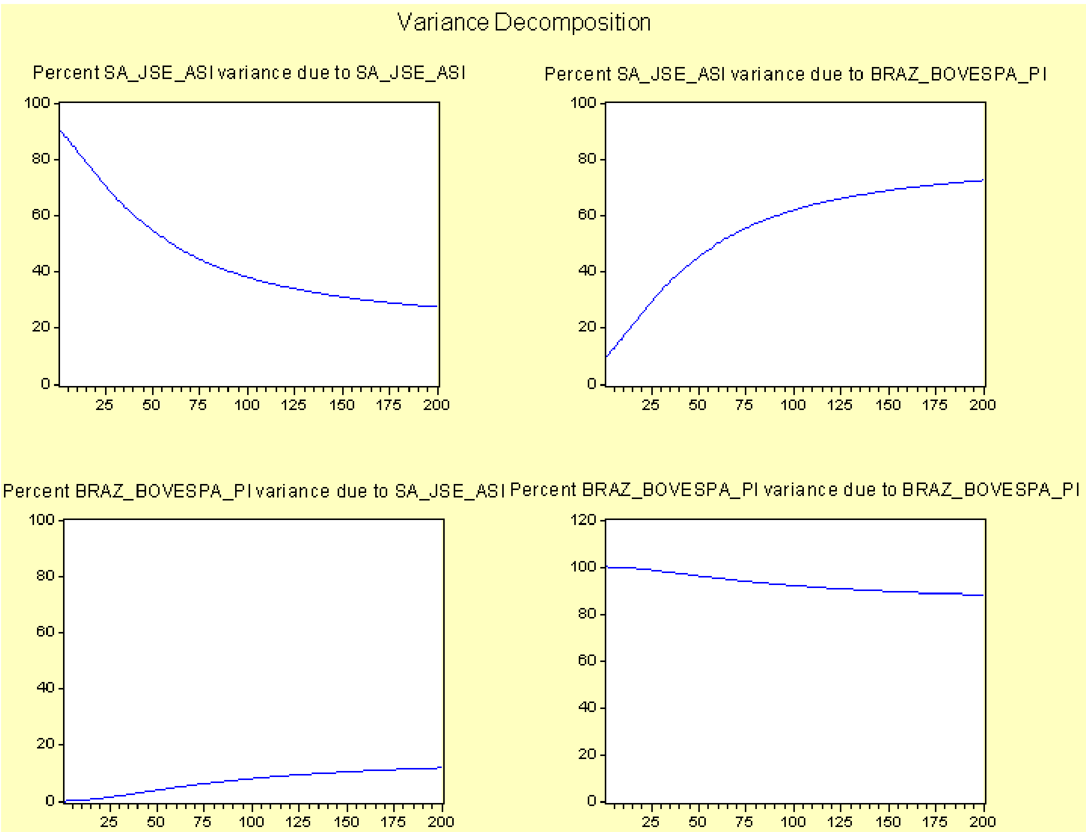
Cholesky ordering Bangladesh – SA



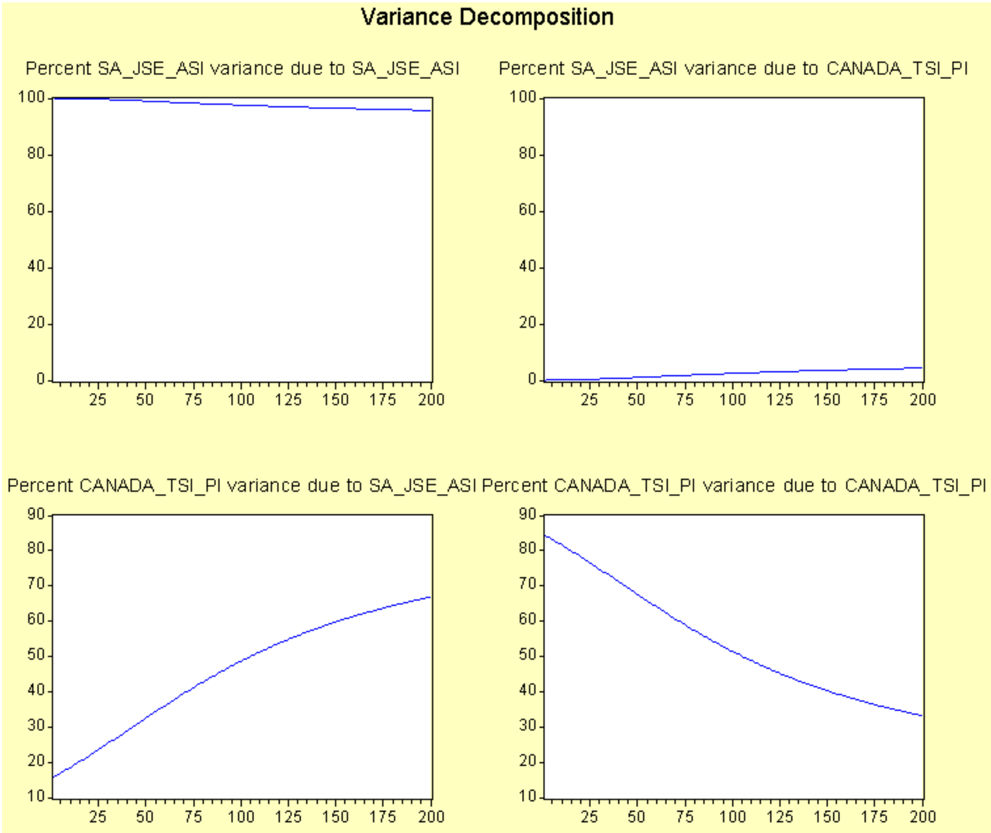
SA – Brazil, Bovespa. Cholesky ordering SA – Brazil



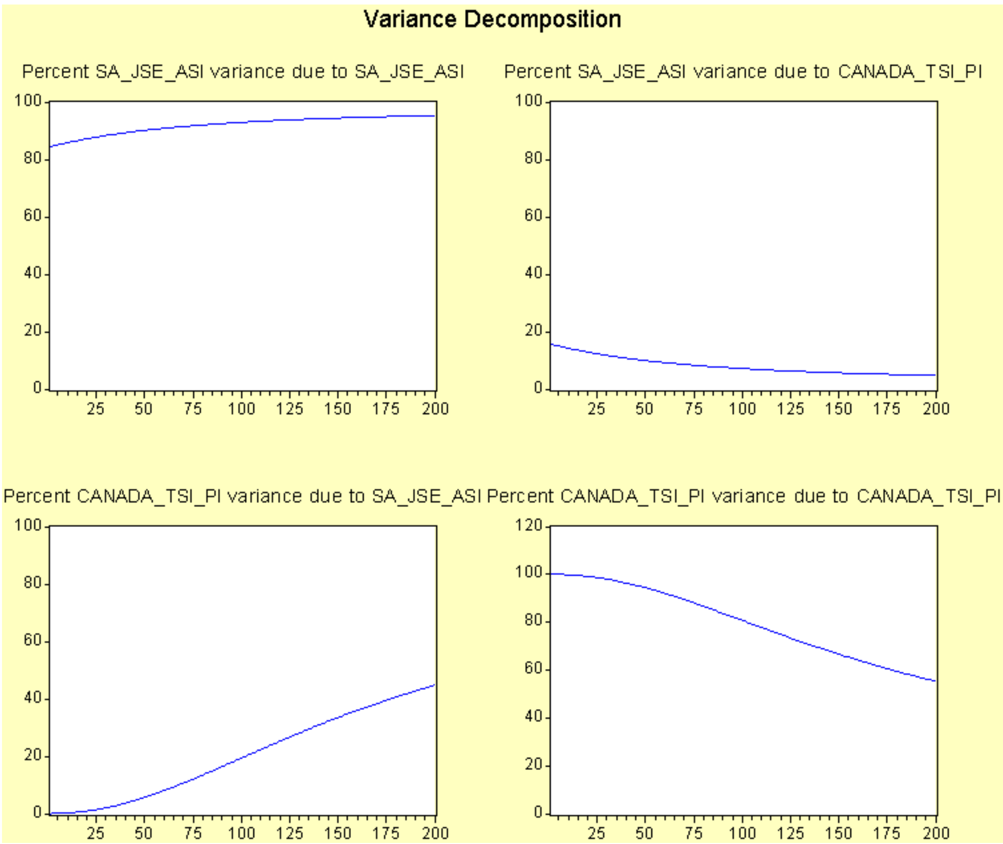
Cholesky ordering Brazil – SA



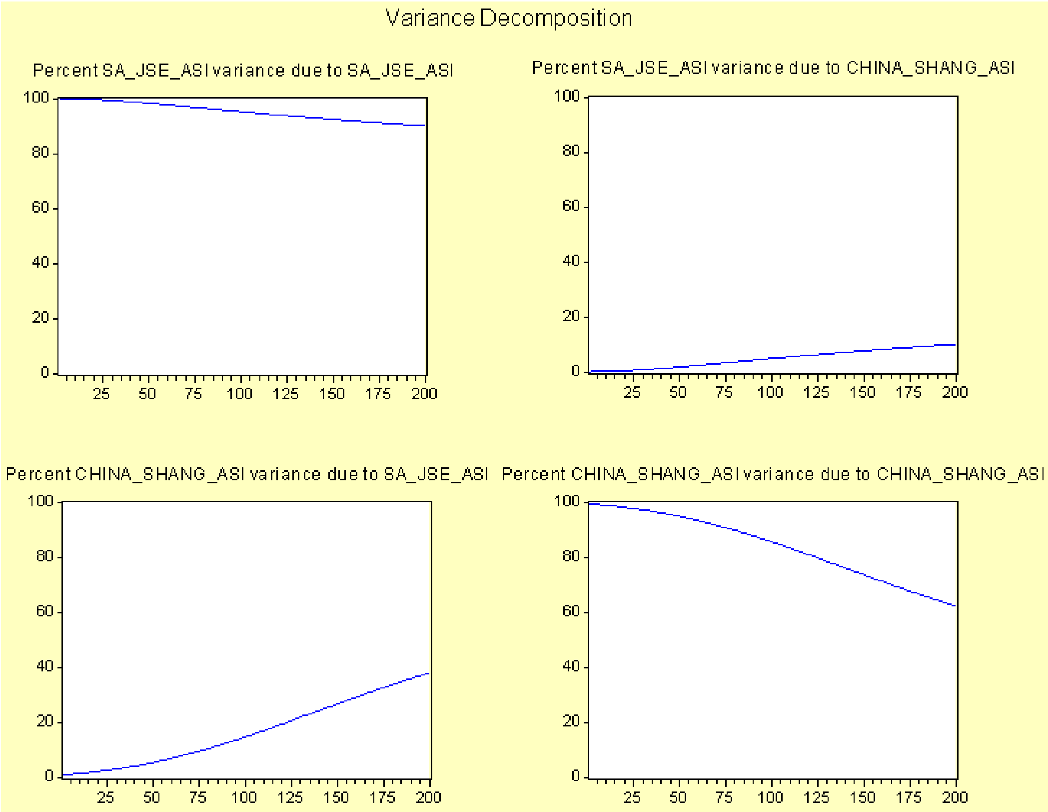
SA – Canada, TSI. Cholesky ordering SA – Canada



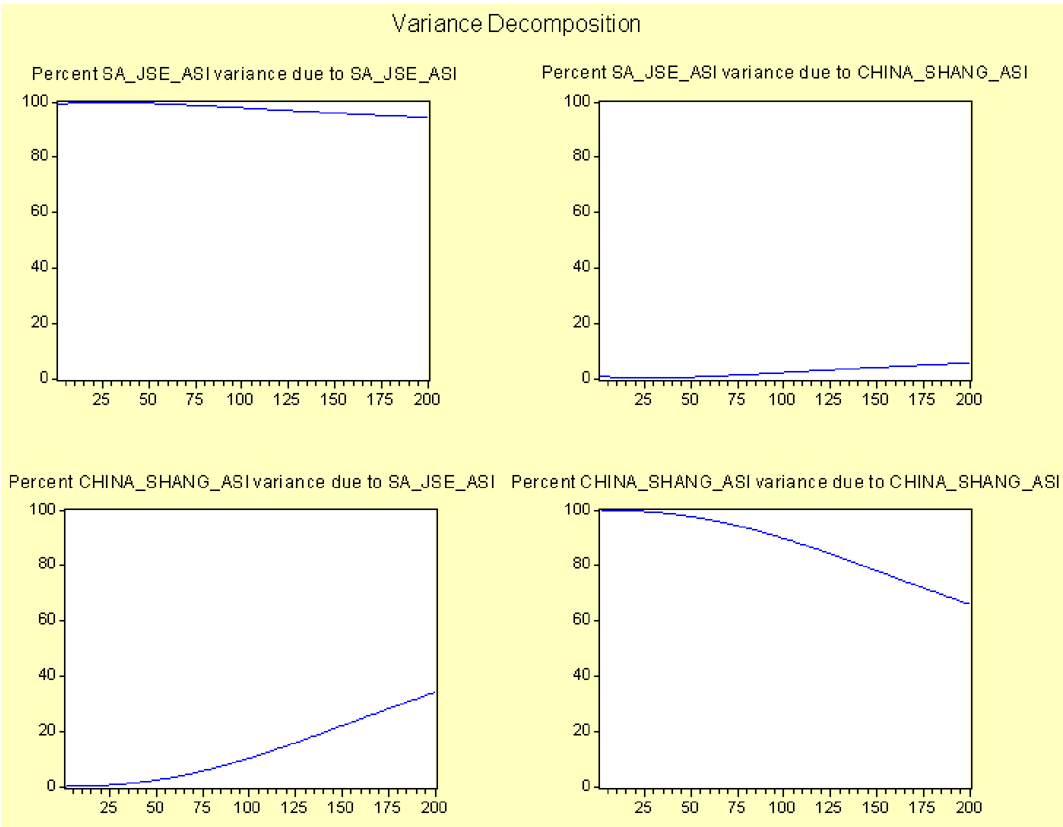
Cholesky ordering Canada – SA



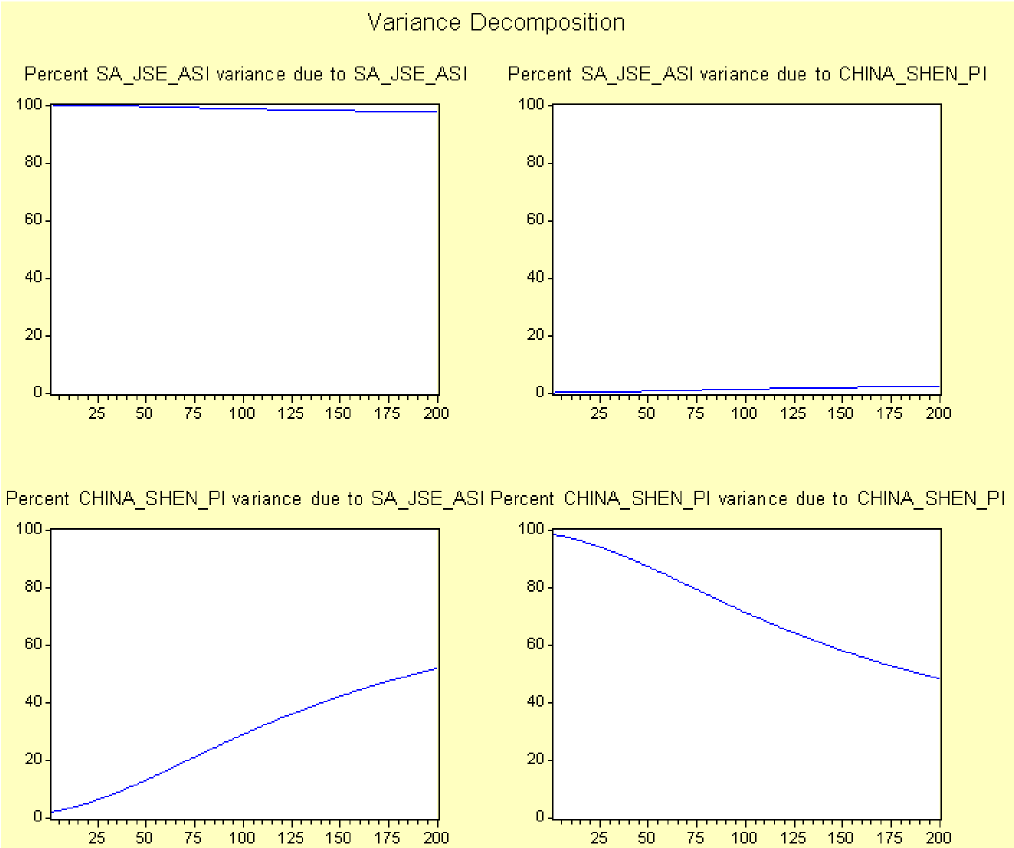
SA – China, Shanghai. Cholesky ordering SA – China



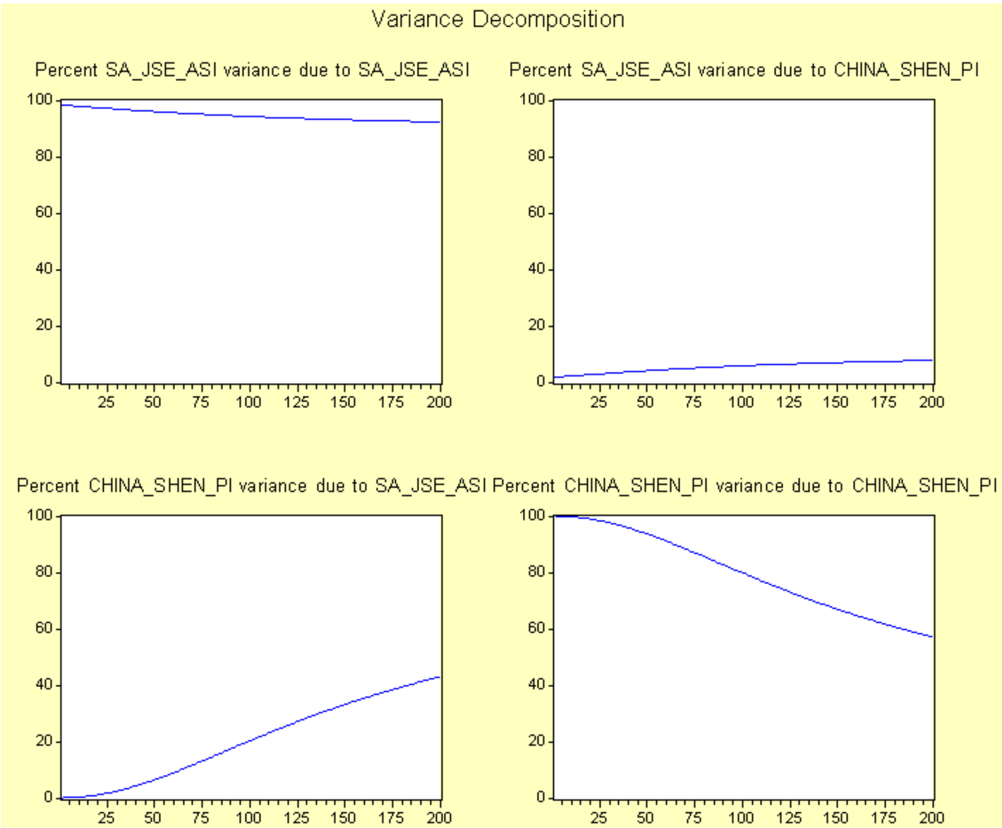
Cholesky ordering China – SA



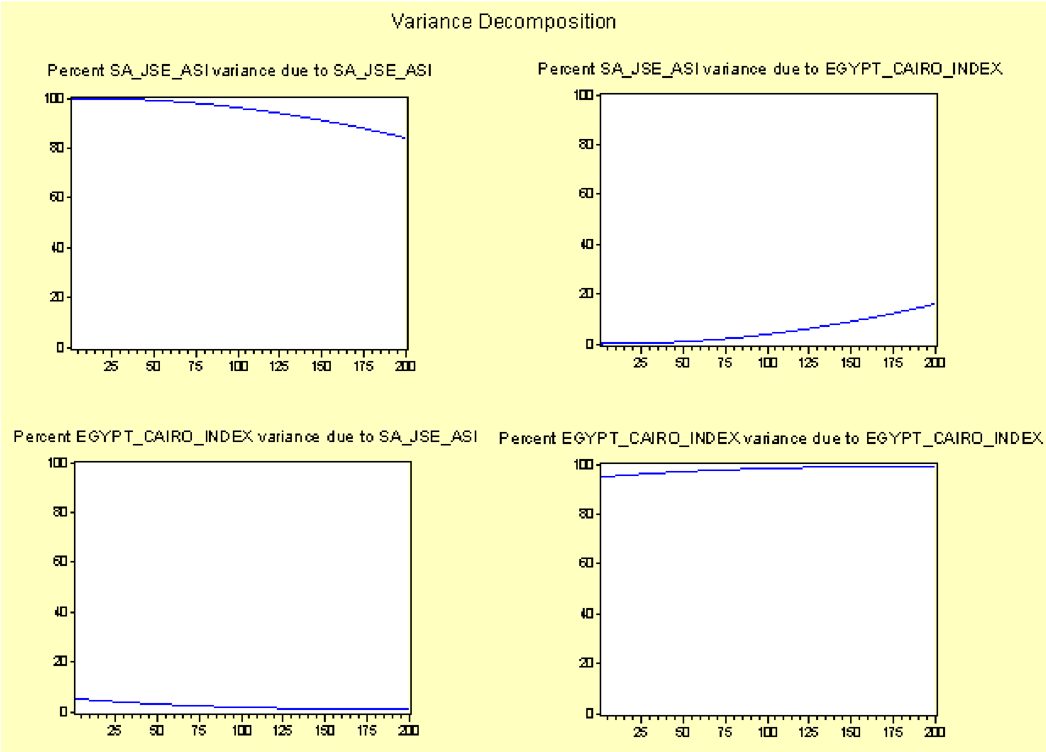
SA – China, Shenzhen. Cholesky ordering SA – China



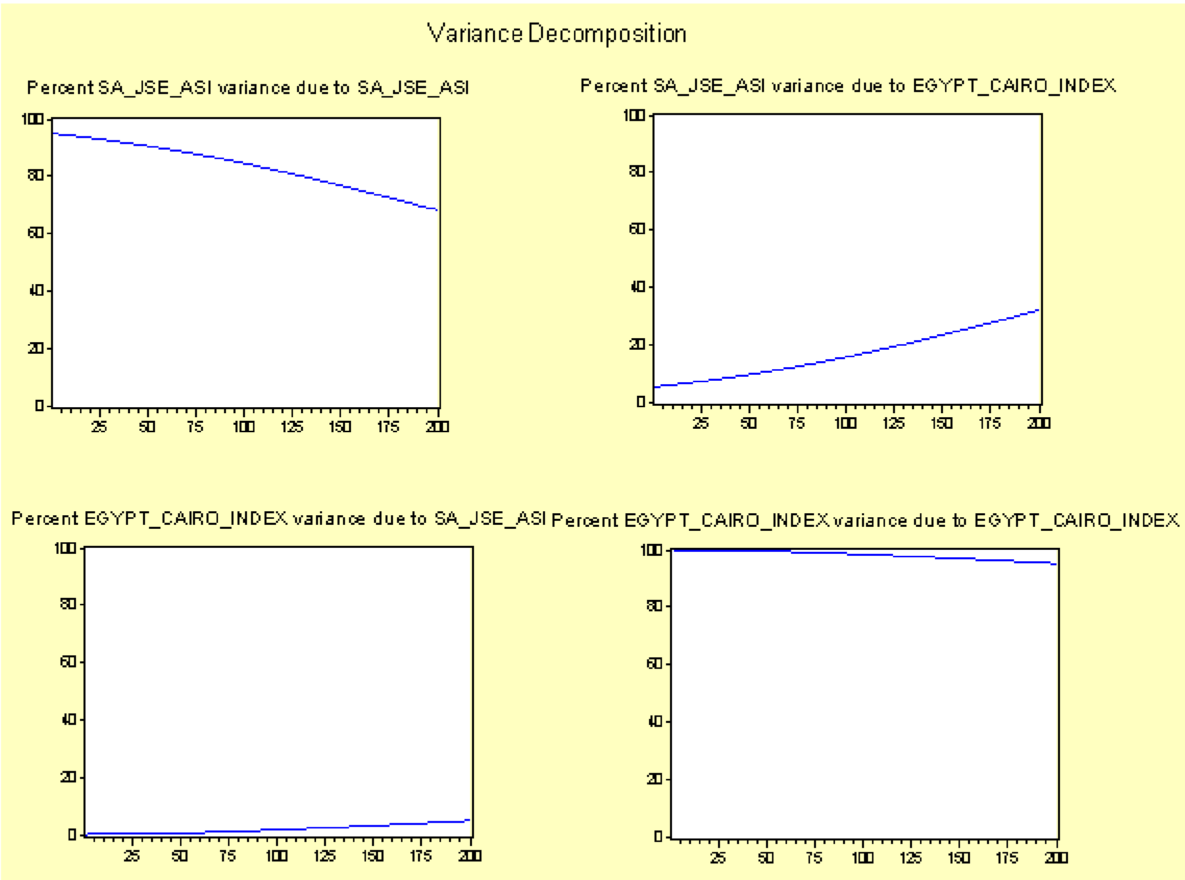
Cholesky ordering China – SA



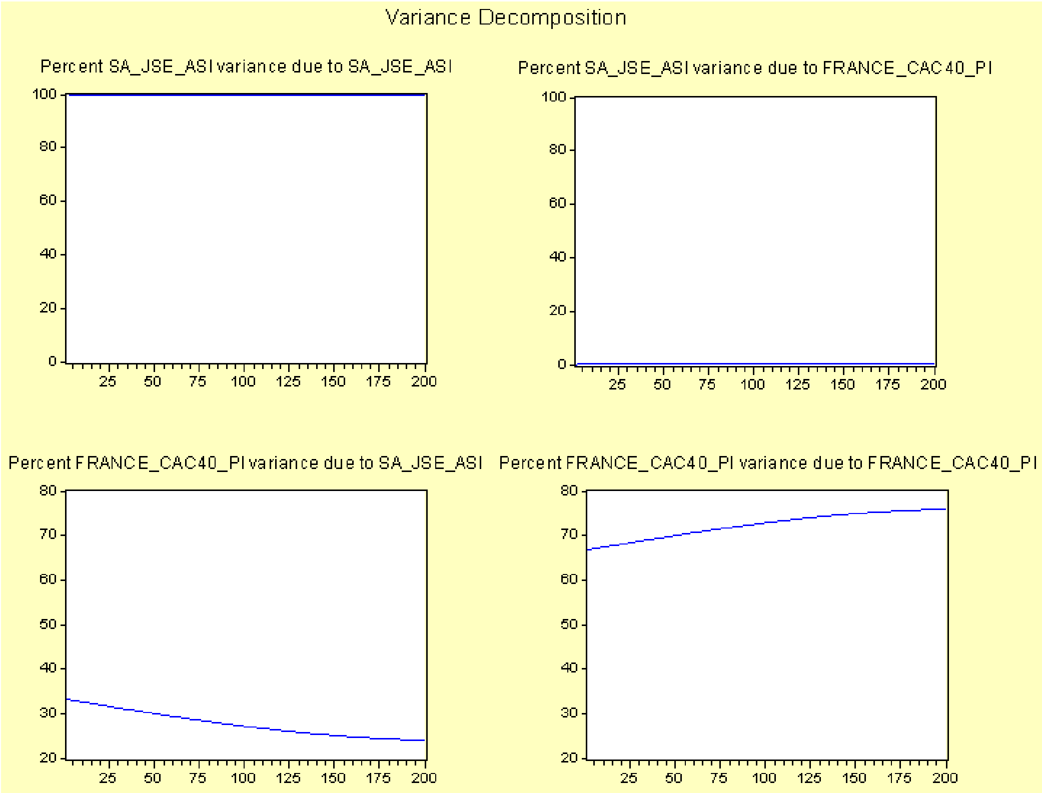
SA – Egypt, Cairo. Cholesky ordering SA – Egypt



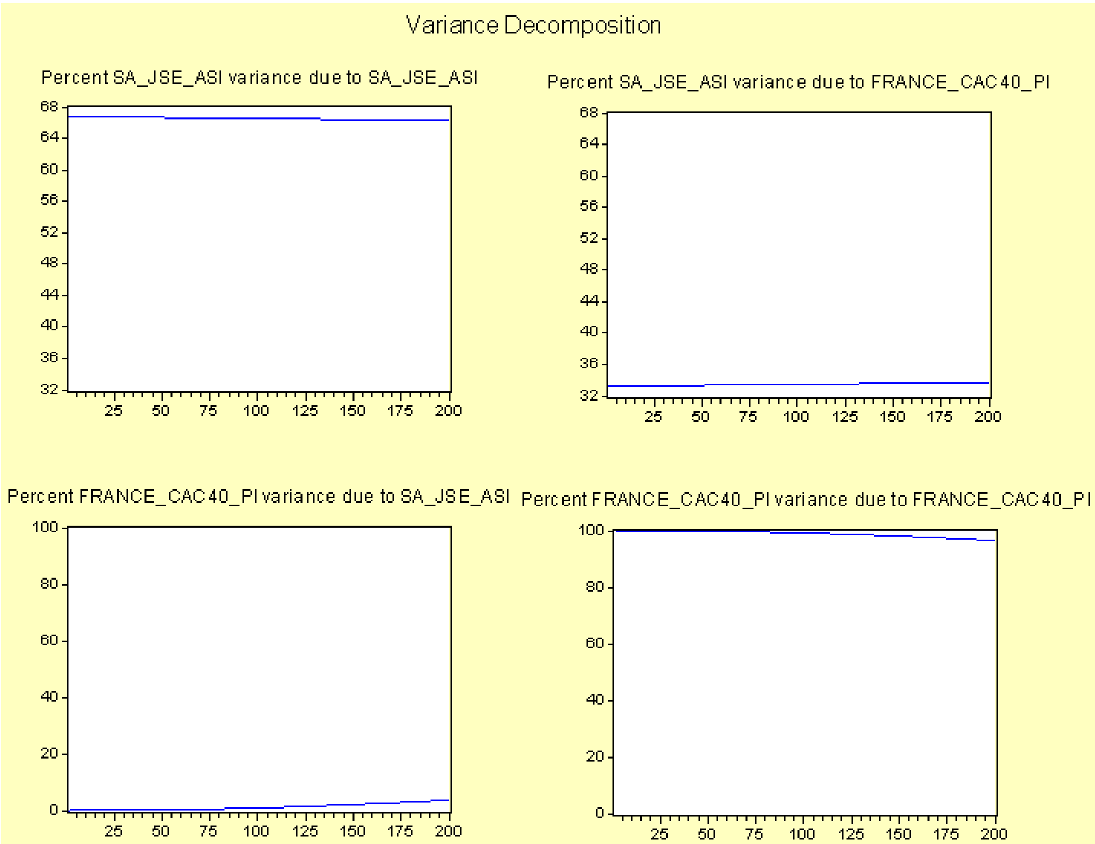
Cholesky ordering Egypt – SA



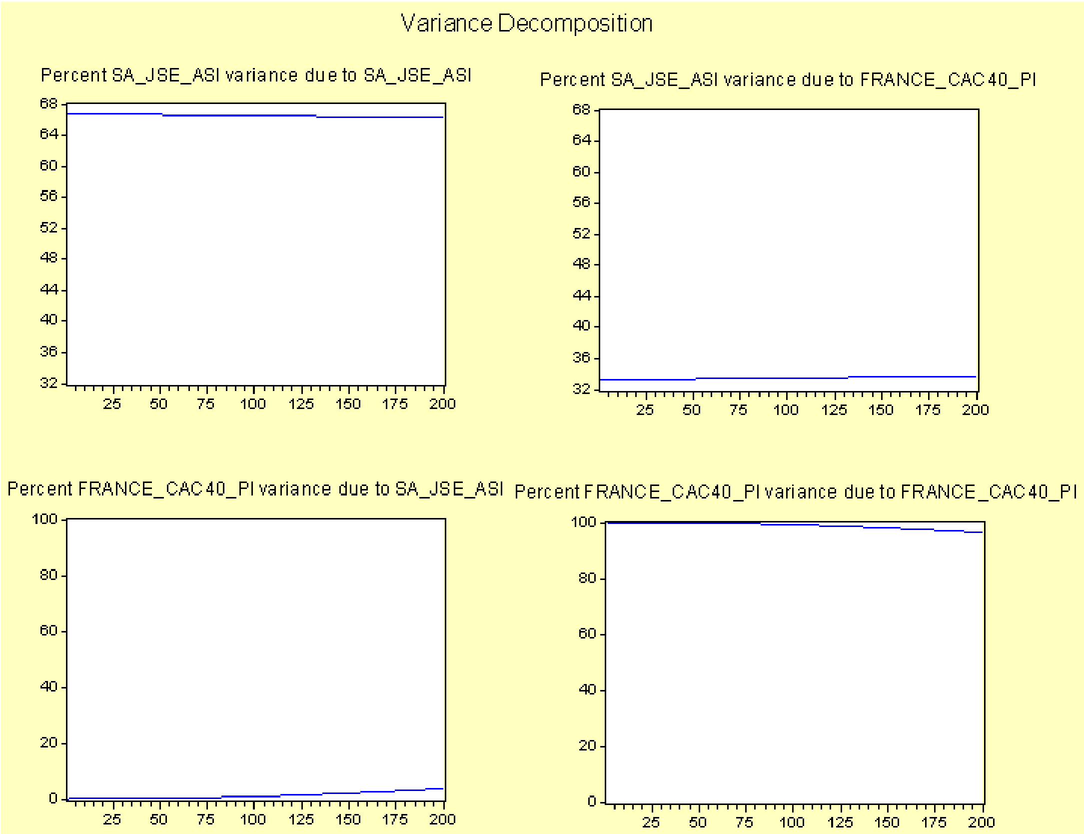
SA – France, Cac40. Cholesky ordering SA – France



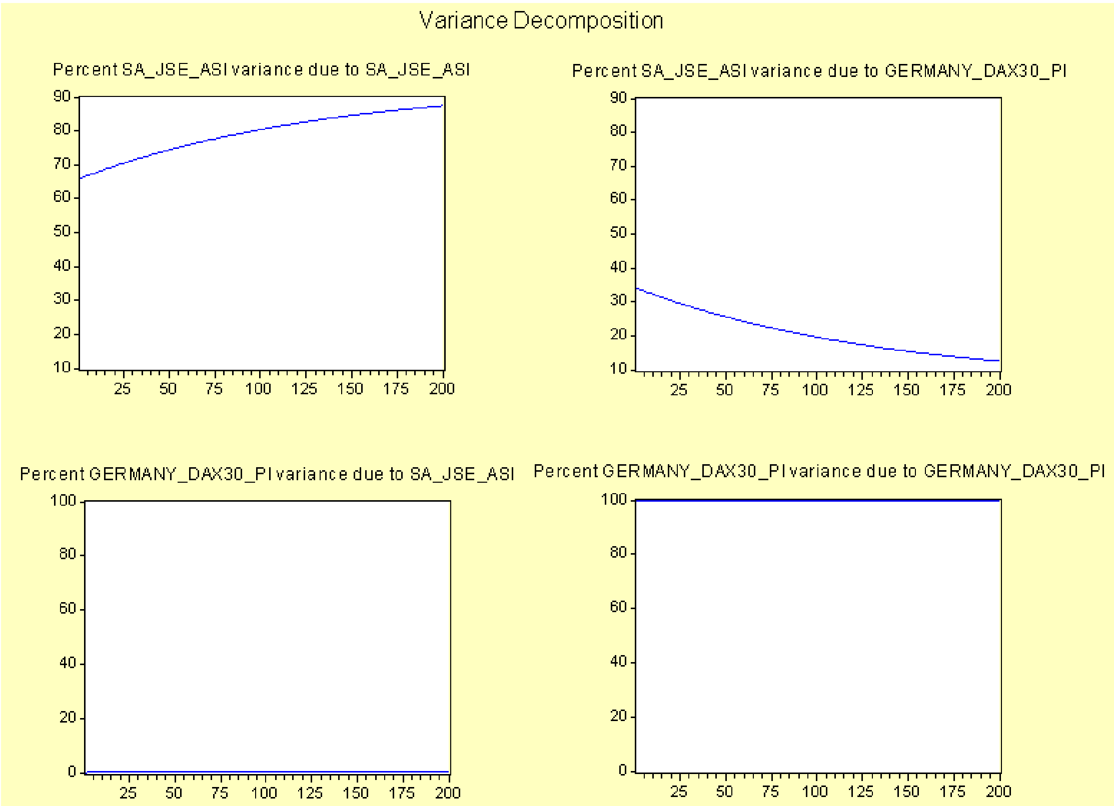
Cholesky ordering France – SA



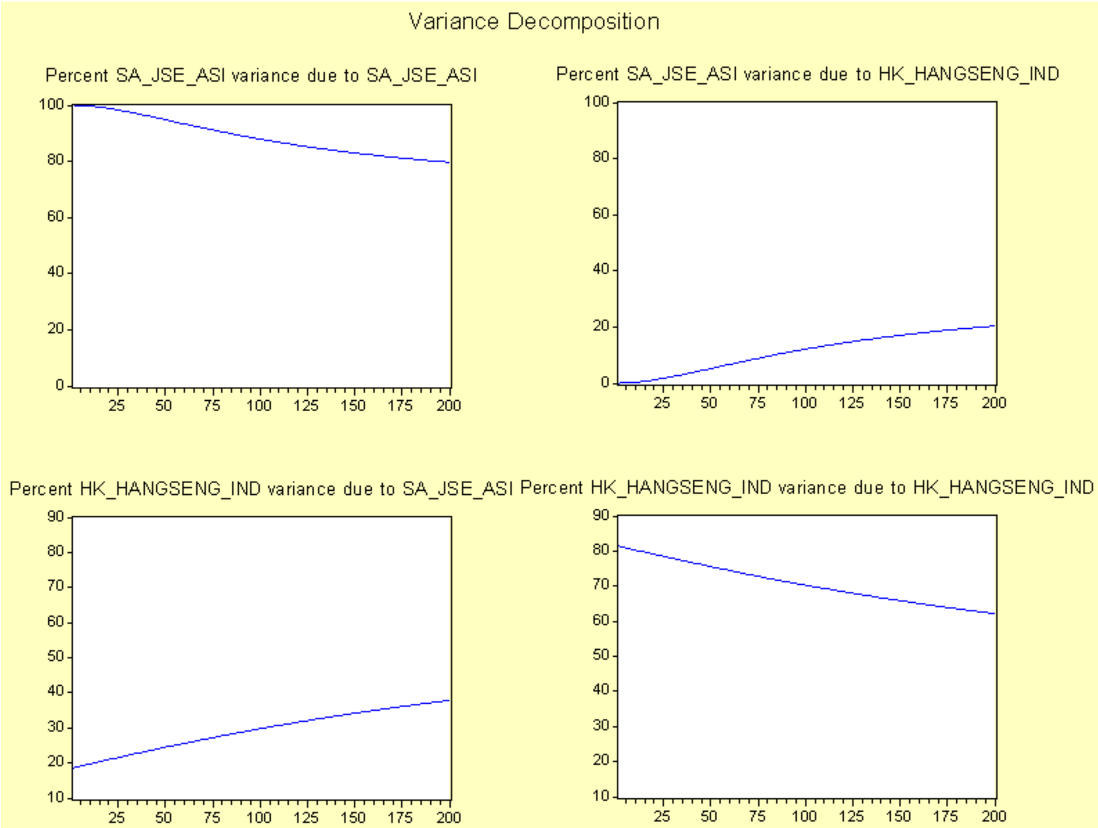
SA – Germany, Dax30. Cholesky ordering SA – Germany



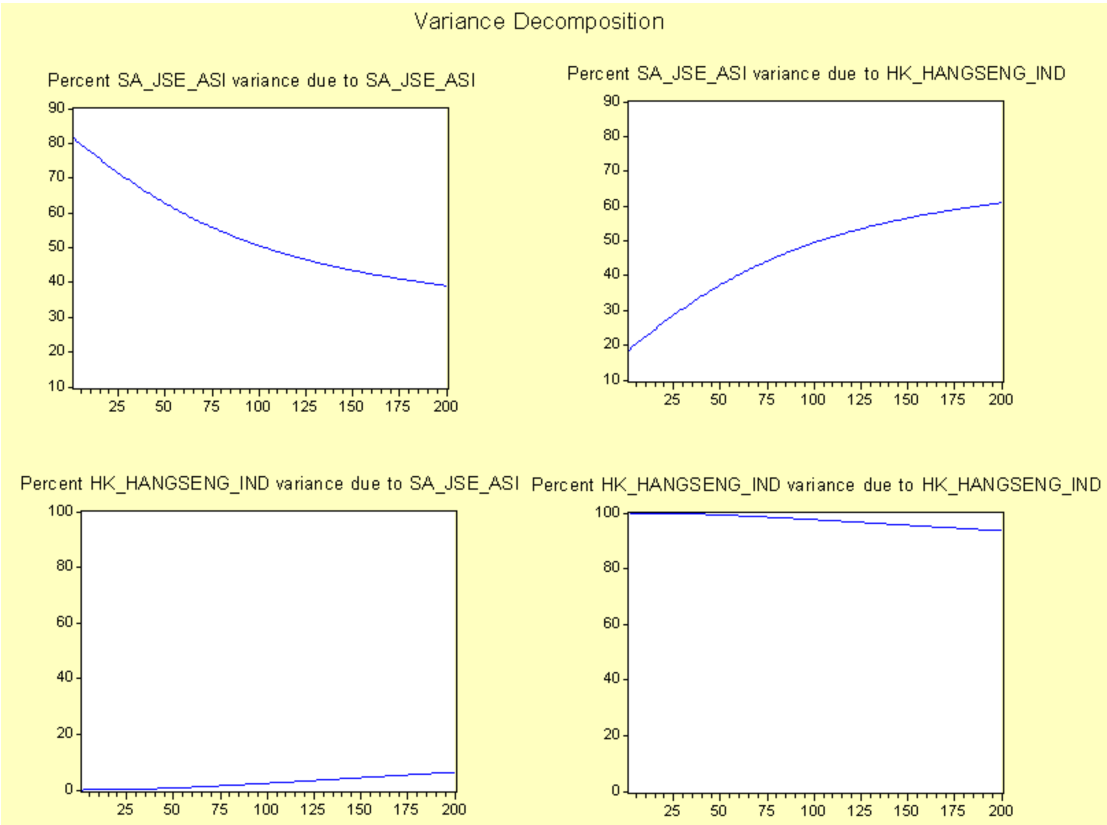
Cholesky ordering Germany – SA



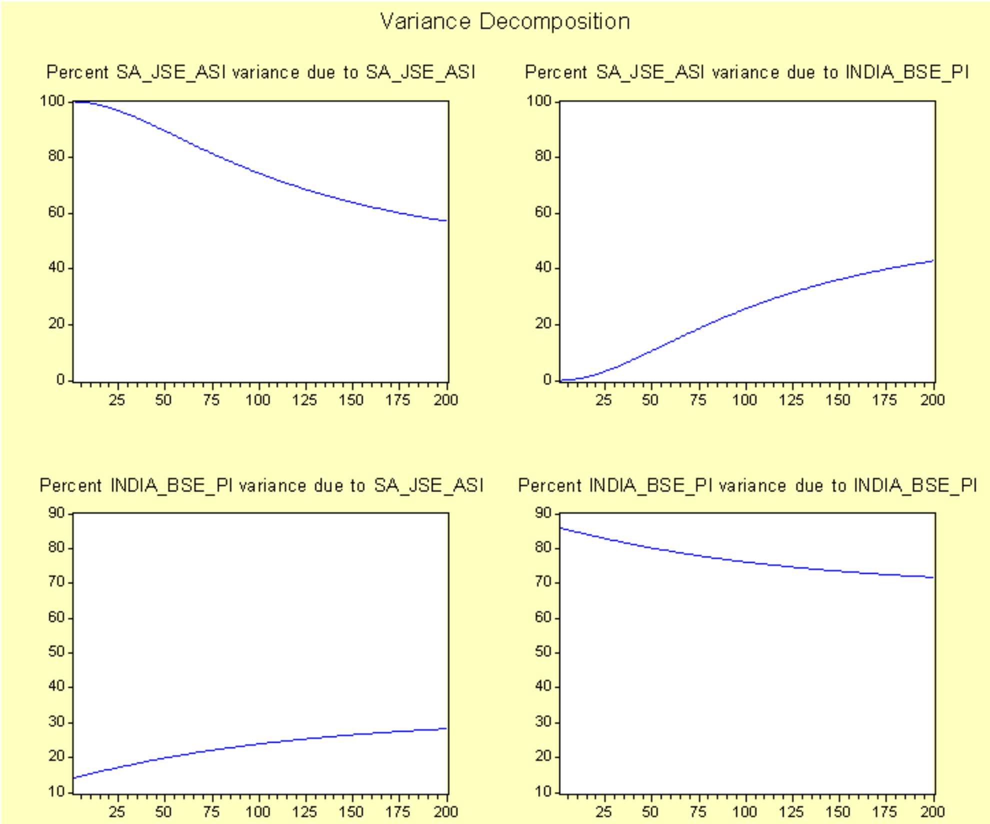
SA – Hong Kong, Hangseng. Cholesky ordering SA – HK



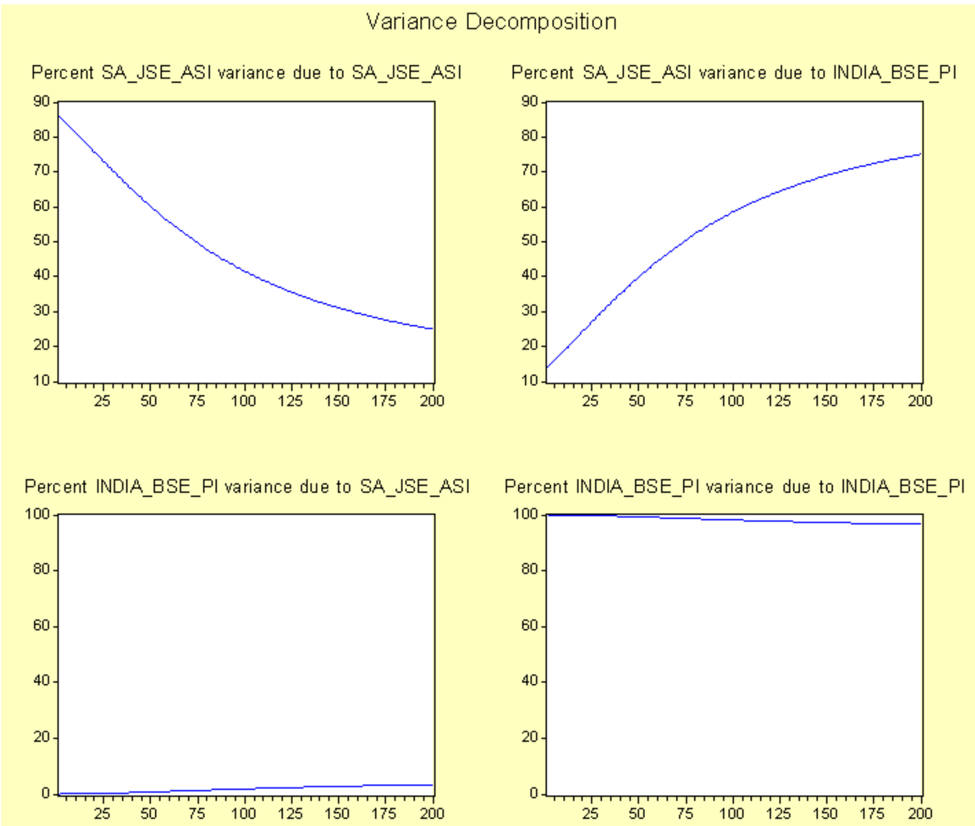
Cholesky ordering HK – SA



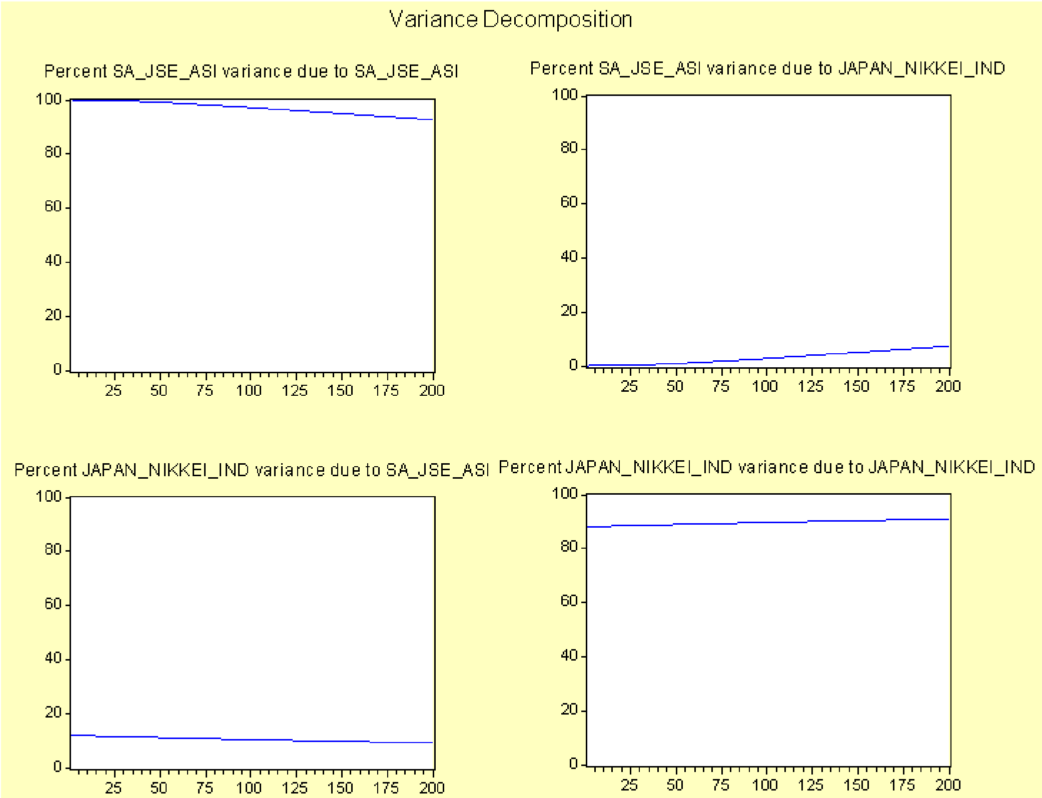
SA – India, BSE. Cholesky ordering SA – India



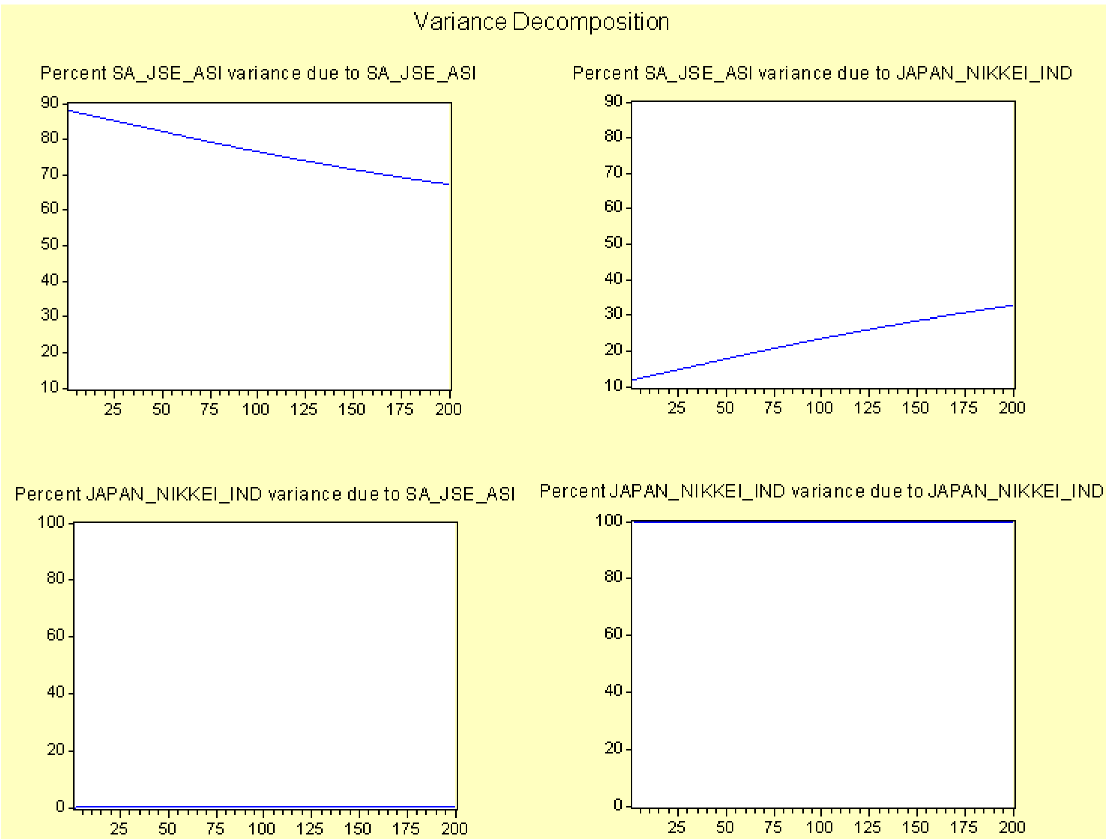
Cholesky ordering India – SA



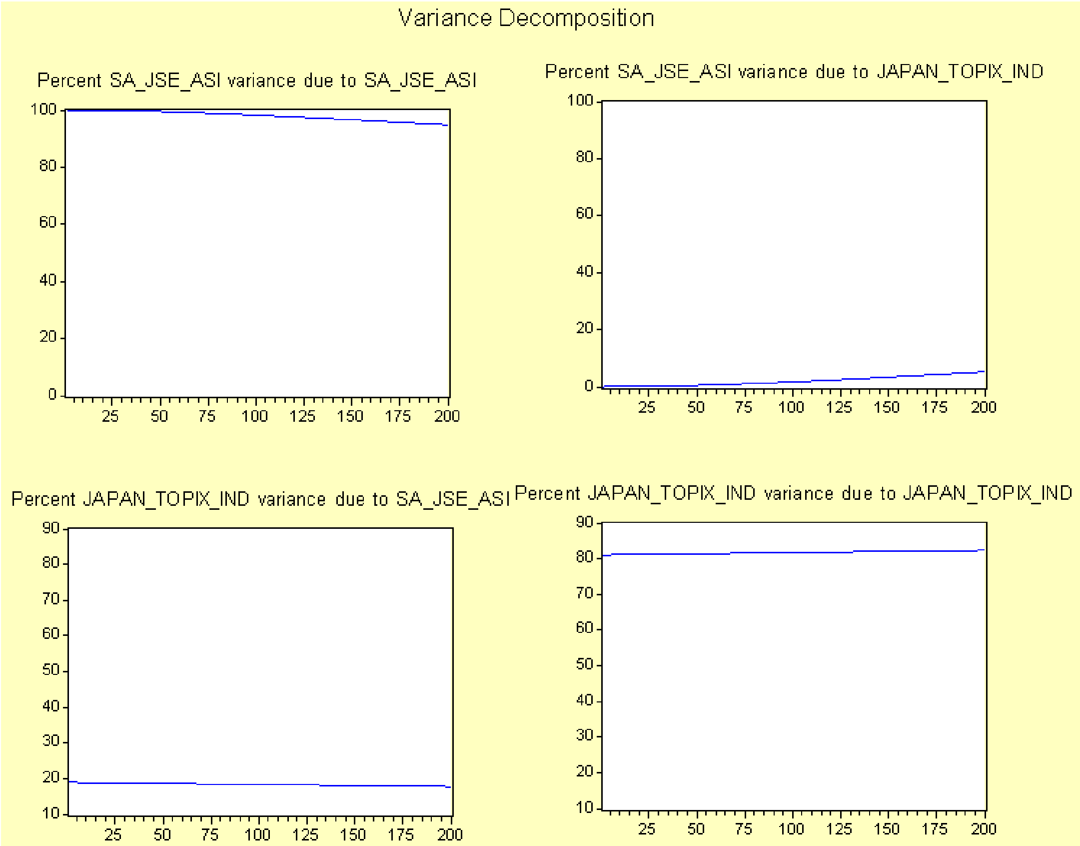
SA – Japan, Nikkei. Cholesky ordering SA – Japan.



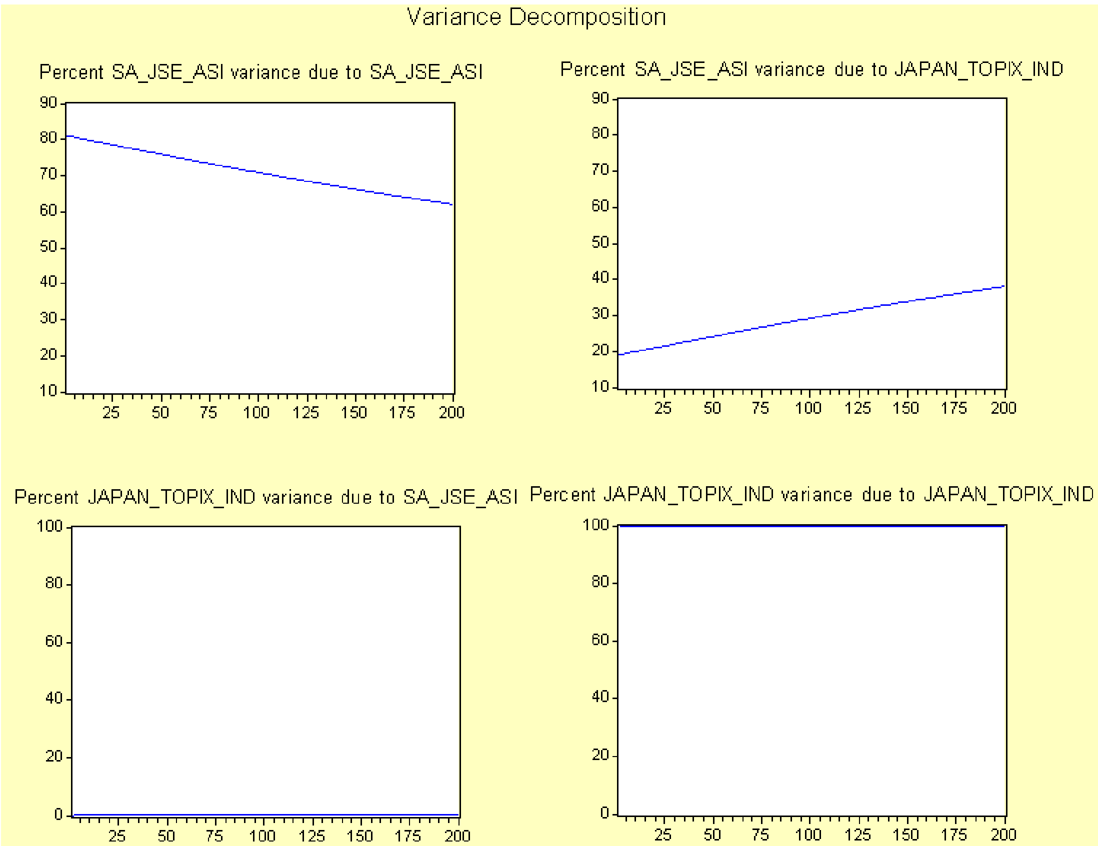
Cholesky ordering Japan – SA



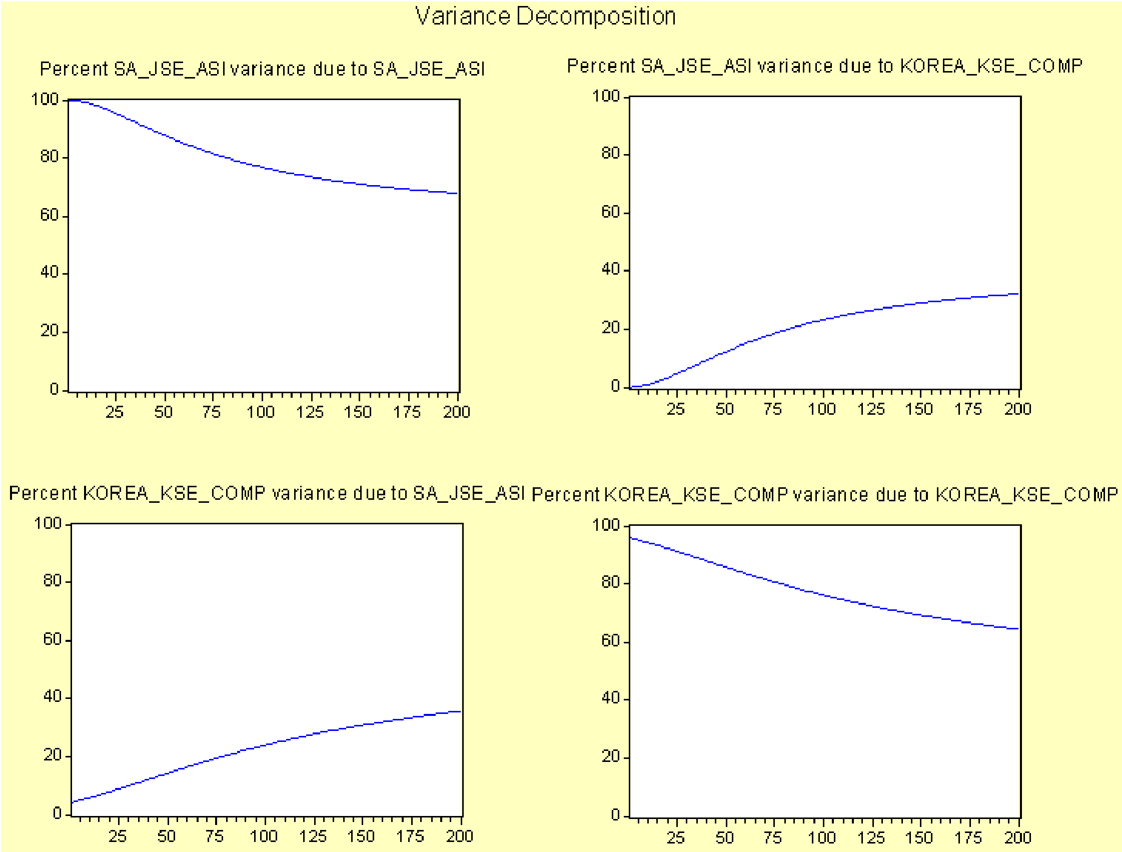
SA – Japan, Topix. Cholesky ordering SA – Japan



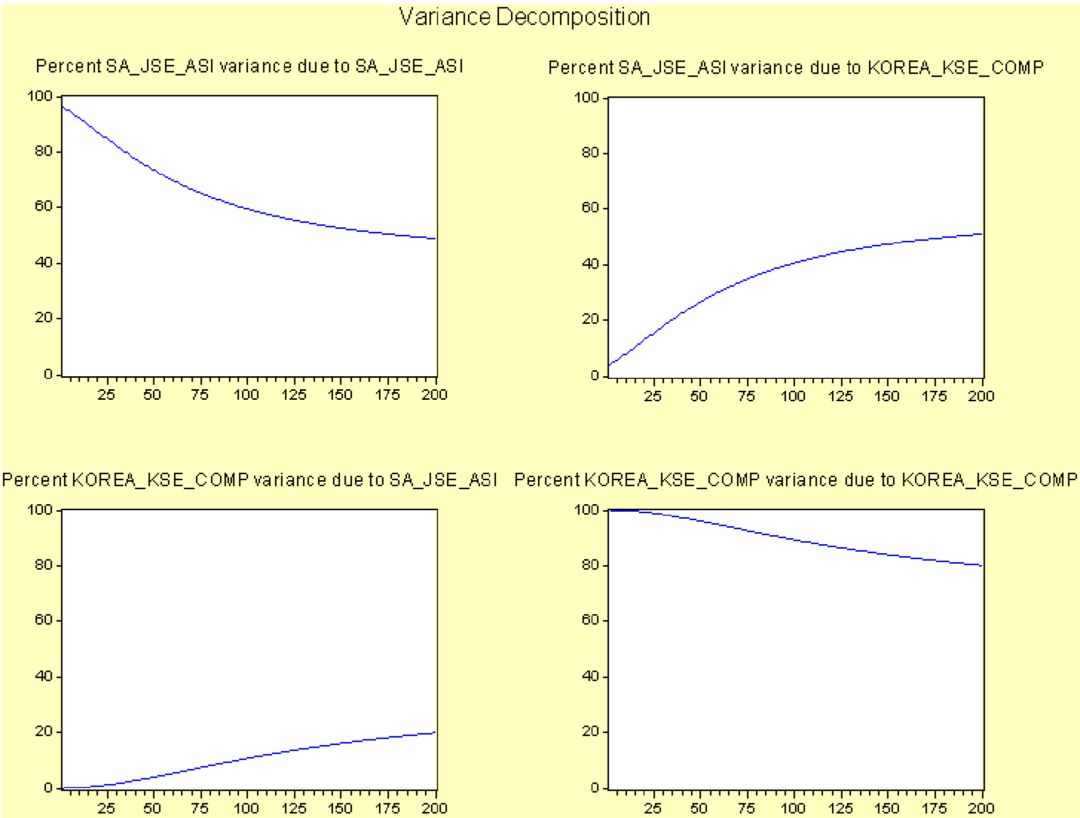
Cholesky ordering Japan – SA



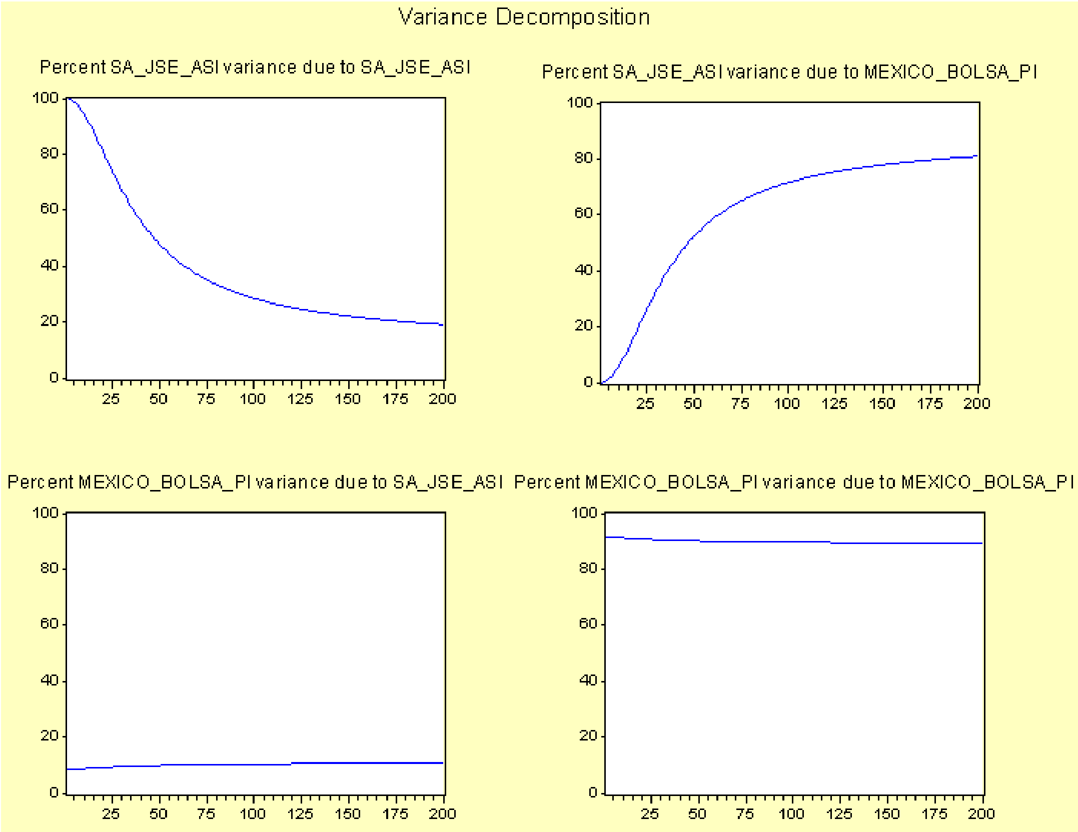
SA – Korea, KSE. Cholesky ordering SA – Korea



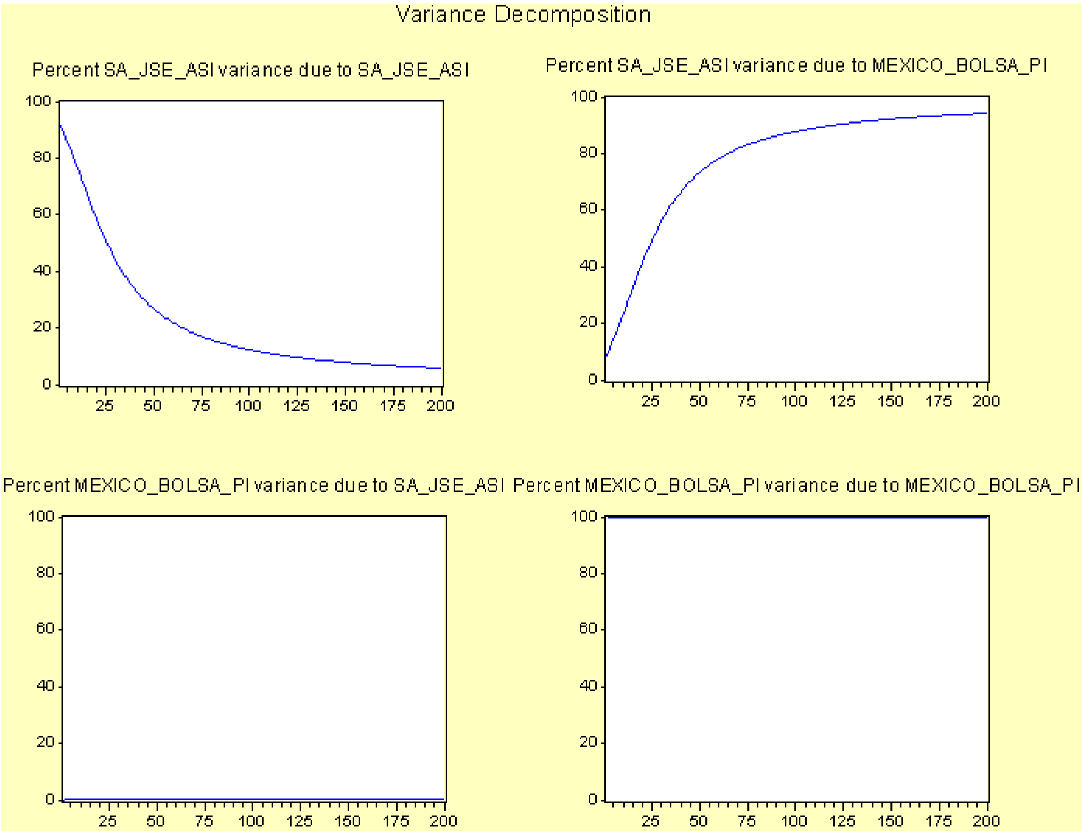
Cholesky ordering Korea – SA



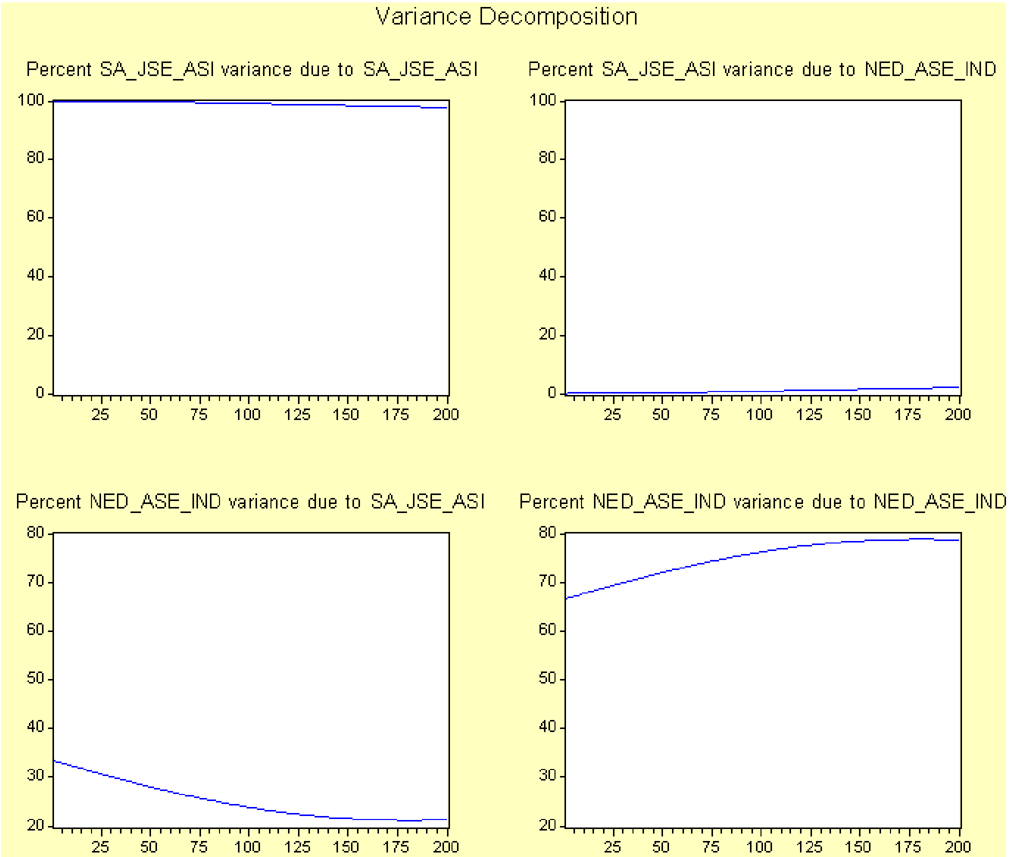
SA – Mexico, Bolsa. Cholesky ordering SA – Mexico



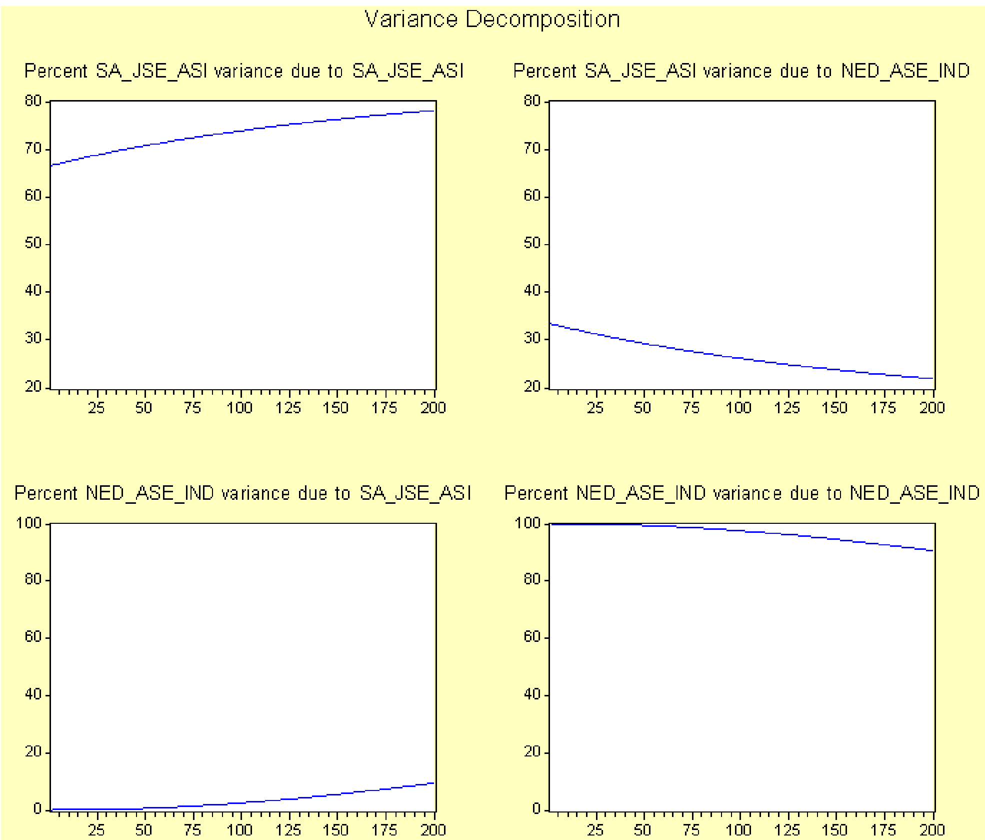
Cholesky ordering Mexico – SA



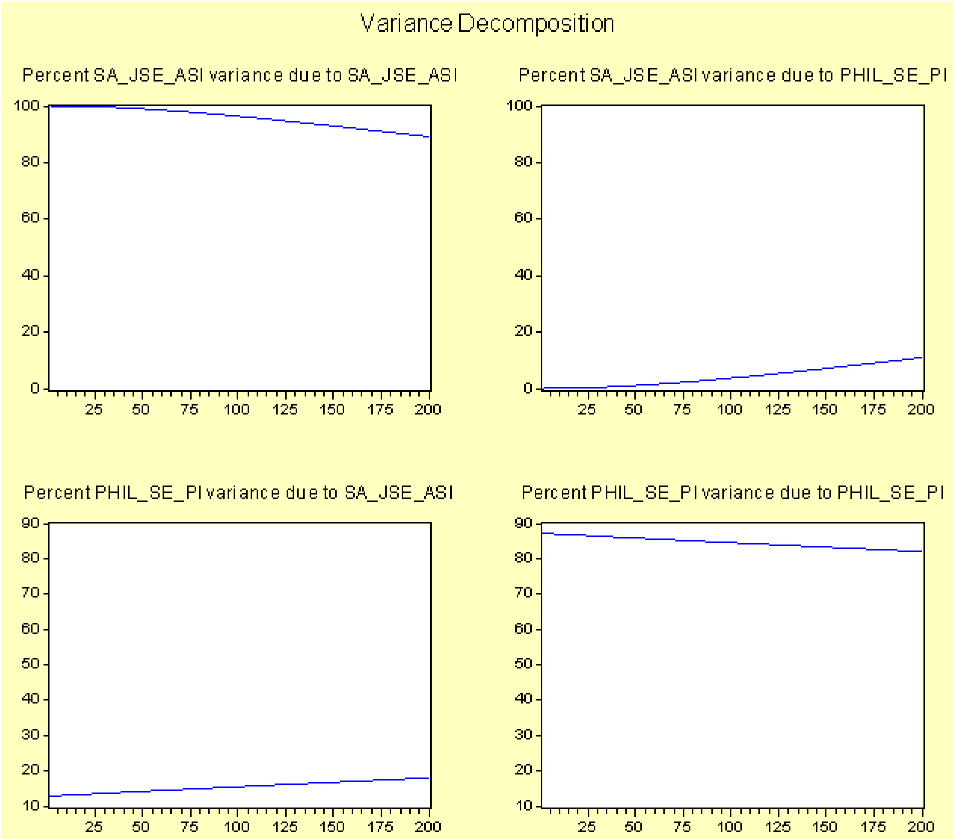
SA – Netherlands, ASE. Cholesky ordering SA – Netherlands



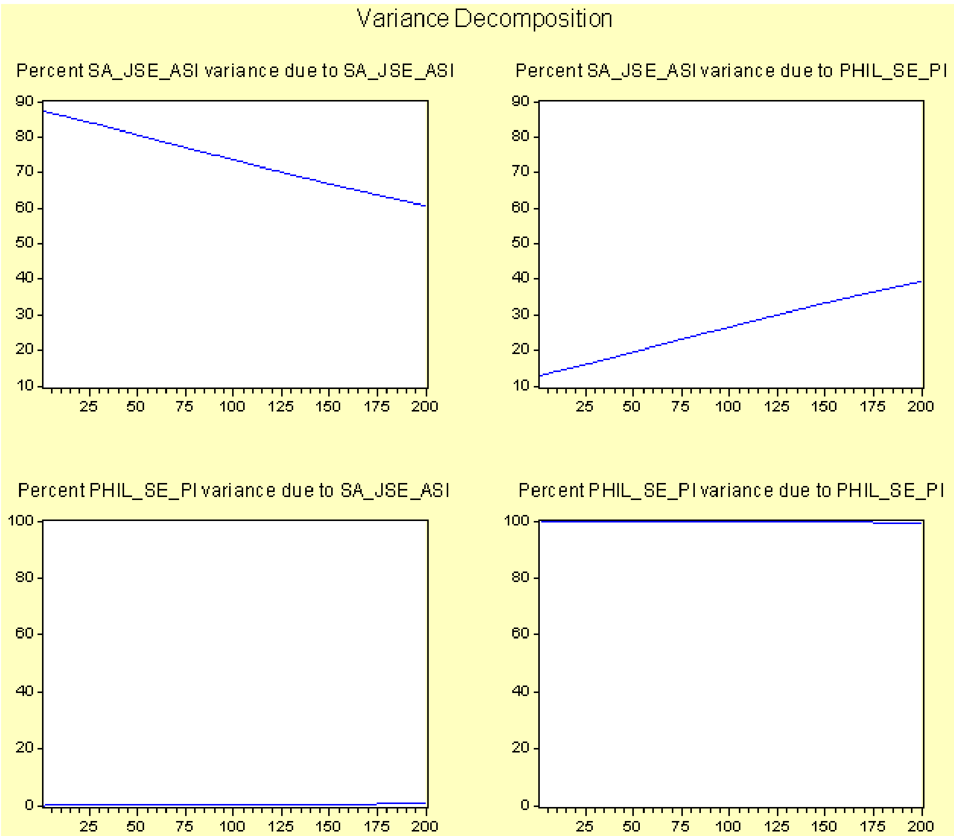
Cholesky ordering Netherlands – SA



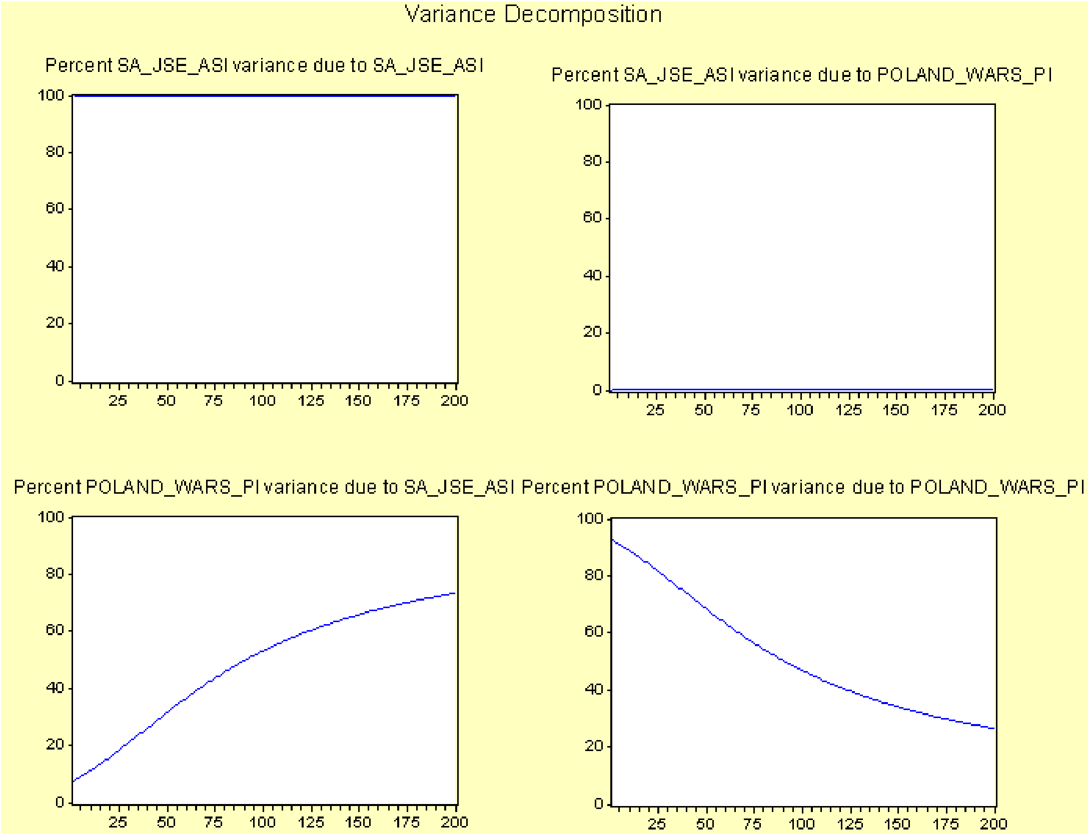
SA – Philippines, PSE. Cholesky ordering SA – Philippines



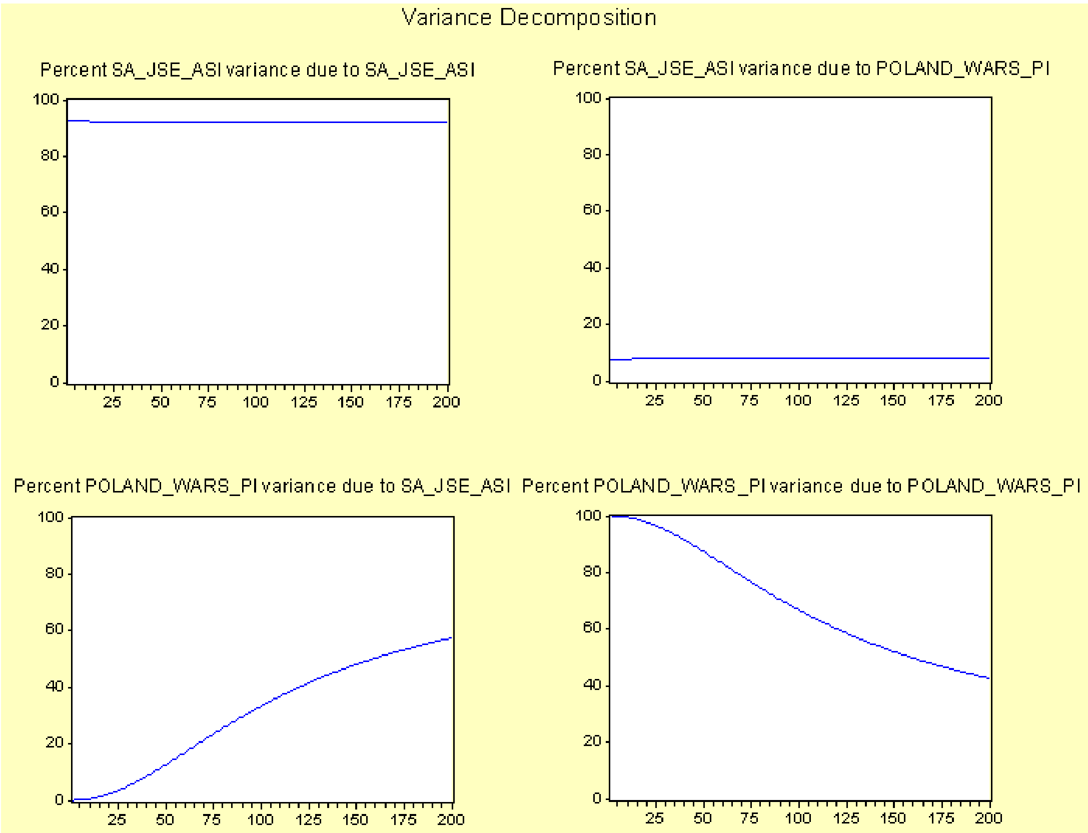
Cholesky ordering Philippines – SA



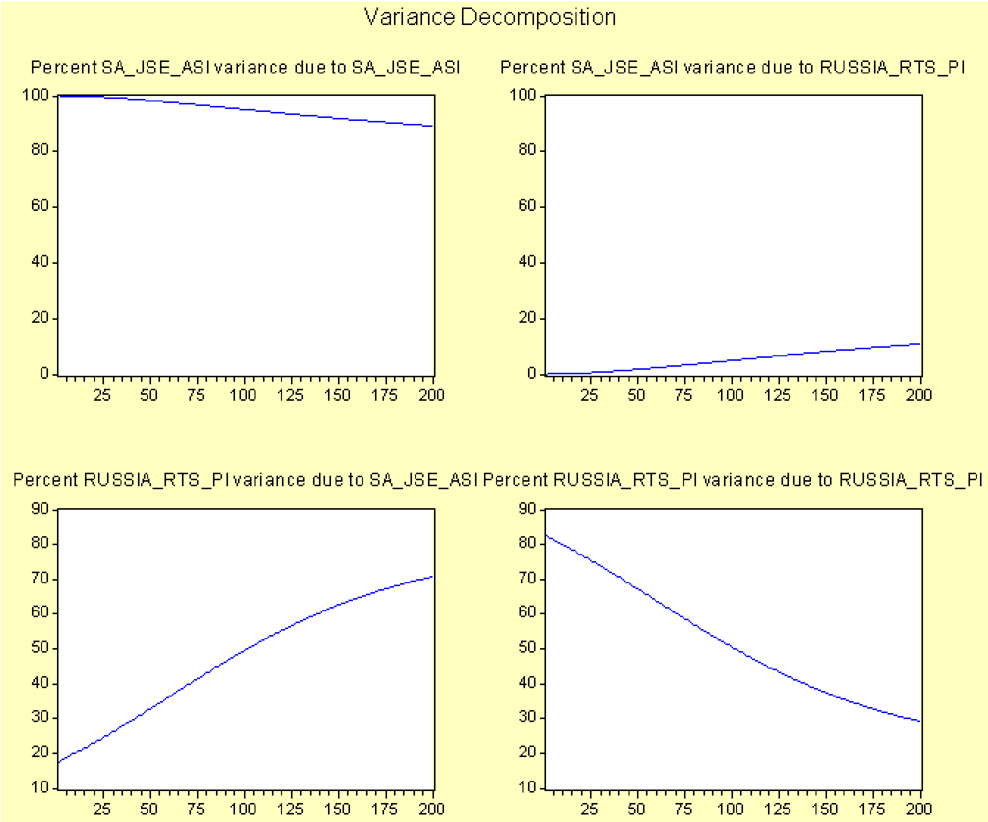
SA – Poland, Warsaw. Cholesky ordering SA – Poland



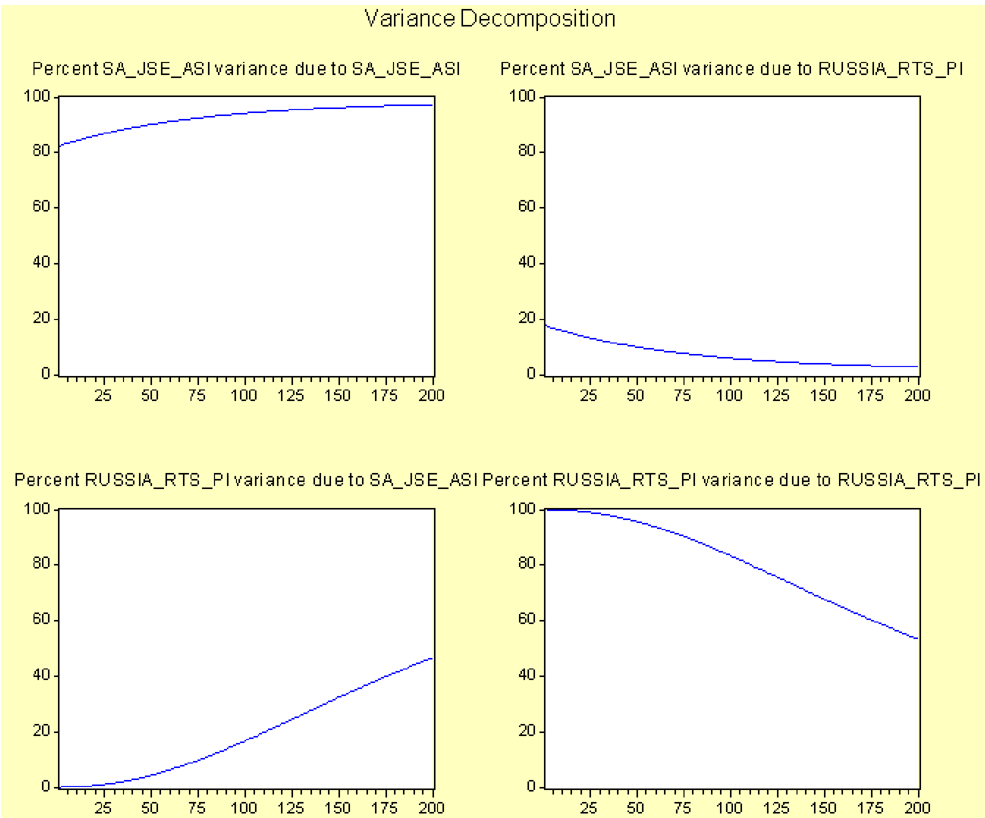
Cholesky ordering Poland – SA



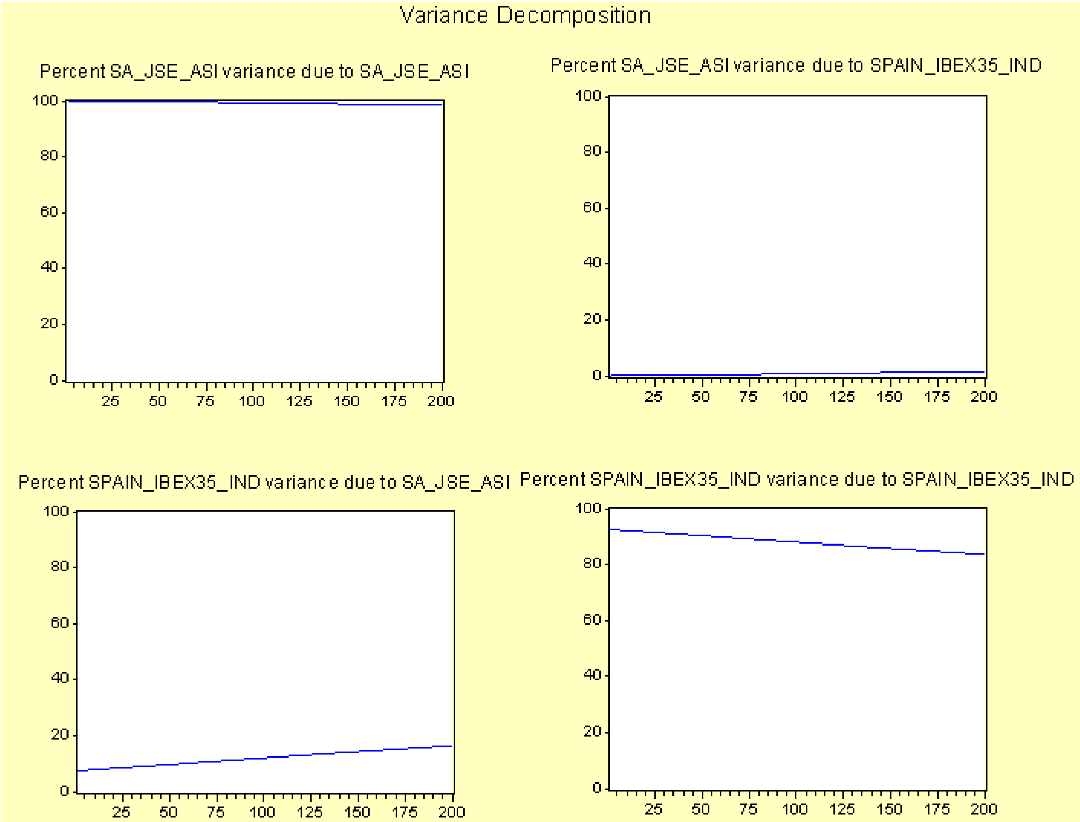
SA – Russia, RTS. Cholesky ordering SA – Russia



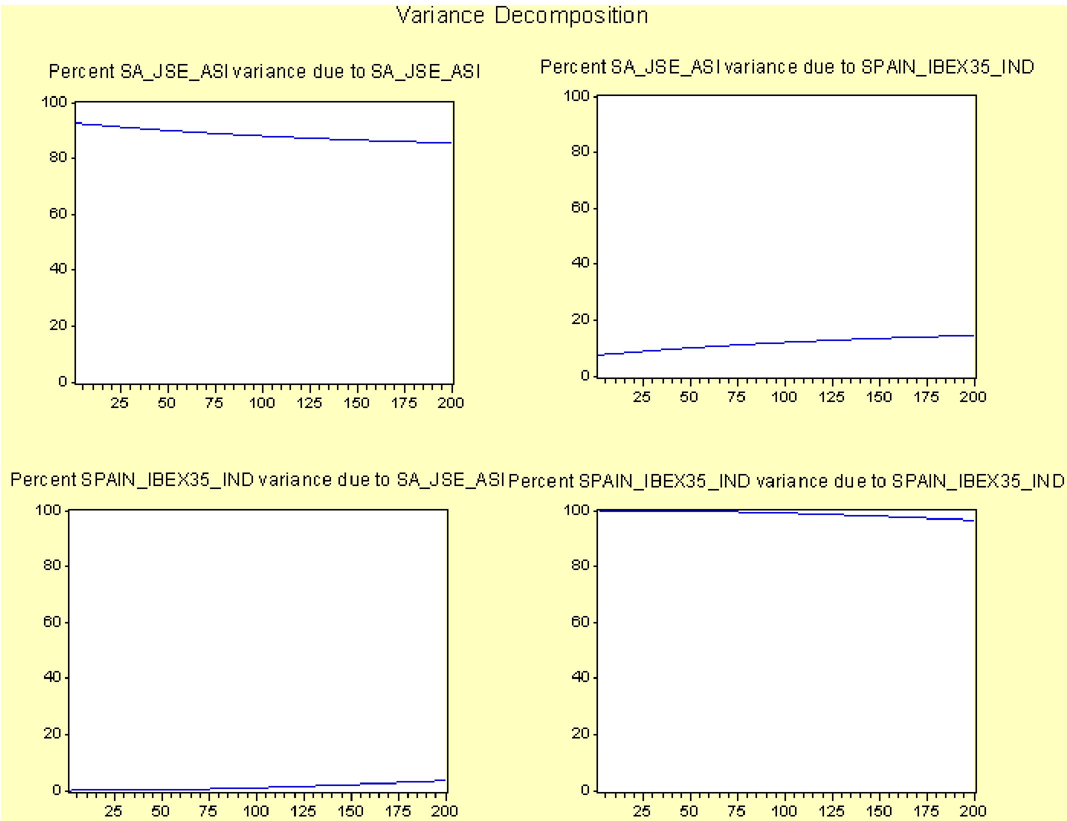
Cholesky ordering Russia – SA



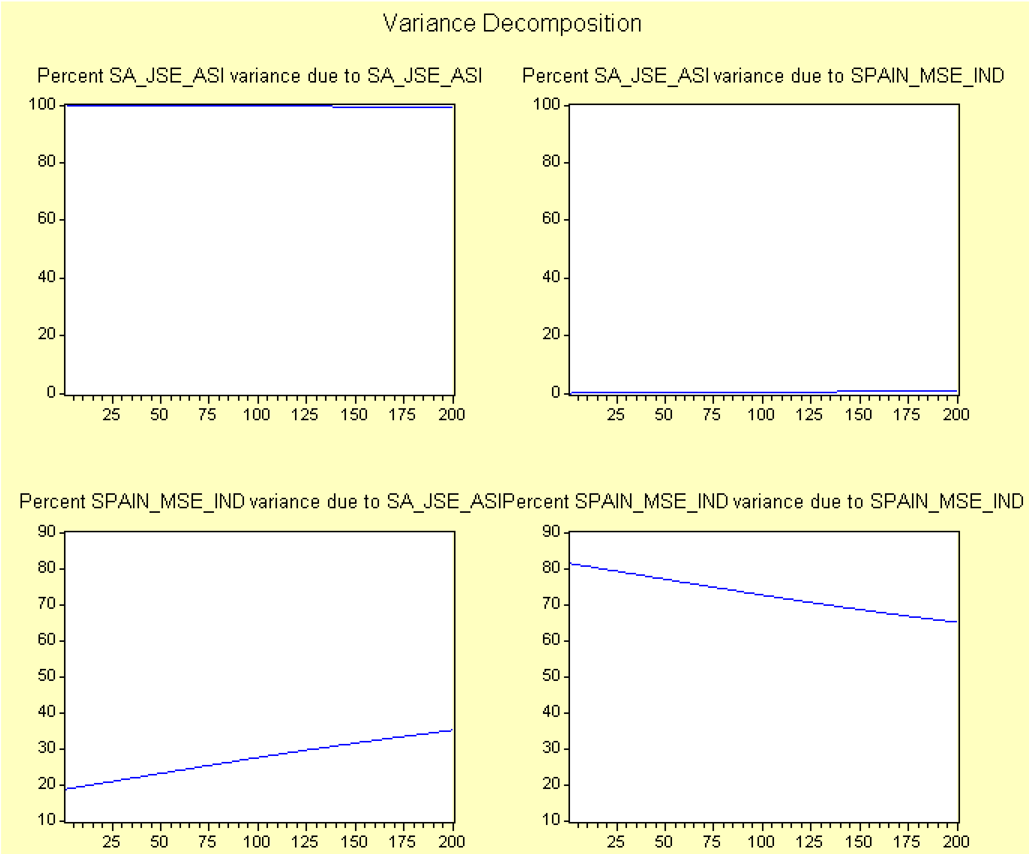
SA – Spain, Ibex35. Cholesky ordering SA – Spain



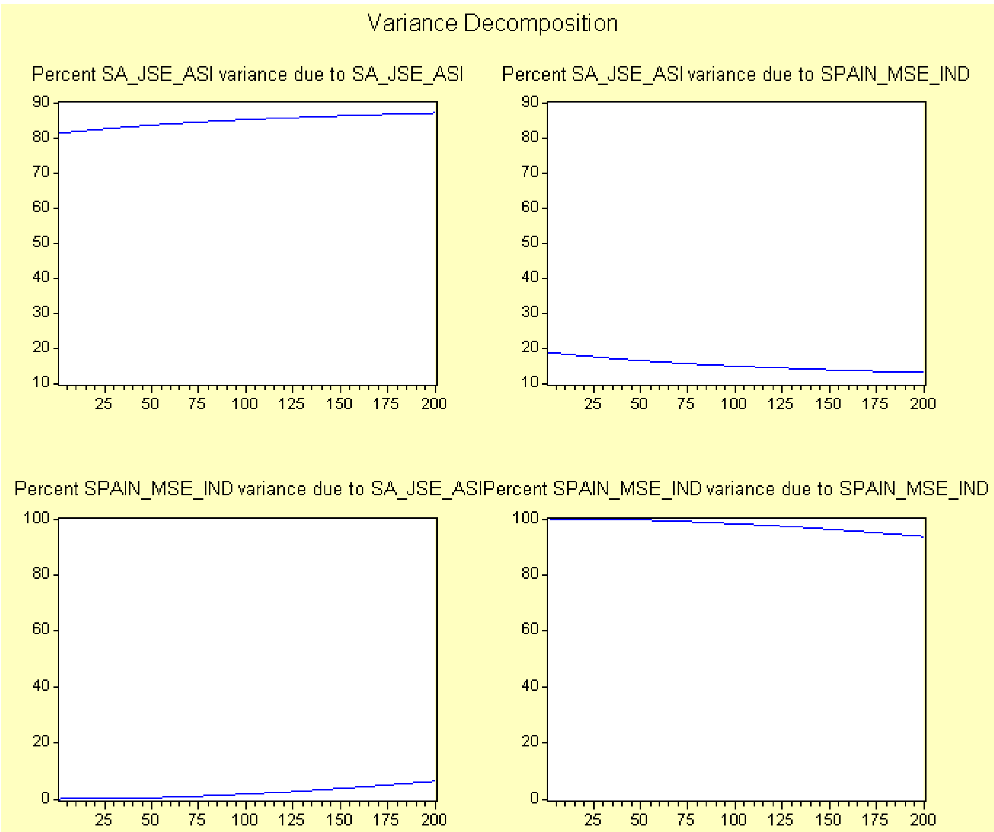
Cholesky ordering Spain – SA



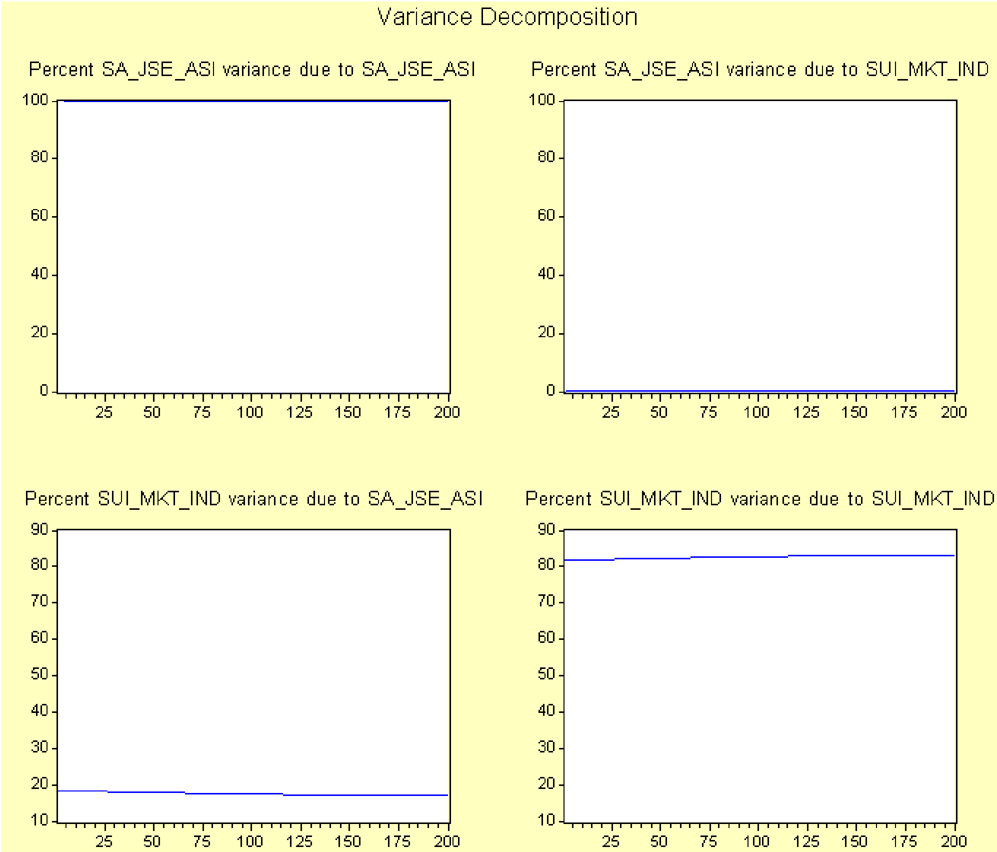
SA – Spain, MSE. Cholesky ordering SA – Spain



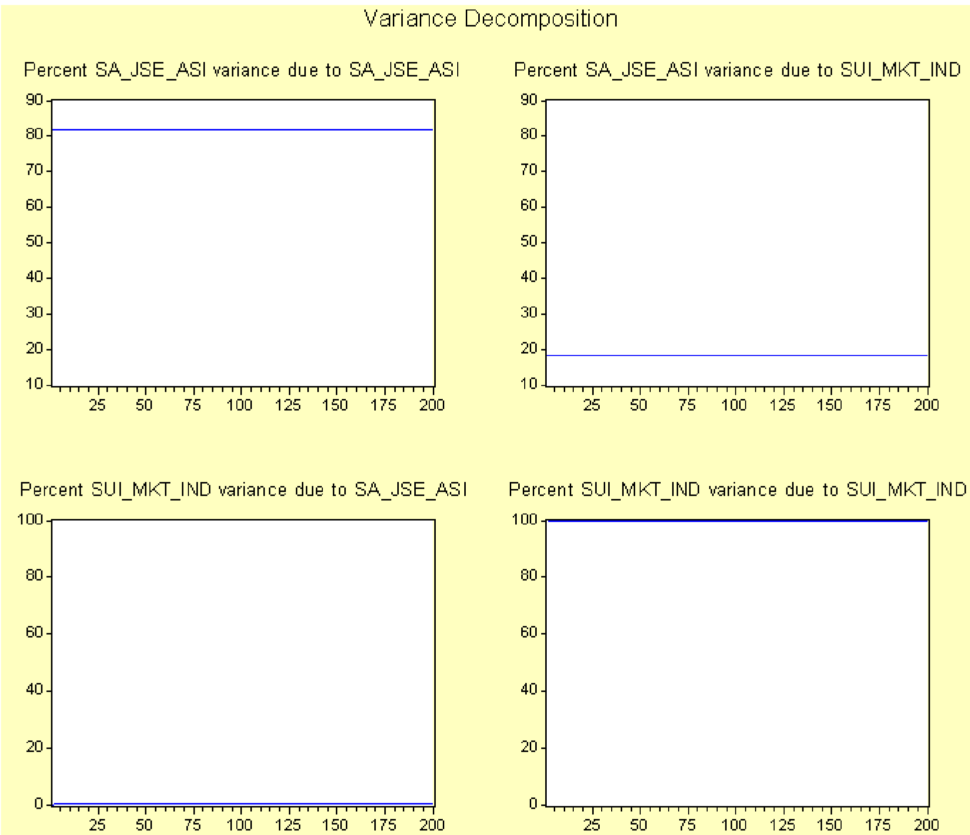
Cholesky ordering Spain – SA



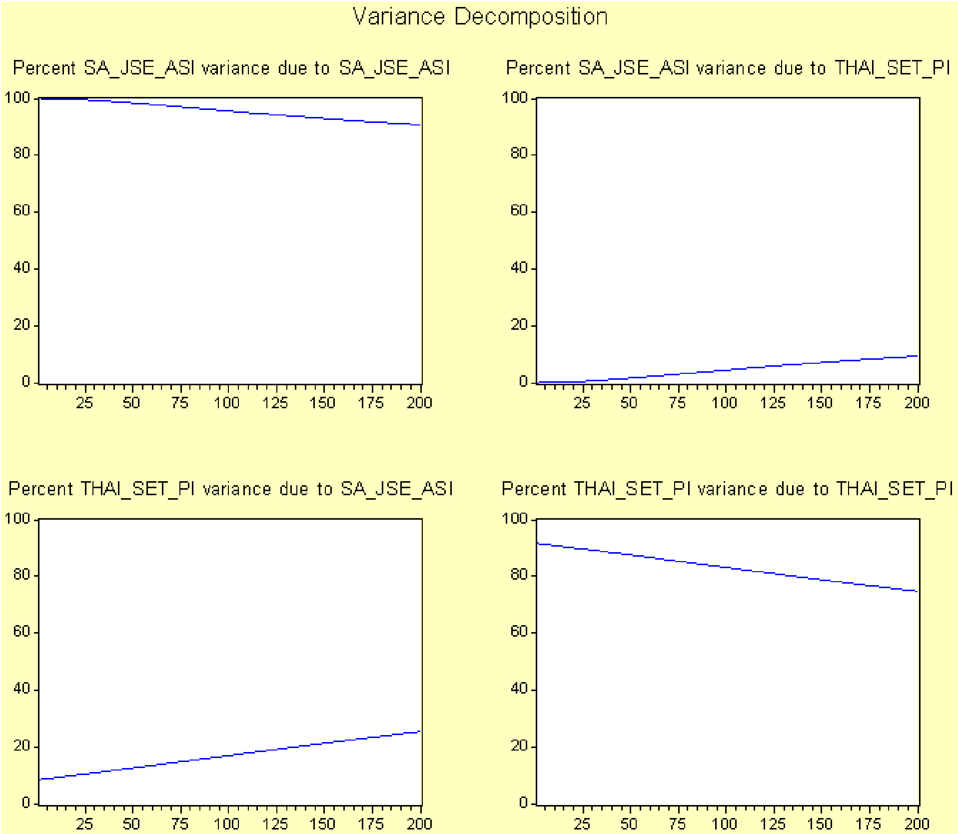
SA – Switzerland, SMkt. Cholesky ordering SA – Switzerland



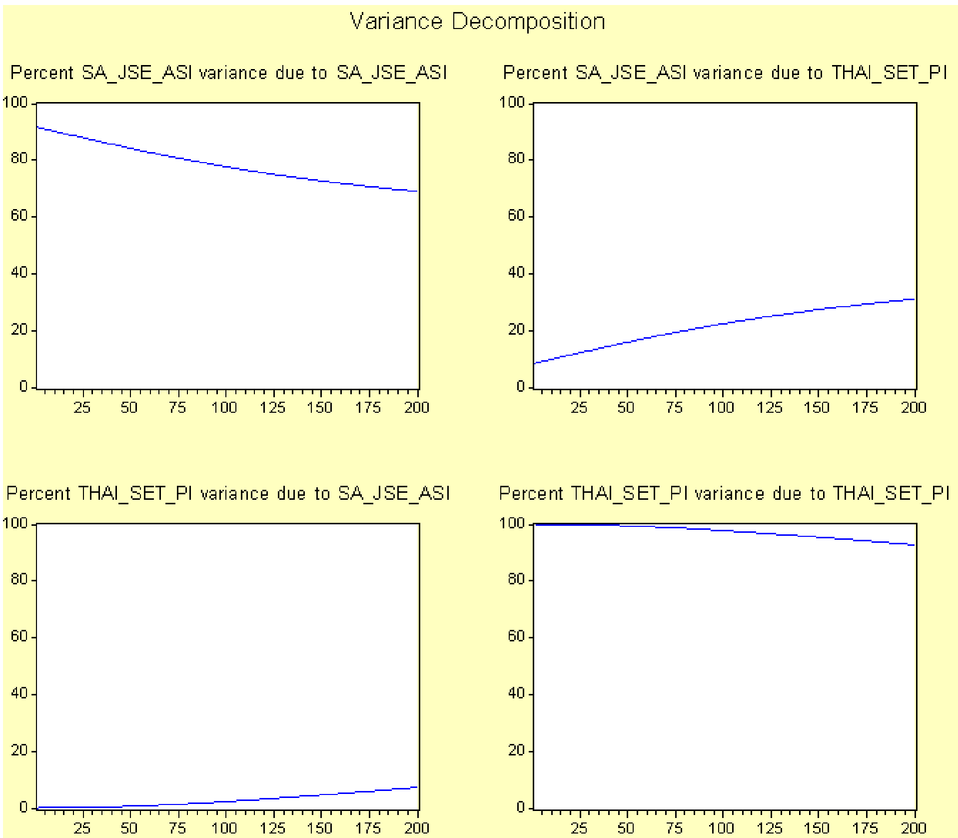
Cholesky ordering Switzerland – SA



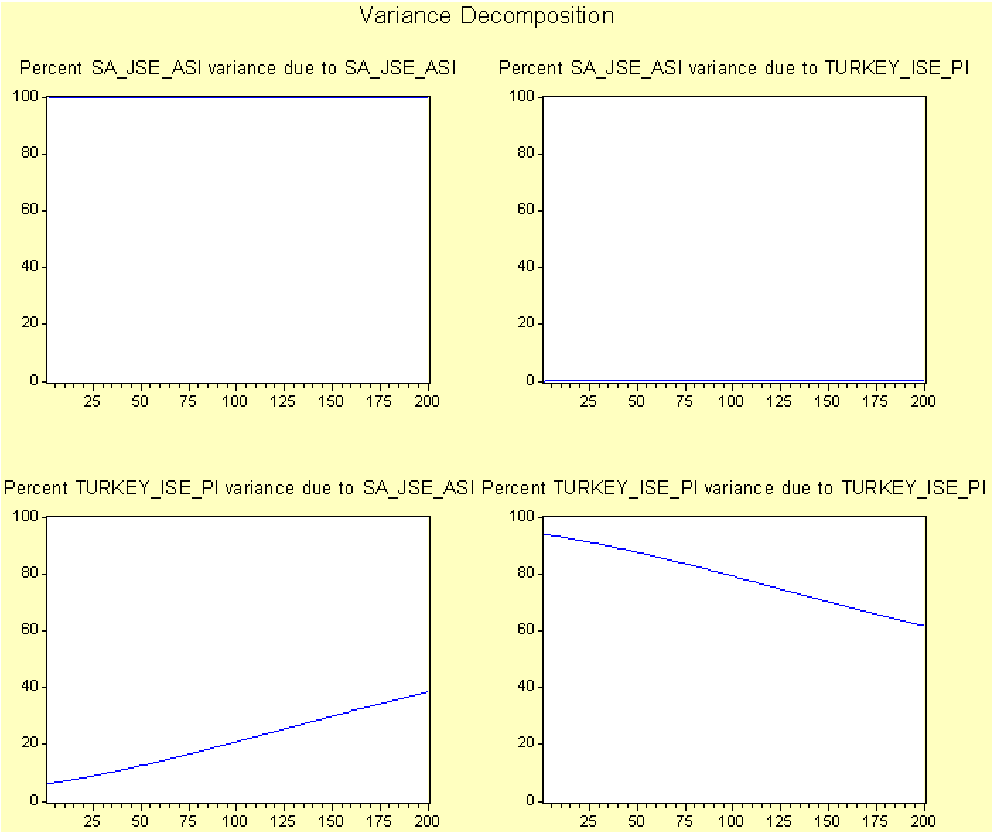
SA – Thailand, SET. Cholesky ordering SA – Thailand



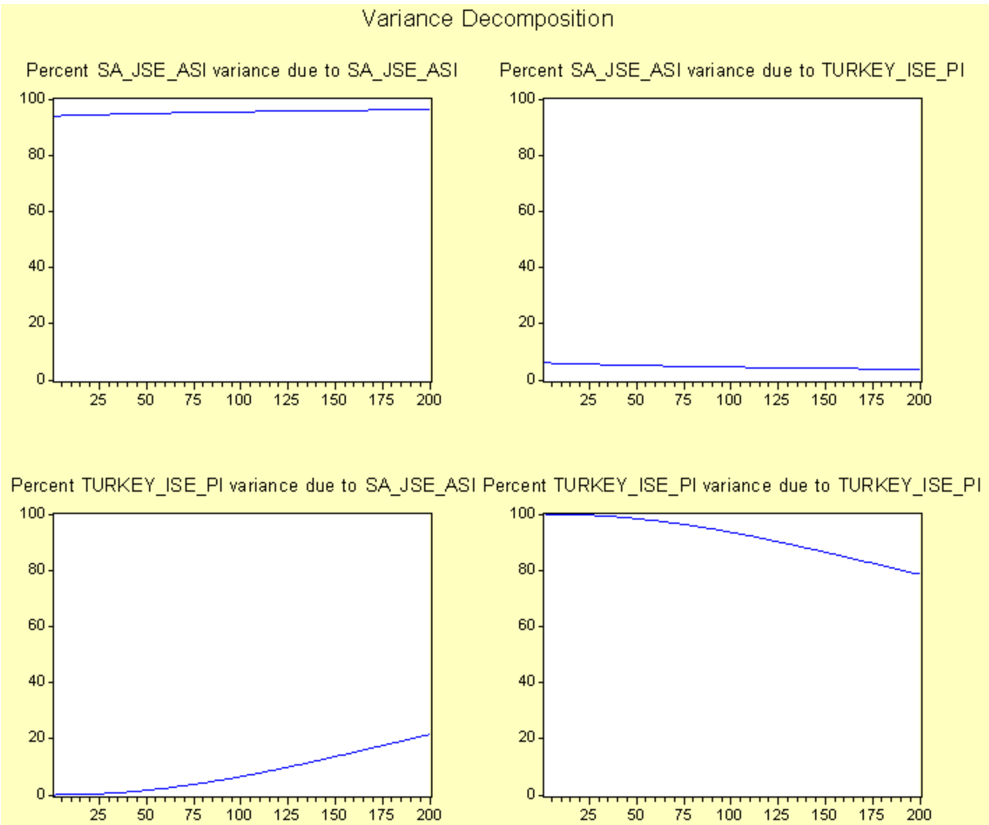
Cholesky ordering Thailand – SA



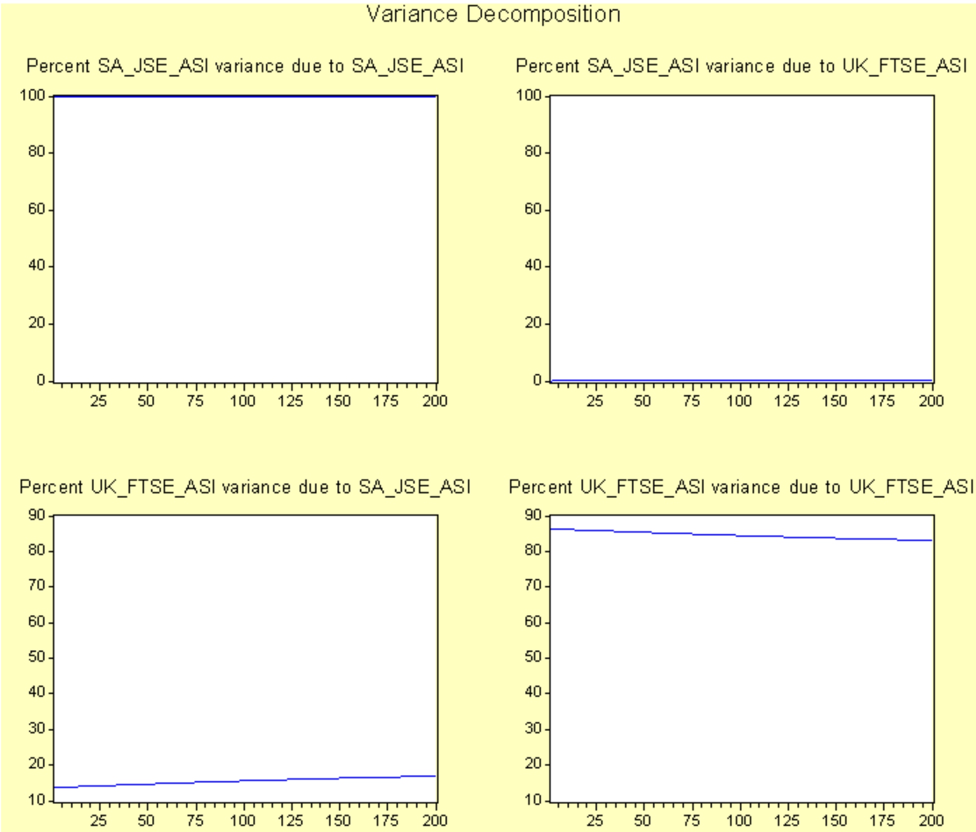
SA – Turkey, ISE. Cholesky ordering SA – Turkey



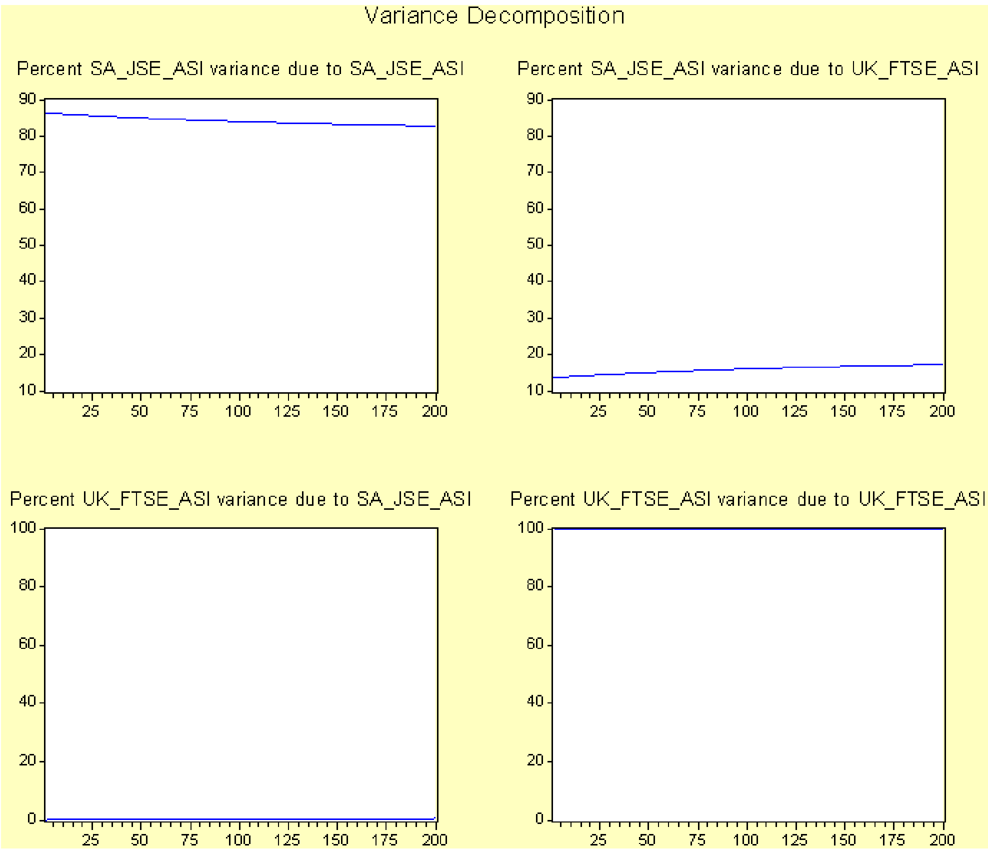
Cholesky ordering Turkey – SA



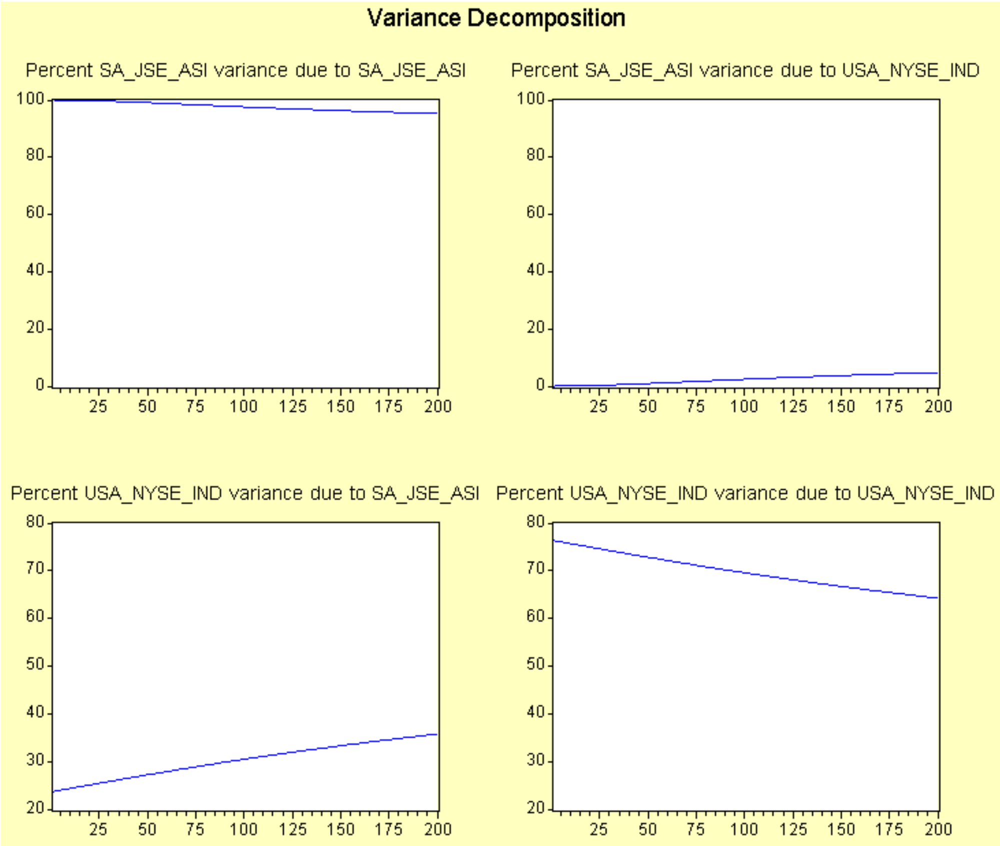
SA – UK, FTSE. Cholesky ordering SA – UK



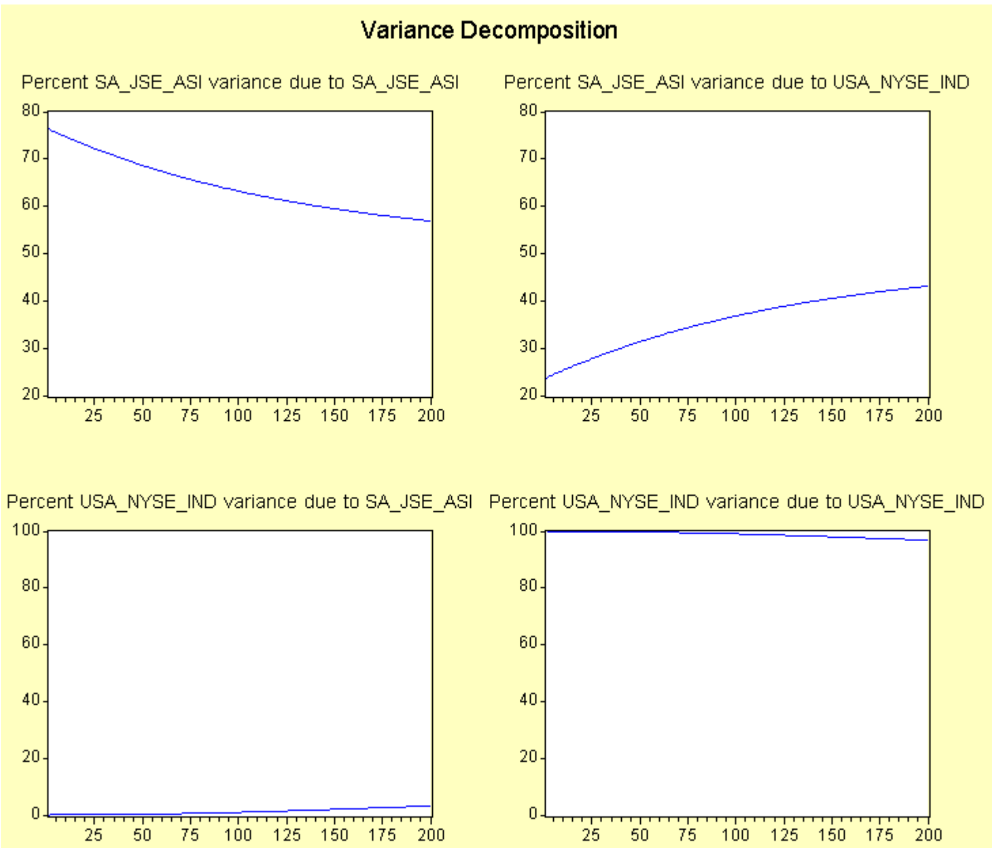
Cholesky ordering UK – SA



SA – USA, NYSE. Cholesky ordering SA – USA



Cholesky ordering USA – SA



Appendix L – Breusch-Godfrey LM test to see at what lag autocorrelation disappears

Portfolio A

VAR Residual Serial Correlation LM Tests
H0: no serial correlation at lag order h
Date: 12/15/10 Time: 09:17
Sample: 12/29/1995 4/16/2010
Included observations: 746

Lags	LM-Stat	Prob
1	43.72242	0.0002
2	61.36015	0.0000
3	45.41109	0.0001
4	18.80452	0.2789
5	19.62454	0.2376
6	36.95939	0.0021
7	27.00795	0.0414
8	20.08783	0.2163
9	26.52456	0.0471
10	27.01997	0.0413
11	26.28549	0.0501
12	21.38942	0.1640
13	24.06240	0.0882
14	21.52243	0.1593

Probs from chi-square with 16 df.

Portfolio B

VAR Residual Serial Correlation LM Tests
H0: no serial correlation at lag order h
Date: 12/15/10 Time: 09:19
Sample: 12/29/1995 4/16/2010
Included observations: 746

Lags	LM-Stat	Prob
1	20.76134	0.1879
2	23.04452	0.1125
3	13.57242	0.6305
4	23.89237	0.0919
5	28.70571	0.0260
6	28.26711	0.0294
7	36.44549	0.0025
8	15.23197	0.5077
9	24.54293	0.0783
10	17.84375	0.3331
11	32.68993	0.0081
12	16.21302	0.4382
13	26.77268	0.0441
14	36.21545	0.0027

Probs from chi-square with 16 df.

Portfolio C

VAR Residual Serial Correlation LM Tests
H0: no serial correlation at lag order h
Date: 12/15/10 Time: 09:23
Sample: 12/29/1995 4/16/2010
Included observations: 746

Lags	LM-Stat	Prob
1	174.5140	0.0000
2	24.04341	0.0886
3	24.91025	0.0714
4	9.941972	0.8696
5	17.07634	0.3807
6	41.71604	0.0004
7	42.65189	0.0003
8	20.80485	0.1861
9	21.34006	0.1658
10	18.55127	0.2926
11	22.29997	0.1338
12	25.66606	0.0589
13	36.20518	0.0027
14	15.19856	0.5101

Probs from chi-square with 16 df.

Portfolio D

VEC Residual Serial Correlation LM Tests
H0: no serial correlation at lag order h
Date: 12/15/10 Time: 09:25
Sample: 12/29/1995 4/16/2010
Included observations: 746

Lags	LM-Stat	Prob
1	71.47531	0.0004
2	87.64356	0.0000
3	66.90776	0.0013
4	55.26951	0.0210
5	56.96245	0.0145
6	64.46484	0.0025
7	60.65772	0.0062
8	52.31960	0.0386
9	59.43669	0.0083
10	65.73664	0.0018
11	49.43654	0.0672
12	43.68182	0.1774
13	42.08225	0.2243
14	40.66116	0.2726

Probs from chi-square with 36 df.

Portfolio E

VAR Residual Serial Correlation LM Tests
H0: no serial correlation at lag order h
Date: 12/15/10 Time: 09:28
Sample: 12/29/1995 4/16/2010
Included observations: 746

Lags	LM-Stat	Prob
1	179.6473	0.0000
2	70.12800	0.0006
3	45.31119	0.1374
4	45.47789	0.1338
5	53.18205	0.0324
6	44.80677	0.1490
7	63.04455	0.0035
8	46.76440	0.1080
9	52.78777	0.0351
10	41.67941	0.2374
11	62.42076	0.0041
12	38.24023	0.3681
13	45.02018	0.1440
14	64.60232	0.0024

Probs from chi-square with 36 df.

Portfolio F

VAR Residual Serial Correlation LM Tests
H0: no serial correlation at lag order h
Date: 12/15/10 Time: 09:31
Sample: 12/29/1995 4/16/2010
Included observations: 746

Lags	LM-Stat	Prob
1	73.40079	0.0002
2	84.63591	0.0000
3	66.57843	0.0014
4	31.78172	0.6695
5	48.56925	0.0787
6	78.17988	0.0001
7	66.41466	0.0015
8	36.21419	0.4587
9	36.93172	0.4257
10	56.90710	0.0147
11	61.90967	0.0046
12	34.43620	0.5430
13	58.32518	0.0107
14	40.25630	0.2874

Probs from chi-square with 36 df.

Portfolio G

VAR Residual Serial Correlation LM Tests
H0: no serial correlation at lag order h
Date: 12/15/10 Time: 09:34
Sample: 12/29/1995 4/16/2010
Included observations: 746

Lags	LM-Stat	Prob
1	156.8225	0.0000
2	175.0263	0.0000
3	114.7930	0.0001
4	92.41127	0.0116
5	93.76626	0.0090
6	104.0683	0.0011
7	118.7850	0.0000
8	78.70914	0.1020
9	86.78040	0.0306
10	123.1246	0.0000
11	90.69706	0.0157
12	62.57579	0.5270
13	85.90206	0.0353
14	63.29586	0.5014

Probs from chi-square with 64 df.

Portfolio H

VAR Residual Serial Correlation LM Tests
H0: no serial correlation at lag order h
Date: 12/15/10 Time: 09:37
Sample: 12/29/1995 4/16/2010
Included observations: 746

Lags	LM-Stat	Prob
1	115.4504	0.0001
2	109.9561	0.0003
3	101.6784	0.0019
4	75.85594	0.1474
5	79.34497	0.0936
6	85.88967	0.0354
7	108.8499	0.0004
8	67.85101	0.3474
9	88.96226	0.0213
10	66.68400	0.3849
11	92.52795	0.0113
12	78.91039	0.0993
13	71.01543	0.2555
14	88.63530	0.0225

Probs from chi-square with 64 df.

Portfolio I

VAR Residual Serial Correlation LM Tests
H0: no serial correlation at lag order h
Date: 12/15/10 Time: 09:39
Sample: 12/29/1995 4/16/2010
Included observations: 746

Lags	LM-Stat	Prob
1	535.8606	0.0000
2	133.4987	0.0000
3	117.8467	0.0000
4	85.11763	0.0400
5	101.0670	0.0022
6	139.9369	0.0000
7	88.58100	0.0227
8	90.29076	0.0169
9	77.63716	0.1176
10	84.29270	0.0455
11	85.27233	0.0390
12	78.45607	0.1056
13	88.09724	0.0246
14	70.06635	0.2814

Probs from chi-square with 64 df.

Appendix M – optimal lag lengths as selected by the various information criteria

Portfolio A

VAR Lag Order Selection Criteria
Endogenous variables: USA_NYSE_IND UK_FTSE_ASI SA_JSE_ASI GERMANY_DAX30_PI
Exogenous variables: C
Date: 12/15/10 Time: 09:17
Sample: 12/29/1995 4/16/2010
Included observations: 733

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1163.484	NA	4.97e-07	-3.163667	-3.138581	-3.153991
1	6774.209	11144.90	1.17e-13	-18.42895	-18.30351	-18.38056
2	6956.078	359.2719	7.41e-14	-18.88152	-18.65574*	-18.79443*
3	6980.902	48.76743	7.24e-14	-18.90560	-18.57947	-18.77980
4	7005.979	48.99108	7.06e-14	-18.93037	-18.50389	-18.76586
5	7025.391	37.71154	6.99e-14	-18.93968	-18.41285	-18.73646
6	7032.392	13.52386	7.17e-14	-18.91512	-18.28795	-18.67320
7	7057.478	48.18825	6.99e-14*	-18.93991*	-18.21240	-18.65929
8	7068.804	21.63254	7.08e-14	-18.92716	-18.09930	-18.60783
9	7075.827	13.33692	7.26e-14	-18.90267	-17.97446	-18.54463
10	7087.402	21.85359	7.35e-14	-18.89059	-17.86203	-18.49384
11	7102.839	28.97993*	7.36e-14	-18.88906	-17.76015	-18.45360
12	7114.436	21.64228	7.45e-14	-18.87704	-17.64779	-18.40288
13	7124.423	18.53002	7.58e-14	-18.86064	-17.53104	-18.34776
14	7134.329	18.27163	7.71e-14	-18.84401	-17.41406	-18.29243

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

Portfolio B

VAR Lag Order Selection Criteria
Endogenous variables: SA_JSE_ASI AUS_ASX_ASI HK_HANGSENG_IND JAPAN_NIKKEI_IND
Exogenous variables: C
Date: 12/15/10 Time: 09:18
Sample: 12/29/1995 4/16/2010
Included observations: 733

Lag	LogL	LR	FPE	AIC	SC	HQ
0	449.1283	NA	3.49e-06	-1.214538	-1.189452	-1.204862
1	6568.859	12155.97	2.04e-13	-17.86865	-17.74321*	-17.82026
2	6610.122	81.51336	1.91e-13*	-17.93758*	-17.71180	-17.85049*
3	6620.155	19.70967	1.94e-13	-17.92130	-17.59517	-17.79550
4	6628.145	15.61028	1.98e-13	-17.89944	-17.47297	-17.73494
5	6642.574	28.03054	1.99e-13	-17.89515	-17.36833	-17.69194
6	6659.012	31.75465	1.99e-13	-17.89635	-17.26918	-17.65443
7	6671.780	24.52595	2.00e-13	-17.88753	-17.16001	-17.60690
8	6690.463	35.68373	1.99e-13	-17.89485	-17.06699	-17.57552
9	6696.866	12.15953	2.04e-13	-17.86867	-16.94046	-17.51062
10	6707.696	20.44881	2.07e-13	-17.85456	-16.82600	-17.45781
11	6717.491	18.38661	2.11e-13	-17.83763	-16.70872	-17.40217
12	6732.751	28.48011	2.11e-13	-17.83561	-16.60636	-17.36145
13	6740.603	14.56946	2.16e-13	-17.81338	-16.48378	-17.30051
14	6758.560	33.12132*	2.15e-13	-17.81872	-16.38877	-17.26714

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

Portfolio C

VAR Lag Order Selection Criteria
Endogenous variables: SA_JSE_ASI CANADA_TSI_PI CHINA_SHANG_ASI FRANCE_CAC40_PI
Exogenous variables: C
Date: 12/15/10 Time: 09:21
Sample: 12/29/1995 4/16/2010
Included observations: 733

Lag	LogL	LR	FPE	AIC	SC	HQ
0	121.5065	NA	8.53e-06	-0.320618	-0.295531	-0.310941
1	6317.955	12308.36	4.05e-13	-17.18405	-17.05862	-17.13567
2	6404.961	171.8747	3.33e-13*	-17.37779*	-17.15201*	-17.29070*
3	6415.118	19.95512	3.39e-13	-17.36185	-17.03572	-17.23605
4	6431.207	31.43126	3.39e-13	-17.36209	-16.93562	-17.19759
5	6437.973	13.14367	3.47e-13	-17.33690	-16.81008	-17.13368
6	6445.823	15.16404	3.55e-13	-17.31466	-16.68749	-17.07274
7	6464.070	35.05121	3.53e-13	-17.32079	-16.59328	-17.04016
8	6485.280	40.50958	3.48e-13	-17.33501	-16.50714	-17.01567
9	6495.727	19.84003	3.53e-13	-17.31986	-16.39165	-16.96181
10	6507.548	22.31951	3.58e-13	-17.30845	-16.27990	-16.91170
11	6515.949	15.77092	3.65e-13	-17.28772	-16.15882	-16.85226
12	6525.300	17.45095	3.72e-13	-17.26958	-16.04033	-16.79541
13	6543.844	34.40605*	3.69e-13	-17.27652	-15.94692	-16.76365
14	6557.221	24.67383	3.72e-13	-17.26936	-15.83942	-16.71778

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

Portfolio D

VAR Lag Order Selection Criteria
Endogenous variables: SA_JSE_ASI USA_NYSE_IND UK_FTSE_ASI GERMANY_DAX30_PI EGYPT_CAIRO_INDEX JAPAN_NIKKEI_IND
Exogenous variables: C
Date: 12/15/10 Time: 09:24
Sample: 12/29/1995 4/16/2010
Included observations: 733

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1075.161	NA	2.18e-09	-2.917219	-2.879589	-2.902704
1	9768.601	17220.84	1.20e-19	-26.53916	-26.27575	-26.43755
2	9965.065	385.9604	7.75e-20	-26.97699	-26.48779*	-26.78829*
3	10004.15	76.13815	7.68e-20	-26.98540	-26.27042	-26.70961
4	10044.12	77.21817	7.60e-20	-26.99623	-26.05548	-26.63335
5	10081.79	72.14997	7.57e-20*	-27.00079*	-25.83425	-26.55081
6	10104.30	42.75092	7.85e-20	-26.96398	-25.57167	-26.42692
7	10148.59	83.37969	7.68e-20	-26.98660	-25.36850	-26.36244
8	10176.53	52.14181	7.85e-20	-26.96460	-25.12072	-26.25336
9	10202.41	47.88812	8.08e-20	-26.93701	-24.86735	-26.13867
10	10227.53	46.04990	8.33e-20	-26.90731	-24.61187	-26.02188
11	10261.61	61.93639*	8.38e-20	-26.90208	-24.38086	-25.92956
12	10287.04	45.78797	8.63e-20	-26.87323	-24.12623	-25.81362
13	10308.69	38.64450	8.98e-20	-26.83409	-23.86131	-25.68739
14	10336.26	48.74547	9.20e-20	-26.81109	-23.61253	-25.57729

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

Portfolio E

VAR Lag Order Selection Criteria
Endogenous variables: SA_JSE_ASI AUS_ASX_ASI HK_HANGSENG_IND JAPAN_NIKKEI_IND PHIL_SE_PI ARG_MERVAL_IND
Exogenous variables: C
Date: 12/15/10 Time: 09:27
Sample: 12/29/1995 4/16/2010
Included observations: 733

Lag	LogL	LR	FPE	AIC	SC	HQ
0	583.5202	NA	8.33e-09	-1.575771	-1.538141	-1.561256
1	9240.476	17148.57	5.07e-19	-25.09816	-24.83475*	-24.99655
2	9330.189	176.2448	4.38e-19*	-25.24472*	-24.75553	-25.05602*
3	9364.942	67.70494	4.40e-19	-25.24132	-24.52634	-24.96553
4	9387.535	43.64403	4.56e-19	-25.20473	-24.26398	-24.84185
5	9410.601	44.18063	4.72e-19	-25.16944	-24.00291	-24.71947
6	9437.544	51.16668	4.84e-19	-25.14473	-23.75242	-24.60767
7	9460.783	43.75097	5.02e-19	-25.10991	-23.49182	-24.48576
8	9493.659	61.35629	5.06e-19	-25.10139	-23.25751	-24.39014
9	9514.154	37.91439	5.28e-19	-25.05908	-22.98943	-24.26075
10	9539.793	47.01046	5.44e-19	-25.03081	-22.73538	-24.14538
11	9559.554	35.90937	5.69e-19	-24.98650	-22.46529	-24.01398
12	9592.607	59.52232*	5.74e-19	-24.97846	-22.23146	-23.91885
13	9612.880	36.17766	6.00e-19	-24.93555	-21.96277	-23.78885
14	9638.331	44.99865	6.18e-19	-24.90677	-21.70821	-23.67298

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

Portfolio F

VAR Lag Order Selection Criteria
Endogenous variables: SA_JSE_ASI CANADA_TSI_PI CHINA_SHANG_ASI FRANCE_CAC40_PI SUI_MKT_IND RUSSIA_RTS_PI
Exogenous variables: C
Date: 12/15/10 Time: 09:30
Sample: 12/29/1995 4/16/2010
Included observations: 733

Lag	LogL	LR	FPE	AIC	SC	HQ
0	625.5585	NA	7.43e-09	-1.690473	-1.652843	-1.675958
1	9114.417	16815.58	7.15e-19	-24.75421	-24.49080	-24.65260
2	9295.115	354.9858	4.82e-19	-25.14902	-24.65983*	-24.96032*
3	9336.196	80.03242	4.75e-19	-25.16288	-24.44791	-24.88709
4	9374.767	74.51023	4.72e-19*	-25.16990*	-24.22914	-24.80702
5	9395.331	39.38875	4.93e-19	-25.12778	-23.96124	-24.67781
6	9420.517	47.83048	5.07e-19	-25.09827	-23.70596	-24.56121
7	9454.970	64.86296	5.10e-19	-25.09405	-23.47596	-24.46990
8	9494.746	74.23439	5.05e-19	-25.10435	-23.26048	-24.39311
9	9525.331	56.58103	5.12e-19	-25.08958	-23.01992	-24.29124
10	9543.341	33.02234	5.39e-19	-25.04050	-22.74506	-24.15507
11	9572.492	52.97237	5.49e-19	-25.02181	-22.50059	-24.04929
12	9604.849	58.26882	5.55e-19	-25.01187	-22.26487	-23.95226
13	9634.854	53.54207*	5.65e-19	-24.99551	-22.02273	-23.84881
14	9656.372	38.04589	5.88e-19	-24.95599	-21.75744	-23.72220

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

Portfolio G

VAR Lag Order Selection Criteria
Endogenous variables: SA_JSE_ASI USA_NYSE_IND UK_FTSE_ASI GERMANY_DAX30_PI EGYPT_CAIRO_INDEX JAPAN_NIKKEI_IND CANADA_TSI_PI FRANCE_CAC40_PI
Exogenous variables: C
Date: 12/15/10 Time: 09:33
Sample: 12/29/1995 4/16/2010
Included observations: 733

Lag	LogL	LR	FPE	AIC	SC	HQ
0	3124.045	NA	2.80e-14	-8.502170	-8.451997	-8.482816
1	13896.10	21279.58	5.74e-27	-37.71923	-37.26767	-37.54505
2	14163.73	522.8540	3.29e-27	-38.27485	-37.42190*	-37.94584*
3	14248.17	163.1259	3.12e-27	-38.33063	-37.07629	-37.84679
4	14313.08	123.9747	3.11e-27*	-38.33311*	-36.67738	-37.69444
5	14370.41	108.2299	3.17e-27	-38.31489	-36.25777	-37.52139
6	14411.75	77.15797	3.37e-27	-38.25306	-35.79456	-37.30474
7	14478.18	122.5321	3.35e-27	-38.25970	-35.39981	-37.15654
8	14530.82	95.93750	3.46e-27	-38.22869	-34.96742	-36.97071
9	14579.01	86.79102	3.62e-27	-38.18557	-34.52291	-36.77276
10	14622.76	77.82782	3.83e-27	-38.13031	-34.06626	-36.56267
11	14684.08	107.7428	3.87e-27	-38.12299	-33.65755	-36.40052
12	14737.63	92.93817*	3.99e-27	-38.09450	-33.22767	-36.21720
13	14770.65	56.57303	4.36e-27	-38.00996	-32.74174	-35.97783
14	14812.84	71.37026	4.65e-27	-37.95044	-32.28084	-35.76349

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

Portfolio H

VAR Lag Order Selection Criteria
Endogenous variables: SA_JSE_ASI AUS_ASX_ASI HK_HANGSENG_IND JAPAN_NIKKEI_IND PHIL_SE_PI ARG_MERVAL_IND USA_NYSE_IND RUSSIA_RTS_PI
Exogenous variables: C
Date: 12/15/10 Time: 09:36
Sample: 12/29/1995 4/16/2010
Included observations: 733

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1446.343	NA	2.73e-12	-3.924536	-3.874363	-3.905183
1	12272.31	21386.10	4.82e-25	-33.28872	-32.83716*	-33.11453
2	12407.55	264.1912	3.97e-25*	-33.48307*	-32.63012	-33.15406*
3	12465.79	112.5064	4.03e-25	-33.46736	-32.21302	-32.98352
4	12517.67	99.09714	4.17e-25	-33.43430	-31.77857	-32.79563
5	12560.91	81.64612	4.41e-25	-33.37766	-31.32055	-32.58416
6	12609.87	91.37846	4.60e-25	-33.33663	-30.87813	-32.38830
7	12650.29	74.53917	4.91e-25	-33.27227	-30.41238	-32.16911
8	12705.16	100.0092	5.04e-25	-33.24736	-29.98608	-31.98937
9	12746.62	74.66151	5.37e-25	-33.18586	-29.52319	-31.77304
10	12785.56	69.28007	5.76e-25	-33.11749	-29.05344	-31.54985
11	12825.94	70.95362	6.16e-25	-33.05304	-28.58760	-31.33057
12	12887.11	106.1532*	6.23e-25	-33.04533	-28.17850	-31.16803
13	12923.24	61.90951	6.74e-25	-32.96928	-27.70107	-30.93715
14	12965.88	72.13674	7.17e-25	-32.91101	-27.24140	-30.72405

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

Portfolio I

VAR Lag Order Selection Criteria
Endogenous variables: SA_JSE_ASI CANADA_TSI_PI CHINA_SHANG_ASI FRANCE_CAC40_PI SUI_MKT_IND RUSSIA_RTS_PI EGYPT_CAIRO_INDEX USA_NYSE_IND
Exogenous variables: C
Date: 12/15/10 Time: 09:38
Sample: 12/29/1995 4/16/2010
Included observations: 733

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1551.774	NA	2.05e-12	-4.212207	-4.162033	-4.192853
1	12494.07	21615.89	2.63e-25	-33.89378	-33.44222	-33.71960
2	12769.50	538.0910	1.48e-25	-34.47068	-33.61773*	-34.14167*
3	12836.72	129.8485	1.47e-25*	-34.47946*	-33.22512	-33.99562
4	12894.56	110.4709	1.49e-25	-34.46265	-32.80692	-33.82398
5	12935.96	78.17540	1.59e-25	-34.40100	-32.34388	-33.60750
6	12978.55	79.47588	1.68e-25	-34.34256	-31.88406	-33.39424
7	13042.14	117.2958	1.69e-25	-34.34145	-31.48156	-33.23830
8	13088.30	84.12161	1.77e-25	-34.29276	-31.03148	-33.03477
9	13146.26	104.3899	1.81e-25	-34.27630	-30.61364	-32.86349
10	13186.12	70.90849	1.93e-25	-34.21043	-30.14638	-32.64279
11	13230.04	77.16446	2.05e-25	-34.15563	-29.69019	-32.43316
12	13289.15	102.5769*	2.08e-25	-34.14229	-29.27546	-32.26499
13	13337.41	82.69557	2.18e-25	-34.09934	-28.83113	-32.06721
14	13371.14	57.06680	2.37e-25	-34.01676	-28.34716	-31.82980

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

Appendix N – results of Granger causality tests to determine Cholesky ordering

Portfolio A – **2 lags**

Pairwise Granger Causality Tests

Date: 11/17/10 Time: 19:02

Sample: 12/29/1995 4/22/2010

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
GERMANY_DAX30_PI does not Granger Cause USA_NYSE_IND	745	0.57337	0.56387
USA_NYSE_IND does not Granger Cause GERMANY_DAX30_PI		25.5796	1.8E-11
SA_JSE_ASI does not Granger Cause USA_NYSE_IND	745	0.16821	0.84521
USA_NYSE_IND does not Granger Cause SA_JSE_ASI		10.6571	2.7E-05
UK_FTSE_ASI does not Granger Cause USA_NYSE_IND	745	1.12333	0.32575
USA_NYSE_IND does not Granger Cause UK_FTSE_ASI		158.528	5.0E-58
SA_JSE_ASI does not Granger Cause GERMANY_DAX30_PI	745	0.08285	0.92050
GERMANY_DAX30_PI does not Granger Cause SA_JSE_ASI		0.64318	0.52591
UK_FTSE_ASI does not Granger Cause GERMANY_DAX30_PI	745	3.70135	0.02515
GERMANY_DAX30_PI does not Granger Cause UK_FTSE_ASI		57.9519	4.2E-24
UK_FTSE_ASI does not Granger Cause SA_JSE_ASI	745	0.66399	0.51510
SA_JSE_ASI does not Granger Cause UK_FTSE_ASI		30.6817	1.6E-13

4 lags

Pairwise Granger Causality Tests

Date: 11/17/10 Time: 19:05

Sample: 12/29/1995 4/22/2010

Lags: 4

Null Hypothesis:	Obs	F-Statistic	Probability
GERMANY_DAX30_PI does not Granger Cause USA_NYSE_IND	743	0.81604	0.51508
USA_NYSE_IND does not Granger Cause GERMANY_DAX30_PI		17.5923	8.5E-14
SA_JSE_ASI does not Granger Cause USA_NYSE_IND	743	1.75151	0.13683
USA_NYSE_IND does not Granger Cause SA_JSE_ASI		7.12195	1.3E-05
UK_FTSE_ASI does not Granger Cause USA_NYSE_IND	743	1.96092	0.09869
USA_NYSE_IND does not Granger Cause UK_FTSE_ASI		91.7495	2.9E-63
SA_JSE_ASI does not Granger Cause GERMANY_DAX30_PI	743	0.14773	0.96401
GERMANY_DAX30_PI does not Granger Cause SA_JSE_ASI		0.78028	0.53815
UK_FTSE_ASI does not Granger Cause GERMANY_DAX30_PI	743	1.90588	0.10761

GERMANY_DAX30_PI does not Granger Cause UK_FTSE_ASI		32.0148	1.3E-24
UK_FTSE_ASI does not Granger Cause SA_JSE_ASI	743	0.93565	0.44260
SA_JSE_ASI does not Granger Cause UK_FTSE_ASI		15.5189	3.4E-12

Portfolio B – 2 lags

Pairwise Granger Causality Tests
Date: 11/17/10 Time: 20:00
Sample: 12/29/1995 4/22/2010
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
AUS_ASX_ASI does not Granger Cause SA_JSE_ASI	745	3.62727	0.02706
SA_JSE_ASI does not Granger Cause AUS_ASX_ASI		1.68511	0.18614
JAPAN_NIKKEI_IND does not Granger Cause SA_JSE_ASI	745	6.16347	0.00221
SA_JSE_ASI does not Granger Cause JAPAN_NIKKEI_IND		1.00821	0.36537
HK_HANGSENG_IND does not Granger Cause SA_JSE_ASI	745	11.4745	1.2E-05
SA_JSE_ASI does not Granger Cause HK_HANGSENG_IND		1.86155	0.15616
JAPAN_NIKKEI_IND does not Granger Cause AUS_ASX_ASI	745	7.34605	0.00069
AUS_ASX_ASI does not Granger Cause JAPAN_NIKKEI_IND		0.66794	0.51307
HK_HANGSENG_IND does not Granger Cause AUS_ASX_ASI	745	0.54316	0.58114
AUS_ASX_ASI does not Granger Cause HK_HANGSENG_IND		1.29333	0.27498
HK_HANGSENG_IND does not Granger Cause JAPAN_NIKKEI_IND	745	1.32560	0.26627
JAPAN_NIKKEI_IND does not Granger Cause HK_HANGSENG_IND		4.53832	0.01099

Portfolio B – 1 lag

Pairwise Granger Causality Tests
Date: 11/17/10 Time: 20:00
Sample: 12/29/1995 4/22/2010
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Probability
AUS_ASX_ASI does not Granger Cause SA_JSE_ASI	746	2.65622	0.10357
SA_JSE_ASI does not Granger Cause AUS_ASX_ASI		0.18697	0.66558

JAPAN_NIKKEI_IND does not Granger Cause SA_JSE_ASI	746	0.12960	0.71895
SA_JSE_ASI does not Granger Cause JAPAN_NIKKEI_IND		0.70724	0.40063
HK_HANGSENG_IND does not Granger Cause SA_JSE_ASI	746	1.05798	0.30401
SA_JSE_ASI does not Granger Cause HK_HANGSENG_IND		1.71346	0.19094
JAPAN_NIKKEI_IND does not Granger Cause AUS_ASX_ASI	746	0.01080	0.91725
AUS_ASX_ASI does not Granger Cause JAPAN_NIKKEI_IND		0.80107	0.37106
HK_HANGSENG_IND does not Granger Cause AUS_ASX_ASI	746	0.00915	0.92383
AUS_ASX_ASI does not Granger Cause HK_HANGSENG_IND		1.43366	0.23155
HK_HANGSENG_IND does not Granger Cause JAPAN_NIKKEI_IND	746	1.36862	0.24242
JAPAN_NIKKEI_IND does not Granger Cause HK_HANGSENG_IND		0.14042	0.70797

Portfolio C – 2 lags

Pairwise Granger Causality Tests

Date: 11/17/10 Time: 20:37

Sample: 12/29/1995 4/22/2010

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
CHINA_SHANG_ASI does not Granger Cause CANADA_TSI_PI	745	1.86291	0.15595
CANADA_TSI_PI does not Granger Cause CHINA_SHANG_ASI		4.18832	0.01553
FRANCE_CAC40_PI does not Granger Cause CANADA_TSI_PI	745	45.4119	2.5E-19
CANADA_TSI_PI does not Granger Cause FRANCE_CAC40_PI		0.33892	0.71265
SA_JSE_ASI does not Granger Cause CANADA_TSI_PI	745	37.1051	4.4E-16
CANADA_TSI_PI does not Granger Cause SA_JSE_ASI		0.92140	0.39842
FRANCE_CAC40_PI does not Granger Cause CHINA_SHANG_ASI	745	2.89991	0.05565
CHINA_SHANG_ASI does not Granger Cause FRANCE_CAC40_PI		1.58277	0.20610
SA_JSE_ASI does not Granger Cause CHINA_SHANG_ASI	745	3.14384	0.04369
CHINA_SHANG_ASI does not Granger Cause SA_JSE_ASI		0.23352	0.79180
SA_JSE_ASI does not Granger Cause FRANCE_CAC40_PI	745	0.58481	0.55747
FRANCE_CAC40_PI does not Granger Cause SA_JSE_ASI		1.21042	0.29866

Portfolio C – 4 lags

Pairwise Granger Causality Tests
Date: 11/17/10 Time: 20:38
Sample: 12/29/1995 4/22/2010
Lags: 4

Null Hypothesis:	Obs	F-Statistic	Probability
CHINA_SHANG_ASI does not Granger Cause CANADA_TSI_PI	743	1.36494	0.24443
CANADA_TSI_PI does not Granger Cause CHINA_SHANG_ASI		3.46712	0.00811
FRANCE_CAC40_PI does not Granger Cause CANADA_TSI_PI	743	26.9376	7.1E-21
CANADA_TSI_PI does not Granger Cause FRANCE_CAC40_PI		0.83009	0.50618
SA_JSE_ASI does not Granger Cause CANADA_TSI_PI	743	20.1257	9.6E-16
CANADA_TSI_PI does not Granger Cause SA_JSE_ASI		0.78427	0.53555
FRANCE_CAC40_PI does not Granger Cause CHINA_SHANG_ASI	743	1.68852	0.15073
CHINA_SHANG_ASI does not Granger Cause FRANCE_CAC40_PI		0.80035	0.52513
SA_JSE_ASI does not Granger Cause CHINA_SHANG_ASI	743	2.01743	0.09025
CHINA_SHANG_ASI does not Granger Cause SA_JSE_ASI		0.12277	0.97432
SA_JSE_ASI does not Granger Cause FRANCE_CAC40_PI	743	0.44306	0.77751
FRANCE_CAC40_PI does not Granger Cause SA_JSE_ASI		1.00609	0.40346

Portfolio D – 2 lags

Pairwise Granger Causality Tests
Date: 11/17/10 Time: 21:03
Sample: 12/29/1995 4/22/2010
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
UK_FTSE_ASI does not Granger Cause USA_NYSE_IND	745	1.12333	0.32575
USA_NYSE_IND does not Granger Cause UK_FTSE_ASI		158.528	5.0E-58
SA_JSE_ASI does not Granger Cause USA_NYSE_IND	745	0.16821	0.84521
USA_NYSE_IND does not Granger Cause SA_JSE_ASI		10.6571	2.7E-05
EGYPT_CAIRO_INDEX does not Granger Cause USA_NYSE_IND	745	3.90801	0.02050
USA_NYSE_IND does not Granger Cause EGYPT_CAIRO_INDEX		6.52681	0.00155
GERMANY_DAX30_PI does not Granger Cause USA_NYSE_IND	745	0.57337	0.56387
USA_NYSE_IND does not Granger Cause GERMANY_DAX30_PI		25.5796	1.8E-11

JAPAN_NIKKEI_IND does not Granger Cause USA_NYSE_IND	745	0.14524	0.86484
USA_NYSE_IND does not Granger Cause JAPAN_NIKKEI_IND		1.29848	0.27357
SA_JSE_ASI does not Granger Cause UK_FTSE_ASI	745	30.6817	1.6E-13
UK_FTSE_ASI does not Granger Cause SA_JSE_ASI		0.66399	0.51510
EGYPT_CAIRO_INDEX does not Granger Cause UK_FTSE_ASI	745	14.7494	5.2E-07
UK_FTSE_ASI does not Granger Cause EGYPT_CAIRO_INDEX		4.64369	0.00990
GERMANY_DAX30_PI does not Granger Cause UK_FTSE_ASI	745	57.9519	4.2E-24
UK_FTSE_ASI does not Granger Cause GERMANY_DAX30_PI		3.70135	0.02515
JAPAN_NIKKEI_IND does not Granger Cause UK_FTSE_ASI	745	74.6094	3.0E-30
UK_FTSE_ASI does not Granger Cause JAPAN_NIKKEI_IND		0.35856	0.69881
EGYPT_CAIRO_INDEX does not Granger Cause SA_JSE_ASI	745	2.11310	0.12159
SA_JSE_ASI does not Granger Cause EGYPT_CAIRO_INDEX		4.10626	0.01685
GERMANY_DAX30_PI does not Granger Cause SA_JSE_ASI	745	0.64318	0.52591
SA_JSE_ASI does not Granger Cause GERMANY_DAX30_PI		0.08285	0.92050
JAPAN_NIKKEI_IND does not Granger Cause SA_JSE_ASI	745	6.16347	0.00221
SA_JSE_ASI does not Granger Cause JAPAN_NIKKEI_IND		1.00821	0.36537
GERMANY_DAX30_PI does not Granger Cause EGYPT_CAIRO_INDEX	745	9.27339	0.00011
EGYPT_CAIRO_INDEX does not Granger Cause GERMANY_DAX30_PI		2.51472	0.08158
JAPAN_NIKKEI_IND does not Granger Cause EGYPT_CAIRO_INDEX	745	2.55304	0.07853
EGYPT_CAIRO_INDEX does not Granger Cause JAPAN_NIKKEI_IND		3.04940	0.04798
JAPAN_NIKKEI_IND does not Granger Cause GERMANY_DAX30_PI	745	16.8069	7.3E-08
GERMANY_DAX30_PI does not Granger Cause JAPAN_NIKKEI_IND		1.95266	0.14263

Portfolio D – 11 lags

Pairwise Granger Causality Tests

Date: 11/17/10 Time: 21:11

Sample: 12/29/1995 4/22/2010

Lags: 11

Null Hypothesis:	Obs	F-Statistic	Probability
JAPAN_NIKKEI_IND does not Granger Cause USA_NYSE_IND	736	1.10928	0.35064
USA_NYSE_IND does not Granger Cause JAPAN_NIKKEI_IND		1.57235	0.10218
UK_FTSE_ASI does not Granger Cause USA_NYSE_IND	736	1.83769	0.04454

USA_NYSE_IND does not Granger Cause UK_FTSE_ASI		35.8215	4.5E-61
GERMANY_DAX30_PI does not Granger Cause USA_NYSE_IND	736	0.92315	0.51726
USA_NYSE_IND does not Granger Cause GERMANY_DAX30_PI		7.12684	1.5E-11
EGYPT_CAIRO_INDEX does not Granger Cause USA_NYSE_IND	736	2.21417	0.01232
USA_NYSE_IND does not Granger Cause EGYPT_CAIRO_INDEX		2.62509	0.00273
SA_JSE_ASI does not Granger Cause USA_NYSE_IND	736	1.31787	0.20952
USA_NYSE_IND does not Granger Cause SA_JSE_ASI		3.78852	2.7E-05
UK_FTSE_ASI does not Granger Cause JAPAN_NIKKEI_IND	736	0.75587	0.68452
JAPAN_NIKKEI_IND does not Granger Cause UK_FTSE_ASI		16.1530	1.6E-28
GERMANY_DAX30_PI does not Granger Cause JAPAN_NIKKEI_IND	736	1.53458	0.11429
JAPAN_NIKKEI_IND does not Granger Cause GERMANY_DAX30_PI		4.59852	8.8E-07
EGYPT_CAIRO_INDEX does not Granger Cause JAPAN_NIKKEI_IND	736	1.19623	0.28551
JAPAN_NIKKEI_IND does not Granger Cause EGYPT_CAIRO_INDEX		2.44655	0.00531
SA_JSE_ASI does not Granger Cause JAPAN_NIKKEI_IND	736	2.93249	0.00084
JAPAN_NIKKEI_IND does not Granger Cause SA_JSE_ASI		2.82077	0.00129
GERMANY_DAX30_PI does not Granger Cause UK_FTSE_ASI	736	13.0068	1.0E-22
UK_FTSE_ASI does not Granger Cause GERMANY_DAX30_PI		1.54712	0.11014
EGYPT_CAIRO_INDEX does not Granger Cause UK_FTSE_ASI	736	4.79822	3.7E-07
UK_FTSE_ASI does not Granger Cause EGYPT_CAIRO_INDEX		1.55780	0.10671
SA_JSE_ASI does not Granger Cause UK_FTSE_ASI	736	7.07658	1.8E-11
UK_FTSE_ASI does not Granger Cause SA_JSE_ASI		1.20191	0.28157
EGYPT_CAIRO_INDEX does not Granger Cause GERMANY_DAX30_PI	736	1.41247	0.16210
GERMANY_DAX30_PI does not Granger Cause EGYPT_CAIRO_INDEX		2.73346	0.00181
SA_JSE_ASI does not Granger Cause GERMANY_DAX30_PI	736	1.43232	0.15335
GERMANY_DAX30_PI does not Granger Cause SA_JSE_ASI		0.87368	0.56611
SA_JSE_ASI does not Granger Cause EGYPT_CAIRO_INDEX	736	2.82831	0.00125
EGYPT_CAIRO_INDEX does not Granger Cause SA_JSE_ASI		1.46786	0.13867

Portfolio E – 2 lags

Pairwise Granger Causality Tests

Date: 11/17/10 Time: 22:05

Sample: 12/29/1995 4/22/2010

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
ARG_MERVAL_IND does not Granger Cause JAPAN_NIKKEI_IND	745	0.35392	0.70205
JAPAN_NIKKEI_IND does not Granger Cause ARG_MERVAL_IND		2.16145	0.11588
HK_HANGSENG_IND does not Granger Cause JAPAN_NIKKEI_IND	745	1.32560	0.26627
JAPAN_NIKKEI_IND does not Granger Cause HK_HANGSENG_IND		4.53832	0.01099
AUS_ASX_ASI does not Granger Cause JAPAN_NIKKEI_IND	745	0.66794	0.51307
JAPAN_NIKKEI_IND does not Granger Cause AUS_ASX_ASI		7.34605	0.00069
SA_JSE_ASI does not Granger Cause JAPAN_NIKKEI_IND	745	1.00821	0.36537
JAPAN_NIKKEI_IND does not Granger Cause SA_JSE_ASI		6.16347	0.00221
PHIL_SE_PI does not Granger Cause JAPAN_NIKKEI_IND	745	2.30842	0.10013
JAPAN_NIKKEI_IND does not Granger Cause PHIL_SE_PI		14.5679	6.2E-07
HK_HANGSENG_IND does not Granger Cause ARG_MERVAL_IND	745	0.21834	0.80391
ARG_MERVAL_IND does not Granger Cause HK_HANGSENG_IND		10.3944	3.5E-05
AUS_ASX_ASI does not Granger Cause ARG_MERVAL_IND	745	1.20131	0.30138
ARG_MERVAL_IND does not Granger Cause AUS_ASX_ASI		8.60038	0.00020
SA_JSE_ASI does not Granger Cause ARG_MERVAL_IND	745	2.21181	0.11023
ARG_MERVAL_IND does not Granger Cause SA_JSE_ASI		16.3836	1.1E-07
PHIL_SE_PI does not Granger Cause ARG_MERVAL_IND	745	0.28255	0.75394
ARG_MERVAL_IND does not Granger Cause PHIL_SE_PI		25.3509	2.2E-11
AUS_ASX_ASI does not Granger Cause HK_HANGSENG_IND	745	1.29333	0.27498
HK_HANGSENG_IND does not Granger Cause AUS_ASX_ASI		0.54316	0.58114
SA_JSE_ASI does not Granger Cause HK_HANGSENG_IND	745	1.86155	0.15616
HK_HANGSENG_IND does not Granger Cause SA_JSE_ASI		11.4745	1.2E-05
PHIL_SE_PI does not Granger Cause HK_HANGSENG_IND	745	1.14009	0.32035
HK_HANGSENG_IND does not Granger Cause PHIL_SE_PI		18.2857	1.8E-08
SA_JSE_ASI does not Granger Cause AUS_ASX_ASI	745	1.68511	0.18614
AUS_ASX_ASI does not Granger Cause SA_JSE_ASI		3.62727	0.02706
PHIL_SE_PI does not Granger Cause AUS_ASX_ASI	745	0.84287	0.43089
AUS_ASX_ASI does not Granger Cause PHIL_SE_PI		8.40036	0.00025
PHIL_SE_PI does not Granger Cause SA_JSE_ASI	745	1.77442	0.17030
SA_JSE_ASI does not Granger Cause PHIL_SE_PI		9.02587	0.00013

Portfolio E – 3 lags

Pairwise Granger Causality Tests

Date: 11/17/10 Time: 22:04

Sample: 12/29/1995 4/22/2010

Lags: 3

Null Hypothesis:	Obs	F-Statistic	Probability
ARG_MERVAL_IND does not Granger Cause JAPAN_NIKKEI_IND	744	0.38703	0.76238
JAPAN_NIKKEI_IND does not Granger Cause ARG_MERVAL_IND		2.96453	0.03141
HK_HANGSENG_IND does not Granger Cause JAPAN_NIKKEI_IND	744	0.82358	0.48105
JAPAN_NIKKEI_IND does not Granger Cause HK_HANGSENG_IND		3.09785	0.02624
AUS_ASX_ASI does not Granger Cause JAPAN_NIKKEI_IND	744	0.93365	0.42391
JAPAN_NIKKEI_IND does not Granger Cause AUS_ASX_ASI		5.10001	0.00169
SA_JSE_ASI does not Granger Cause JAPAN_NIKKEI_IND	744	1.19707	0.30991
JAPAN_NIKKEI_IND does not Granger Cause SA_JSE_ASI		4.18544	0.00597
PHIL_SE_PI does not Granger Cause JAPAN_NIKKEI_IND	744	2.07877	0.10164
JAPAN_NIKKEI_IND does not Granger Cause PHIL_SE_PI		11.7527	1.6E-07
HK_HANGSENG_IND does not Granger Cause ARG_MERVAL_IND	744	4.33557	0.00485
ARG_MERVAL_IND does not Granger Cause HK_HANGSENG_IND		7.26491	8.3E-05
AUS_ASX_ASI does not Granger Cause ARG_MERVAL_IND	744	2.23906	0.08242
ARG_MERVAL_IND does not Granger Cause AUS_ASX_ASI		5.80921	0.00063
SA_JSE_ASI does not Granger Cause ARG_MERVAL_IND	744	3.42350	0.01689
ARG_MERVAL_IND does not Granger Cause SA_JSE_ASI		10.9226	5.0E-07
PHIL_SE_PI does not Granger Cause ARG_MERVAL_IND	744	1.88597	0.13049
ARG_MERVAL_IND does not Granger Cause PHIL_SE_PI		19.8204	2.3E-12
AUS_ASX_ASI does not Granger Cause HK_HANGSENG_IND	744	0.96210	0.41008
HK_HANGSENG_IND does not Granger Cause AUS_ASX_ASI		0.46836	0.70443
SA_JSE_ASI does not Granger Cause HK_HANGSENG_IND	744	1.61736	0.18394
HK_HANGSENG_IND does not Granger Cause SA_JSE_ASI		7.52698	5.8E-05
PHIL_SE_PI does not Granger Cause HK_HANGSENG_IND	744	1.73305	0.15878
HK_HANGSENG_IND does not Granger Cause PHIL_SE_PI		13.7893	9.3E-09

SA_JSE_ASI does not Granger Cause AUS_ASX_ASI	744	2.09974	0.09890
AUS_ASX_ASI does not Granger Cause SA_JSE_ASI		2.34674	0.07153
PHIL_SE_PI does not Granger Cause AUS_ASX_ASI	744	0.74531	0.52527
AUS_ASX_ASI does not Granger Cause PHIL_SE_PI		8.05293	2.8E-05
PHIL_SE_PI does not Granger Cause SA_JSE_ASI	744	0.93070	0.42536
SA_JSE_ASI does not Granger Cause PHIL_SE_PI		7.94257	3.2E-05

Portfolio F – 2 lags

Pairwise Granger Causality Tests
Date: 11/17/10 Time: 22:21
Sample: 12/29/1995 4/22/2010
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
CANADA_TSI_PI does not Granger Cause SA_JSE_ASI	745	0.92140	0.39842
SA_JSE_ASI does not Granger Cause CANADA_TSI_PI		37.1051	4.4E-16
CHINA_SHANG_ASI does not Granger Cause SA_JSE_ASI	745	0.23352	0.79180
SA_JSE_ASI does not Granger Cause CHINA_SHANG_ASI		3.14384	0.04369
FRANCE_CAC40_PI does not Granger Cause SA_JSE_ASI	745	1.21042	0.29866
SA_JSE_ASI does not Granger Cause FRANCE_CAC40_PI		0.58481	0.55747
SUI_MKT_IND does not Granger Cause SA_JSE_ASI	745	4.68253	0.00953
SA_JSE_ASI does not Granger Cause SUI_MKT_IND		0.29335	0.74585
RUSSIA_RTS_PI does not Granger Cause SA_JSE_ASI	745	4.83635	0.00819
SA_JSE_ASI does not Granger Cause RUSSIA_RTS_PI		2.25010	0.10611
CHINA_SHANG_ASI does not Granger Cause CANADA_TSI_PI	745	1.86291	0.15595
CANADA_TSI_PI does not Granger Cause CHINA_SHANG_ASI		4.18832	0.01553
FRANCE_CAC40_PI does not Granger Cause CANADA_TSI_PI	745	45.4119	2.5E-19
CANADA_TSI_PI does not Granger Cause FRANCE_CAC40_PI		0.33892	0.71265
SUI_MKT_IND does not Granger Cause CANADA_TSI_PI	745	63.6700	3.1E-26
CANADA_TSI_PI does not Granger Cause SUI_MKT_IND		0.14456	0.86543
RUSSIA_RTS_PI does not Granger Cause CANADA_TSI_PI	745	47.4988	3.9E-20
CANADA_TSI_PI does not Granger Cause RUSSIA_RTS_PI		0.26221	0.76942
FRANCE_CAC40_PI does not Granger Cause CHINA_SHANG_ASI	745	2.89991	0.05565
CHINA_SHANG_ASI does not Granger Cause FRANCE_CAC40_PI		1.58277	0.20610
SUI_MKT_IND does not Granger Cause	745	5.20297	0.00570

CHINA_SHANG_ASI			
CHINA_SHANG_ASI does not Granger Cause SUI_MKT_IND		0.18286	0.83292
RUSSIA_RTS_PI does not Granger Cause CHINA_SHANG_ASI	745	2.69571	0.06816
CHINA_SHANG_ASI does not Granger Cause RUSSIA_RTS_PI		0.73859	0.47814
SUI_MKT_IND does not Granger Cause FRANCE_CAC40_PI	745	17.4372	4.0E-08
FRANCE_CAC40_PI does not Granger Cause SUI_MKT_IND		1.02643	0.35879
RUSSIA_RTS_PI does not Granger Cause FRANCE_CAC40_PI	745	3.57173	0.02859
FRANCE_CAC40_PI does not Granger Cause RUSSIA_RTS_PI		1.30206	0.27259
RUSSIA_RTS_PI does not Granger Cause SUI_MKT_IND	745	1.24662	0.28808
SUI_MKT_IND does not Granger Cause RUSSIA_RTS_PI		2.88313	0.05659

Portfolio F – 4 lags

Pairwise Granger Causality Tests

Date: 11/17/10 Time: 22:36

Sample: 12/29/1995 4/22/2010

Lags: 4

Null Hypothesis:	Obs	F-Statistic	Probability
RUSSIA_RTS_PI does not Granger Cause SUI_MKT_IND	743	1.18223	0.31723
SUI_MKT_IND does not Granger Cause RUSSIA_RTS_PI		4.54813	0.00124
SA_JSE_ASI does not Granger Cause SUI_MKT_IND	743	1.08125	0.36466
SUI_MKT_IND does not Granger Cause SA_JSE_ASI		4.35630	0.00173
CANADA_TSI_PI does not Granger Cause SUI_MKT_IND	743	0.51827	0.72234
SUI_MKT_IND does not Granger Cause CANADA_TSI_PI		35.1115	7.5E-27
FRANCE_CAC40_PI does not Granger Cause SUI_MKT_IND	743	1.41869	0.22597
SUI_MKT_IND does not Granger Cause FRANCE_CAC40_PI		12.5268	7.3E-10
CHINA_SHANG_ASI does not Granger Cause SUI_MKT_IND	743	0.78538	0.53483
SUI_MKT_IND does not Granger Cause CHINA_SHANG_ASI		2.68332	0.03053
SA_JSE_ASI does not Granger Cause RUSSIA_RTS_PI	743	2.59573	0.03531
RUSSIA_RTS_PI does not Granger Cause SA_JSE_ASI		2.49400	0.04176
CANADA_TSI_PI does not Granger Cause RUSSIA_RTS_PI	743	1.88209	0.11170
RUSSIA_RTS_PI does not Granger Cause CANADA_TSI_PI		23.1447	4.9E-18
FRANCE_CAC40_PI does not Granger Cause RUSSIA_RTS_PI	743	0.49836	0.73696
RUSSIA_RTS_PI does not Granger Cause FRANCE_CAC40_PI		2.51171	0.04056
CHINA_SHANG_ASI does not Granger Cause	743	0.49367	0.74041

RUSSIA_RTS_PI			
RUSSIA_RTS_PI does not Granger Cause CHINA_SHANG_ASI		2.63403	0.03314
CANADA_TSI_PI does not Granger Cause SA_JSE_ASI	743	0.78427	0.53555
SA_JSE_ASI does not Granger Cause CANADA_TSI_PI		20.1257	9.6E-16
FRANCE_CAC40_PI does not Granger Cause SA_JSE_ASI	743	1.00609	0.40346
SA_JSE_ASI does not Granger Cause FRANCE_CAC40_PI		0.44306	0.77751
CHINA_SHANG_ASI does not Granger Cause SA_JSE_ASI	743	0.12277	0.97432
SA_JSE_ASI does not Granger Cause CHINA_SHANG_ASI		2.01743	0.09025
FRANCE_CAC40_PI does not Granger Cause CANADA_TSI_PI	743	26.9376	7.1E-21
CANADA_TSI_PI does not Granger Cause FRANCE_CAC40_PI		0.83009	0.50618
CHINA_SHANG_ASI does not Granger Cause CANADA_TSI_PI	743	1.36494	0.24443
CANADA_TSI_PI does not Granger Cause CHINA_SHANG_ASI		3.46712	0.00811
CHINA_SHANG_ASI does not Granger Cause FRANCE_CAC40_PI	743	0.80035	0.52513
FRANCE_CAC40_PI does not Granger Cause CHINA_SHANG_ASI		1.68852	0.15073

Portfolio G – 2 lags

Pairwise Granger Causality Tests

Date: 11/30/10 Time: 18:39

Sample: 12/29/1995 4/22/2010

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
UK_FTSE_ASI does not Granger Cause USA_NYSE_IND	745	1.12333	0.32575
USA_NYSE_IND does not Granger Cause UK_FTSE_ASI		158.528	5.0E-58
SA_JSE_ASI does not Granger Cause USA_NYSE_IND	745	0.16821	0.84521
USA_NYSE_IND does not Granger Cause SA_JSE_ASI		10.6571	2.7E-05
GERMANY_DAX30_PI does not Granger Cause USA_NYSE_IND	745	0.57337	0.56387
USA_NYSE_IND does not Granger Cause GERMANY_DAX30_PI		25.5796	1.8E-11
EGYPT_CAIRO_INDEX does not Granger Cause USA_NYSE_IND	745	3.90801	0.02050
USA_NYSE_IND does not Granger Cause EGYPT_CAIRO_INDEX		6.52681	0.00155
JAPAN_NIKKEI_IND does not Granger Cause USA_NYSE_IND	745	0.14524	0.86484
USA_NYSE_IND does not Granger Cause JAPAN_NIKKEI_IND		1.29848	0.27357
CANADA_TSI_PI does not Granger Cause USA_NYSE_IND	745	0.08518	0.91836
USA_NYSE_IND does not Granger Cause CANADA_TSI_PI		163.284	1.8E-59

FRANCE_CAC40_PI does not Granger Cause USA_NYSE_IND	745	0.60821	0.54460
USA_NYSE_IND does not Granger Cause FRANCE_CAC40_PI		22.2313	4.2E-10
SA_JSE_ASI does not Granger Cause UK_FTSE_ASI	745	30.6817	1.6E-13
UK_FTSE_ASI does not Granger Cause SA_JSE_ASI		0.66399	0.51510
GERMANY_DAX30_PI does not Granger Cause UK_FTSE_ASI	745	57.9519	4.2E-24
UK_FTSE_ASI does not Granger Cause GERMANY_DAX30_PI		3.70135	0.02515
EGYPT_CAIRO_INDEX does not Granger Cause UK_FTSE_ASI	745	14.7494	5.2E-07
UK_FTSE_ASI does not Granger Cause EGYPT_CAIRO_INDEX		4.64369	0.00990
JAPAN_NIKKEI_IND does not Granger Cause UK_FTSE_ASI	745	74.6094	3.0E-30
UK_FTSE_ASI does not Granger Cause JAPAN_NIKKEI_IND		0.35856	0.69881
CANADA_TSI_PI does not Granger Cause UK_FTSE_ASI	745	1.25824	0.28476
UK_FTSE_ASI does not Granger Cause CANADA_TSI_PI		0.08629	0.91733
FRANCE_CAC40_PI does not Granger Cause UK_FTSE_ASI	745	74.3378	3.8E-30
UK_FTSE_ASI does not Granger Cause FRANCE_CAC40_PI		1.64197	0.19430
GERMANY_DAX30_PI does not Granger Cause SA_JSE_ASI	745	0.64318	0.52591
SA_JSE_ASI does not Granger Cause GERMANY_DAX30_PI		0.08285	0.92050
EGYPT_CAIRO_INDEX does not Granger Cause SA_JSE_ASI	745	2.11310	0.12159
SA_JSE_ASI does not Granger Cause EGYPT_CAIRO_INDEX		4.10626	0.01685
JAPAN_NIKKEI_IND does not Granger Cause SA_JSE_ASI	745	6.16347	0.00221
SA_JSE_ASI does not Granger Cause JAPAN_NIKKEI_IND		1.00821	0.36537
CANADA_TSI_PI does not Granger Cause SA_JSE_ASI	745	0.92140	0.39842
SA_JSE_ASI does not Granger Cause CANADA_TSI_PI		37.1051	4.4E-16
FRANCE_CAC40_PI does not Granger Cause SA_JSE_ASI	745	1.21042	0.29866
SA_JSE_ASI does not Granger Cause FRANCE_CAC40_PI		0.58481	0.55747
EGYPT_CAIRO_INDEX does not Granger Cause GERMANY_DAX30_PI	745	2.51472	0.08158
GERMANY_DAX30_PI does not Granger Cause EGYPT_CAIRO_INDEX		9.27339	0.00011
JAPAN_NIKKEI_IND does not Granger Cause GERMANY_DAX30_PI	745	16.8069	7.3E-08
GERMANY_DAX30_PI does not Granger Cause JAPAN_NIKKEI_IND		1.95266	0.14263
CANADA_TSI_PI does not Granger Cause GERMANY_DAX30_PI	745	0.30041	0.74061
GERMANY_DAX30_PI does not Granger Cause CANADA_TSI_PI		43.2951	1.7E-18
FRANCE_CAC40_PI does not Granger Cause GERMANY_DAX30_PI	745	0.64545	0.52472

GERMANY_DAX30_PI does not Granger Cause FRANCE_CAC40_PI		0.57156	0.56489

JAPAN_NIKKEI_IND does not Granger Cause EGYPT_CAIRO_INDEX	745	2.55304	0.07853
EGYPT_CAIRO_INDEX does not Granger Cause JAPAN_NIKKEI_IND		3.04940	0.04798
CANADA_TSI_PI does not Granger Cause EGYPT_CAIRO_INDEX	745	2.17614	0.11420
EGYPT_CAIRO_INDEX does not Granger Cause CANADA_TSI_PI		13.1514	2.4E-06
FRANCE_CAC40_PI does not Granger Cause EGYPT_CAIRO_INDEX	745	6.81801	0.00116
EGYPT_CAIRO_INDEX does not Granger Cause FRANCE_CAC40_PI		0.30197	0.73945
CANADA_TSI_PI does not Granger Cause JAPAN_NIKKEI_IND	745	0.95529	0.38517
JAPAN_NIKKEI_IND does not Granger Cause CANADA_TSI_PI		72.6361	1.6E-29
FRANCE_CAC40_PI does not Granger Cause JAPAN_NIKKEI_IND	745	1.59022	0.20458
JAPAN_NIKKEI_IND does not Granger Cause FRANCE_CAC40_PI		16.4083	1.1E-07
FRANCE_CAC40_PI does not Granger Cause CANADA_TSI_PI	745	45.4119	2.5E-19
CANADA_TSI_PI does not Granger Cause FRANCE_CAC40_PI		0.33892	0.71265

Portfolio G – 8 lags

Pairwise Granger Causality Tests

Date: 11/30/10 Time: 19:06

Sample: 12/29/1995 4/22/2010

Lags: 8

Null Hypothesis:	Obs	F-Statistic	Probability
JAPAN_NIKKEI_IND does not Granger Cause USA_NYSE_IND	739	1.27516	0.25317
USA_NYSE_IND does not Granger Cause JAPAN_NIKKEI_IND		1.74528	0.08478
EGYPT_CAIRO_INDEX does not Granger Cause USA_NYSE_IND	739	2.87010	0.00378
USA_NYSE_IND does not Granger Cause EGYPT_CAIRO_INDEX		3.38239	0.00080
FRANCE_CAC40_PI does not Granger Cause USA_NYSE_IND	739	1.75147	0.08347
USA_NYSE_IND does not Granger Cause FRANCE_CAC40_PI		10.0168	2.7E-13
GERMANY_DAX30_PI does not Granger Cause USA_NYSE_IND	739	0.99394	0.43927
USA_NYSE_IND does not Granger Cause GERMANY_DAX30_PI		9.87711	4.3E-13
SA_JSE_ASI does not Granger Cause USA_NYSE_IND	739	1.46298	0.16712
USA_NYSE_IND does not Granger Cause SA_JSE_ASI		5.11520	3.2E-06
UK_FTSE_ASI does not Granger Cause USA_NYSE_IND	739	2.13929	0.03027
USA_NYSE_IND does not Granger Cause UK_FTSE_ASI		49.6205	7.4E-64

CANADA_TSI_PI does not Granger Cause USA_NYSE_IND	739	1.69454	0.09618
USA_NYSE_IND does not Granger Cause CANADA_TSI_PI		46.2118	4.7E-60
EGYPT_CAIRO_INDEX does not Granger Cause JAPAN_NIKKEI_IND	739	1.21839	0.28508
JAPAN_NIKKEI_IND does not Granger Cause EGYPT_CAIRO_INDEX		2.29983	0.01947
FRANCE_CAC40_PI does not Granger Cause JAPAN_NIKKEI_IND	739	1.98559	0.04568
JAPAN_NIKKEI_IND does not Granger Cause FRANCE_CAC40_PI		6.10049	1.3E-07
GERMANY_DAX30_PI does not Granger Cause JAPAN_NIKKEI_IND	739	1.98205	0.04610
JAPAN_NIKKEI_IND does not Granger Cause GERMANY_DAX30_PI		6.30771	6.4E-08
SA_JSE_ASI does not Granger Cause JAPAN_NIKKEI_IND	739	3.33353	0.00093
JAPAN_NIKKEI_IND does not Granger Cause SA_JSE_ASI		2.81917	0.00439
UK_FTSE_ASI does not Granger Cause JAPAN_NIKKEI_IND	739	1.03400	0.40858
JAPAN_NIKKEI_IND does not Granger Cause UK_FTSE_ASI		21.4783	2.0E-29
CANADA_TSI_PI does not Granger Cause JAPAN_NIKKEI_IND	739	1.87045	0.06168
JAPAN_NIKKEI_IND does not Granger Cause CANADA_TSI_PI		18.9378	5.9E-26
FRANCE_CAC40_PI does not Granger Cause EGYPT_CAIRO_INDEX	739	3.71960	0.00028
EGYPT_CAIRO_INDEX does not Granger Cause FRANCE_CAC40_PI		1.30162	0.23927
GERMANY_DAX30_PI does not Granger Cause EGYPT_CAIRO_INDEX	739	3.42139	0.00071
EGYPT_CAIRO_INDEX does not Granger Cause GERMANY_DAX30_PI		1.41674	0.18567
SA_JSE_ASI does not Granger Cause EGYPT_CAIRO_INDEX	739	3.22937	0.00128
EGYPT_CAIRO_INDEX does not Granger Cause SA_JSE_ASI		1.72219	0.08981
UK_FTSE_ASI does not Granger Cause EGYPT_CAIRO_INDEX	739	2.13554	0.03058
EGYPT_CAIRO_INDEX does not Granger Cause UK_FTSE_ASI		6.22644	8.4E-08
CANADA_TSI_PI does not Granger Cause EGYPT_CAIRO_INDEX	739	1.58085	0.12678
EGYPT_CAIRO_INDEX does not Granger Cause CANADA_TSI_PI		5.42730	1.2E-06
GERMANY_DAX30_PI does not Granger Cause FRANCE_CAC40_PI	739	0.60041	0.77797
FRANCE_CAC40_PI does not Granger Cause GERMANY_DAX30_PI		0.69245	0.69845
SA_JSE_ASI does not Granger Cause FRANCE_CAC40_PI	739	1.42607	0.18180
FRANCE_CAC40_PI does not Granger Cause SA_JSE_ASI		0.85587	0.55367
UK_FTSE_ASI does not Granger Cause FRANCE_CAC40_PI	739	0.89175	0.52284
FRANCE_CAC40_PI does not Granger Cause UK_FTSE_ASI		25.1506	2.4E-34

CANADA_TSI_PI does not Granger Cause FRANCE_CAC40_PI	739	0.66942	0.71875
FRANCE_CAC40_PI does not Granger Cause CANADA_TSI_PI		14.1591	3.0E-19
SA_JSE_ASI does not Granger Cause GERMANY_DAX30_PI	739	1.36023	0.21061
GERMANY_DAX30_PI does not Granger Cause SA_JSE_ASI		0.72438	0.67009
UK_FTSE_ASI does not Granger Cause GERMANY_DAX30_PI	739	1.48564	0.15862
GERMANY_DAX30_PI does not Granger Cause UK_FTSE_ASI		17.5698	4.7E-24
CANADA_TSI_PI does not Granger Cause GERMANY_DAX30_PI	739	0.52536	0.83788
GERMANY_DAX30_PI does not Granger Cause CANADA_TSI_PI		12.8709	2.1E-17
UK_FTSE_ASI does not Granger Cause SA_JSE_ASI	739	1.03093	0.41089
SA_JSE_ASI does not Granger Cause UK_FTSE_ASI		9.76061	6.4E-13
CANADA_TSI_PI does not Granger Cause SA_JSE_ASI	739	1.27579	0.25283
SA_JSE_ASI does not Granger Cause CANADA_TSI_PI		12.6571	4.2E-17
CANADA_TSI_PI does not Granger Cause UK_FTSE_ASI	739	1.68874	0.09756
UK_FTSE_ASI does not Granger Cause CANADA_TSI_PI		1.07026	0.38194

Pairwise Granger Causality Tests

Date: 11/30/10 Time: 19:06

Sample: 12/29/1995 4/22/2010

Lags: 8

Null Hypothesis:	Obs	F-Statistic	Probability
JAPAN_NIKKEI_IND does not Granger Cause USA_NYSE_IND	739	1.27516	0.25317
USA_NYSE_IND does not Granger Cause JAPAN_NIKKEI_IND		1.74528	0.08478
EGYPT_CAIRO_INDEX does not Granger Cause USA_NYSE_IND	739	2.87010	0.00378
USA_NYSE_IND does not Granger Cause EGYPT_CAIRO_INDEX		3.38239	0.00080
FRANCE_CAC40_PI does not Granger Cause USA_NYSE_IND	739	1.75147	0.08347
USA_NYSE_IND does not Granger Cause FRANCE_CAC40_PI		10.0168	2.7E-13
GERMANY_DAX30_PI does not Granger Cause USA_NYSE_IND	739	0.99394	0.43927
USA_NYSE_IND does not Granger Cause GERMANY_DAX30_PI		9.87711	4.3E-13
SA_JSE_ASI does not Granger Cause USA_NYSE_IND	739	1.46298	0.16712
USA_NYSE_IND does not Granger Cause SA_JSE_ASI		5.11520	3.2E-06
UK_FTSE_ASI does not Granger Cause USA_NYSE_IND	739	2.13929	0.03027
USA_NYSE_IND does not Granger Cause UK_FTSE_ASI		49.6205	7.4E-64
CANADA_TSI_PI does not Granger Cause USA_NYSE_IND	739	1.69454	0.09618

USA_NYSE_IND does not Granger Cause CANADA_TSI_PI		46.2118	4.7E-60
EGYPT_CAIRO_INDEX does not Granger Cause JAPAN_NIKKEI_IND	739	1.21839	0.28508
JAPAN_NIKKEI_IND does not Granger Cause EGYPT_CAIRO_INDEX		2.29983	0.01947
FRANCE_CAC40_PI does not Granger Cause JAPAN_NIKKEI_IND	739	1.98559	0.04568
JAPAN_NIKKEI_IND does not Granger Cause FRANCE_CAC40_PI		6.10049	1.3E-07
GERMANY_DAX30_PI does not Granger Cause JAPAN_NIKKEI_IND	739	1.98205	0.04610
JAPAN_NIKKEI_IND does not Granger Cause GERMANY_DAX30_PI		6.30771	6.4E-08
SA_JSE_ASI does not Granger Cause JAPAN_NIKKEI_IND	739	3.33353	0.00093
JAPAN_NIKKEI_IND does not Granger Cause SA_JSE_ASI		2.81917	0.00439
UK_FTSE_ASI does not Granger Cause JAPAN_NIKKEI_IND	739	1.03400	0.40858
JAPAN_NIKKEI_IND does not Granger Cause UK_FTSE_ASI		21.4783	2.0E-29
CANADA_TSI_PI does not Granger Cause JAPAN_NIKKEI_IND	739	1.87045	0.06168
JAPAN_NIKKEI_IND does not Granger Cause CANADA_TSI_PI		18.9378	5.9E-26
FRANCE_CAC40_PI does not Granger Cause EGYPT_CAIRO_INDEX	739	3.71960	0.00028
EGYPT_CAIRO_INDEX does not Granger Cause FRANCE_CAC40_PI		1.30162	0.23927
GERMANY_DAX30_PI does not Granger Cause EGYPT_CAIRO_INDEX	739	3.42139	0.00071
EGYPT_CAIRO_INDEX does not Granger Cause GERMANY_DAX30_PI		1.41674	0.18567
SA_JSE_ASI does not Granger Cause EGYPT_CAIRO_INDEX	739	3.22937	0.00128
EGYPT_CAIRO_INDEX does not Granger Cause SA_JSE_ASI		1.72219	0.08981
UK_FTSE_ASI does not Granger Cause EGYPT_CAIRO_INDEX	739	2.13554	0.03058
EGYPT_CAIRO_INDEX does not Granger Cause UK_FTSE_ASI		6.22644	8.4E-08
CANADA_TSI_PI does not Granger Cause EGYPT_CAIRO_INDEX	739	1.58085	0.12678
EGYPT_CAIRO_INDEX does not Granger Cause CANADA_TSI_PI		5.42730	1.2E-06
GERMANY_DAX30_PI does not Granger Cause FRANCE_CAC40_PI	739	0.60041	0.77797
FRANCE_CAC40_PI does not Granger Cause GERMANY_DAX30_PI		0.69245	0.69845
SA_JSE_ASI does not Granger Cause FRANCE_CAC40_PI	739	1.42607	0.18180
FRANCE_CAC40_PI does not Granger Cause SA_JSE_ASI		0.85587	0.55367
UK_FTSE_ASI does not Granger Cause FRANCE_CAC40_PI	739	0.89175	0.52284
FRANCE_CAC40_PI does not Granger Cause UK_FTSE_ASI		25.1506	2.4E-34
CANADA_TSI_PI does not Granger Cause FRANCE_CAC40_PI	739	0.66942	0.71875

FRANCE_CAC40_PI does not Granger Cause CANADA_TSI_PI		14.1591	3.0E-19
SA_JSE_ASI does not Granger Cause GERMANY_DAX30_PI	739	1.36023	0.21061
GERMANY_DAX30_PI does not Granger Cause SA_JSE_ASI		0.72438	0.67009
UK_FTSE_ASI does not Granger Cause GERMANY_DAX30_PI	739	1.48564	0.15862
GERMANY_DAX30_PI does not Granger Cause UK_FTSE_ASI		17.5698	4.7E-24
CANADA_TSI_PI does not Granger Cause GERMANY_DAX30_PI	739	0.52536	0.83788
GERMANY_DAX30_PI does not Granger Cause CANADA_TSI_PI		12.8709	2.1E-17
UK_FTSE_ASI does not Granger Cause SA_JSE_ASI	739	1.03093	0.41089
SA_JSE_ASI does not Granger Cause UK_FTSE_ASI		9.76061	6.4E-13
CANADA_TSI_PI does not Granger Cause SA_JSE_ASI	739	1.27579	0.25283
SA_JSE_ASI does not Granger Cause CANADA_TSI_PI		12.6571	4.2E-17
CANADA_TSI_PI does not Granger Cause UK_FTSE_ASI	739	1.68874	0.09756
UK_FTSE_ASI does not Granger Cause CANADA_TSI_PI		1.07026	0.38194

Portfolio H – 2 lags

Pairwise Granger Causality Tests

Date: 11/30/10 Time: 19:26

Sample: 12/29/1995 4/22/2010

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
AUS_ASX_ASI does not Granger Cause SA_JSE_ASI	745	3.62727	0.02706
SA_JSE_ASI does not Granger Cause AUS_ASX_ASI		1.68511	0.18614
HK_HANGSENG_IND does not Granger Cause SA_JSE_ASI	745	11.4745	1.2E-05
SA_JSE_ASI does not Granger Cause HK_HANGSENG_IND		1.86155	0.15616
JAPAN_NIKKEI_IND does not Granger Cause SA_JSE_ASI	745	6.16347	0.00221
SA_JSE_ASI does not Granger Cause JAPAN_NIKKEI_IND		1.00821	0.36537
PHIL_SE_PI does not Granger Cause SA_JSE_ASI	745	1.77442	0.17030
SA_JSE_ASI does not Granger Cause PHIL_SE_PI		9.02587	0.00013
ARG_MERVAL_IND does not Granger Cause SA_JSE_ASI	745	16.3836	1.1E-07
SA_JSE_ASI does not Granger Cause ARG_MERVAL_IND		2.21181	0.11023
USA_NYSE_IND does not Granger Cause SA_JSE_ASI	745	10.6571	2.7E-05
SA_JSE_ASI does not Granger Cause USA_NYSE_IND		0.16821	0.84521
RUSSIA_RTS_PI does not Granger Cause SA_JSE_ASI	745	4.83635	0.00819
SA_JSE_ASI does not Granger Cause RUSSIA_RTS_PI		2.25010	0.10611

HK_HANGSENG_IND does not Granger Cause AUS_ASX_ASI	745	0.54316	0.58114
AUS_ASX_ASI does not Granger Cause HK_HANGSENG_IND		1.29333	0.27498
JAPAN_NIKKEI_IND does not Granger Cause AUS_ASX_ASI	745	7.34605	0.00069
AUS_ASX_ASI does not Granger Cause JAPAN_NIKKEI_IND		0.66794	0.51307
PHIL_SE_PI does not Granger Cause AUS_ASX_ASI	745	0.84287	0.43089
AUS_ASX_ASI does not Granger Cause PHIL_SE_PI		8.40036	0.00025
ARG_MERVAL_IND does not Granger Cause AUS_ASX_ASI	745	8.60038	0.00020
AUS_ASX_ASI does not Granger Cause ARG_MERVAL_IND		1.20131	0.30138
USA_NYSE_IND does not Granger Cause AUS_ASX_ASI	745	22.5557	3.1E-10
AUS_ASX_ASI does not Granger Cause USA_NYSE_IND		0.38592	0.67996
RUSSIA_RTS_PI does not Granger Cause AUS_ASX_ASI	745	1.19845	0.30225
AUS_ASX_ASI does not Granger Cause RUSSIA_RTS_PI		1.78115	0.16917
JAPAN_NIKKEI_IND does not Granger Cause HK_HANGSENG_IND	745	4.53832	0.01099
HK_HANGSENG_IND does not Granger Cause JAPAN_NIKKEI_IND		1.32560	0.26627
PHIL_SE_PI does not Granger Cause HK_HANGSENG_IND	745	1.14009	0.32035
HK_HANGSENG_IND does not Granger Cause PHIL_SE_PI		18.2857	1.8E-08
ARG_MERVAL_IND does not Granger Cause HK_HANGSENG_IND	745	10.3944	3.5E-05
HK_HANGSENG_IND does not Granger Cause ARG_MERVAL_IND		0.21834	0.80391
USA_NYSE_IND does not Granger Cause HK_HANGSENG_IND	745	7.19625	0.00080
HK_HANGSENG_IND does not Granger Cause USA_NYSE_IND		0.27179	0.76209
RUSSIA_RTS_PI does not Granger Cause HK_HANGSENG_IND	745	0.42718	0.65251
HK_HANGSENG_IND does not Granger Cause RUSSIA_RTS_PI		3.10202	0.04554
PHIL_SE_PI does not Granger Cause JAPAN_NIKKEI_IND	745	2.30842	0.10013
JAPAN_NIKKEI_IND does not Granger Cause PHIL_SE_PI		14.5679	6.2E-07
ARG_MERVAL_IND does not Granger Cause JAPAN_NIKKEI_IND	745	0.35392	0.70205
JAPAN_NIKKEI_IND does not Granger Cause ARG_MERVAL_IND		2.16145	0.11588
USA_NYSE_IND does not Granger Cause JAPAN_NIKKEI_IND	745	1.29848	0.27357
JAPAN_NIKKEI_IND does not Granger Cause USA_NYSE_IND		0.14524	0.86484
RUSSIA_RTS_PI does not Granger Cause JAPAN_NIKKEI_IND	745	4.48631	0.01157
JAPAN_NIKKEI_IND does not Granger Cause RUSSIA_RTS_PI		0.90505	0.40497
ARG_MERVAL_IND does not Granger Cause PHIL_SE_PI	745	25.3509	2.2E-11
PHIL_SE_PI does not Granger Cause ARG_MERVAL_IND		0.28255	0.75394

USA_NYSE_IND does not Granger Cause PHIL_SE_PI	745	20.0030	3.5E-09
PHIL_SE_PI does not Granger Cause USA_NYSE_IND		0.51244	0.59925
RUSSIA_RTS_PI does not Granger Cause PHIL_SE_PI	745	8.24029	0.00029
PHIL_SE_PI does not Granger Cause RUSSIA_RTS_PI		1.15461	0.31575
USA_NYSE_IND does not Granger Cause ARG_MERVAL_IND	745	1.06040	0.34684
ARG_MERVAL_IND does not Granger Cause USA_NYSE_IND		3.14881	0.04348
RUSSIA_RTS_PI does not Granger Cause ARG_MERVAL_IND	745	1.37199	0.25425
ARG_MERVAL_IND does not Granger Cause RUSSIA_RTS_PI		9.30800	0.00010
RUSSIA_RTS_PI does not Granger Cause USA_NYSE_IND	745	1.28086	0.27841
USA_NYSE_IND does not Granger Cause RUSSIA_RTS_PI		3.08520	0.04631

Portfolio H – 4 lags

Pairwise Granger Causality Tests

Date: 11/30/10 Time: 19:57

Sample: 12/29/1995 4/22/2010

Lags: 4

Null Hypothesis:	Obs	F-Statistic	Probability
ARG_MERVAL_IND does not Granger Cause USA_NYSE_IND	743	2.52080	0.03996
USA_NYSE_IND does not Granger Cause ARG_MERVAL_IND		2.86891	0.02240
JAPAN_NIKKEI_IND does not Granger Cause USA_NYSE_IND	743	0.87529	0.47825
USA_NYSE_IND does not Granger Cause JAPAN_NIKKEI_IND		2.88177	0.02192
HK_HANGSENG_IND does not Granger Cause USA_NYSE_IND	743	1.52760	0.19228
USA_NYSE_IND does not Granger Cause HK_HANGSENG_IND		4.65670	0.00102
SA_JSE_ASI does not Granger Cause USA_NYSE_IND	743	1.75151	0.13683
USA_NYSE_IND does not Granger Cause SA_JSE_ASI		7.12195	1.3E-05
RUSSIA_RTS_PI does not Granger Cause USA_NYSE_IND	743	0.94434	0.43763
USA_NYSE_IND does not Granger Cause RUSSIA_RTS_PI		3.02107	0.01734
AUS_ASX_ASI does not Granger Cause USA_NYSE_IND	743	0.91951	0.45194
USA_NYSE_IND does not Granger Cause AUS_ASX_ASI		13.5935	1.1E-10
PHIL_SE_PI does not Granger Cause USA_NYSE_IND	743	2.14411	0.07373
USA_NYSE_IND does not Granger Cause PHIL_SE_PI		15.5207	3.4E-12
JAPAN_NIKKEI_IND does not Granger Cause ARG_MERVAL_IND	743	2.36674	0.05143
ARG_MERVAL_IND does not Granger Cause JAPAN_NIKKEI_IND		0.77532	0.54141

HK_HANGSENG_IND does not Granger Cause ARG_MERVAL_IND	743	3.65383	0.00588
ARG_MERVAL_IND does not Granger Cause HK_HANGSENG_IND		6.91665	1.8E-05
SA_JSE_ASI does not Granger Cause ARG_MERVAL_IND	743	2.75342	0.02717
ARG_MERVAL_IND does not Granger Cause SA_JSE_ASI		8.26939	1.6E-06
RUSSIA_RTS_PI does not Granger Cause ARG_MERVAL_IND	743	1.26920	0.28057
ARG_MERVAL_IND does not Granger Cause RUSSIA_RTS_PI		6.02759	8.9E-05
AUS_ASX_ASI does not Granger Cause ARG_MERVAL_IND	743	1.81998	0.12306
ARG_MERVAL_IND does not Granger Cause AUS_ASX_ASI		6.18418	6.8E-05
PHIL_SE_PI does not Granger Cause ARG_MERVAL_IND	743	1.64607	0.16081
ARG_MERVAL_IND does not Granger Cause PHIL_SE_PI		15.2258	5.7E-12
HK_HANGSENG_IND does not Granger Cause JAPAN_NIKKEI_IND	743	0.80754	0.52051
JAPAN_NIKKEI_IND does not Granger Cause HK_HANGSENG_IND		2.38133	0.05022
SA_JSE_ASI does not Granger Cause JAPAN_NIKKEI_IND	743	1.94277	0.10155
JAPAN_NIKKEI_IND does not Granger Cause SA_JSE_ASI		3.29300	0.01092
RUSSIA_RTS_PI does not Granger Cause JAPAN_NIKKEI_IND	743	2.20609	0.06674
JAPAN_NIKKEI_IND does not Granger Cause RUSSIA_RTS_PI		0.88158	0.47444
AUS_ASX_ASI does not Granger Cause JAPAN_NIKKEI_IND	743	0.75921	0.55203
JAPAN_NIKKEI_IND does not Granger Cause AUS_ASX_ASI		3.93629	0.00361
PHIL_SE_PI does not Granger Cause JAPAN_NIKKEI_IND	743	3.08280	0.01562
JAPAN_NIKKEI_IND does not Granger Cause PHIL_SE_PI		9.49085	1.7E-07
SA_JSE_ASI does not Granger Cause HK_HANGSENG_IND	743	1.28988	0.27240
HK_HANGSENG_IND does not Granger Cause SA_JSE_ASI		5.86597	0.00012
RUSSIA_RTS_PI does not Granger Cause HK_HANGSENG_IND	743	3.04699	0.01659
HK_HANGSENG_IND does not Granger Cause RUSSIA_RTS_PI		3.43317	0.00860
AUS_ASX_ASI does not Granger Cause HK_HANGSENG_IND	743	0.95162	0.43349
HK_HANGSENG_IND does not Granger Cause AUS_ASX_ASI		1.14756	0.33291
PHIL_SE_PI does not Granger Cause HK_HANGSENG_IND	743	1.45949	0.21278
HK_HANGSENG_IND does not Granger Cause PHIL_SE_PI		11.7192	3.1E-09
RUSSIA_RTS_PI does not Granger Cause SA_JSE_ASI	743	2.49400	0.04176
SA_JSE_ASI does not Granger Cause RUSSIA_RTS_PI		2.59573	0.03531
AUS_ASX_ASI does not Granger Cause SA_JSE_ASI	743	1.88187	0.11174
SA_JSE_ASI does not Granger Cause AUS_ASX_ASI		1.66111	0.15717

PHIL_SE_PI does not Granger Cause SA_JSE_ASI	743	0.93521	0.44285
SA_JSE_ASI does not Granger Cause PHIL_SE_PI		5.92888	0.00011
AUS_ASX_ASI does not Granger Cause RUSSIA_RTS_PI	743	2.50366	0.04110
RUSSIA_RTS_PI does not Granger Cause AUS_ASX_ASI		1.91184	0.10661
PHIL_SE_PI does not Granger Cause RUSSIA_RTS_PI	743	1.29179	0.27166
RUSSIA_RTS_PI does not Granger Cause PHIL_SE_PI		5.34797	0.00030
PHIL_SE_PI does not Granger Cause AUS_ASX_ASI	743	1.33898	0.25381
AUS_ASX_ASI does not Granger Cause PHIL_SE_PI		6.57321	3.4E-05

Portfolio I – 2 lags

Pairwise Granger Causality Tests
Date: 11/30/10 Time: 20:07
Sample: 12/29/1995 4/22/2010
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
CANADA_TSI_PI does not Granger Cause SA_JSE_ASI	745	0.92140	0.39842
SA_JSE_ASI does not Granger Cause CANADA_TSI_PI		37.1051	4.4E-16
CHINA_SHANG_ASI does not Granger Cause SA_JSE_ASI	745	0.23352	0.79180
SA_JSE_ASI does not Granger Cause CHINA_SHANG_ASI		3.14384	0.04369
FRANCE_CAC40_PI does not Granger Cause SA_JSE_ASI	745	1.21042	0.29866
SA_JSE_ASI does not Granger Cause FRANCE_CAC40_PI		0.58481	0.55747
SUI_MKT_IND does not Granger Cause SA_JSE_ASI	745	4.68253	0.00953
SA_JSE_ASI does not Granger Cause SUI_MKT_IND		0.29335	0.74585
RUSSIA_RTS_PI does not Granger Cause SA_JSE_ASI	745	4.83635	0.00819
SA_JSE_ASI does not Granger Cause RUSSIA_RTS_PI		2.25010	0.10611
EGYPT_CAIRO_INDEX does not Granger Cause SA_JSE_ASI	745	2.11310	0.12159
SA_JSE_ASI does not Granger Cause EGYPT_CAIRO_INDEX		4.10626	0.01685
USA_NYSE_IND does not Granger Cause SA_JSE_ASI	745	10.6571	2.7E-05
SA_JSE_ASI does not Granger Cause USA_NYSE_IND		0.16821	0.84521
CHINA_SHANG_ASI does not Granger Cause CANADA_TSI_PI	745	1.86291	0.15595
CANADA_TSI_PI does not Granger Cause CHINA_SHANG_ASI		4.18832	0.01553
FRANCE_CAC40_PI does not Granger Cause CANADA_TSI_PI	745	45.4119	2.5E-19
CANADA_TSI_PI does not Granger Cause FRANCE_CAC40_PI		0.33892	0.71265
SUI_MKT_IND does not Granger Cause CANADA_TSI_PI	745	63.6700	3.1E-26

CANADA_TSI_PI does not Granger Cause SUI_MKT_IND		0.14456	0.86543
RUSSIA_RTS_PI does not Granger Cause CANADA_TSI_PI	745	47.4988	3.9E-20
CANADA_TSI_PI does not Granger Cause RUSSIA_RTS_PI		0.26221	0.76942
EGYPT_CAIRO_INDEX does not Granger Cause CANADA_TSI_PI	745	13.1514	2.4E-06
CANADA_TSI_PI does not Granger Cause EGYPT_CAIRO_INDEX		2.17614	0.11420
USA_NYSE_IND does not Granger Cause CANADA_TSI_PI	745	163.284	1.8E-59
CANADA_TSI_PI does not Granger Cause USA_NYSE_IND		0.08518	0.91836
FRANCE_CAC40_PI does not Granger Cause CHINA_SHANG_ASI	745	2.89991	0.05565
CHINA_SHANG_ASI does not Granger Cause FRANCE_CAC40_PI		1.58277	0.20610
SUI_MKT_IND does not Granger Cause CHINA_SHANG_ASI	745	5.20297	0.00570
CHINA_SHANG_ASI does not Granger Cause SUI_MKT_IND		0.18286	0.83292
RUSSIA_RTS_PI does not Granger Cause CHINA_SHANG_ASI	745	2.69571	0.06816
CHINA_SHANG_ASI does not Granger Cause RUSSIA_RTS_PI		0.73859	0.47814
EGYPT_CAIRO_INDEX does not Granger Cause CHINA_SHANG_ASI	745	2.77016	0.06330
CHINA_SHANG_ASI does not Granger Cause EGYPT_CAIRO_INDEX		0.85853	0.42421
USA_NYSE_IND does not Granger Cause CHINA_SHANG_ASI	745	11.2576	1.5E-05
CHINA_SHANG_ASI does not Granger Cause USA_NYSE_IND		1.64910	0.19293
SUI_MKT_IND does not Granger Cause FRANCE_CAC40_PI	745	17.4372	4.0E-08
FRANCE_CAC40_PI does not Granger Cause SUI_MKT_IND		1.02643	0.35879
RUSSIA_RTS_PI does not Granger Cause FRANCE_CAC40_PI	745	3.57173	0.02859
FRANCE_CAC40_PI does not Granger Cause RUSSIA_RTS_PI		1.30206	0.27259
EGYPT_CAIRO_INDEX does not Granger Cause FRANCE_CAC40_PI	745	0.30197	0.73945
FRANCE_CAC40_PI does not Granger Cause EGYPT_CAIRO_INDEX		6.81801	0.00116
USA_NYSE_IND does not Granger Cause FRANCE_CAC40_PI	745	22.2313	4.2E-10
FRANCE_CAC40_PI does not Granger Cause USA_NYSE_IND		0.60821	0.54460
RUSSIA_RTS_PI does not Granger Cause SUI_MKT_IND	745	1.24662	0.28808
SUI_MKT_IND does not Granger Cause RUSSIA_RTS_PI		2.88313	0.05659
EGYPT_CAIRO_INDEX does not Granger Cause SUI_MKT_IND	745	4.00725	0.01858
SUI_MKT_IND does not Granger Cause EGYPT_CAIRO_INDEX		4.27587	0.01425
USA_NYSE_IND does not Granger Cause SUI_MKT_IND	745	1.35696	0.25808
SUI_MKT_IND does not Granger Cause USA_NYSE_IND		0.17008	0.84363

EGYPT_CAIRO_INDEX does not Granger Cause RUSSIA_RTS_PI	745	0.45033	0.63759
RUSSIA_RTS_PI does not Granger Cause EGYPT_CAIRO_INDEX		6.58989	0.00146
USA_NYSE_IND does not Granger Cause RUSSIA_RTS_PI	745	3.08520	0.04631
RUSSIA_RTS_PI does not Granger Cause USA_NYSE_IND		1.28086	0.27841
USA_NYSE_IND does not Granger Cause EGYPT_CAIRO_INDEX	745	6.52681	0.00155
EGYPT_CAIRO_INDEX does not Granger Cause USA_NYSE_IND		3.90801	0.02050

Portfolio I – 9 lags

Pairwise Granger Causality Tests

Date: 11/30/10 Time: 20:29

Sample: 12/29/1995 4/22/2010

Lags: 9

Null Hypothesis:	Obs	F-Statistic	Probability
SUI_MKT_IND does not Granger Cause USA_NYSE_IND	738	0.58535	0.80976
USA_NYSE_IND does not Granger Cause SUI_MKT_IND		1.07598	0.37820
RUSSIA_RTS_PI does not Granger Cause USA_NYSE_IND	738	1.51329	0.13895
USA_NYSE_IND does not Granger Cause RUSSIA_RTS_PI		2.24387	0.01783
EGYPT_CAIRO_INDEX does not Granger Cause USA_NYSE_IND	738	2.64292	0.00514
USA_NYSE_IND does not Granger Cause EGYPT_CAIRO_INDEX		3.11169	0.00111
SA_JSE_ASI does not Granger Cause USA_NYSE_IND	738	1.31574	0.22469
USA_NYSE_IND does not Granger Cause SA_JSE_ASI		4.57035	7.0E-06
FRANCE_CAC40_PI does not Granger Cause USA_NYSE_IND	738	1.68495	0.08877
USA_NYSE_IND does not Granger Cause FRANCE_CAC40_PI		9.04713	5.0E-13
CANADA_TSI_PI does not Granger Cause USA_NYSE_IND	738	1.51221	0.13933
USA_NYSE_IND does not Granger Cause CANADA_TSI_PI		41.6488	5.7E-60
CHINA_SHANG_ASI does not Granger Cause USA_NYSE_IND	738	2.30840	0.01465
USA_NYSE_IND does not Granger Cause CHINA_SHANG_ASI		2.41031	0.01070
RUSSIA_RTS_PI does not Granger Cause SUI_MKT_IND	738	1.71425	0.08203
SUI_MKT_IND does not Granger Cause RUSSIA_RTS_PI		2.44774	0.00952
EGYPT_CAIRO_INDEX does not Granger Cause SUI_MKT_IND	738	2.30769	0.01468
SUI_MKT_IND does not Granger Cause EGYPT_CAIRO_INDEX		2.32972	0.01372
SA_JSE_ASI does not Granger Cause SUI_MKT_IND	738	1.38086	0.19265
SUI_MKT_IND does not Granger Cause SA_JSE_ASI		3.05740	0.00133

FRANCE_CAC40_PI does not Granger Cause SUI_MKT_IND	738	1.38957	0.18866
SUI_MKT_IND does not Granger Cause FRANCE_CAC40_PI		7.36011	2.6E-10
CANADA_TSI_PI does not Granger Cause SUI_MKT_IND	738	1.37670	0.19458
SUI_MKT_IND does not Granger Cause CANADA_TSI_PI		17.7082	1.1E-26
CHINA_SHANG_ASI does not Granger Cause SUI_MKT_IND	738	1.68291	0.08926
SUI_MKT_IND does not Granger Cause CHINA_SHANG_ASI		1.47511	0.15295
EGYPT_CAIRO_INDEX does not Granger Cause RUSSIA_RTS_PI	738	0.85306	0.56731
RUSSIA_RTS_PI does not Granger Cause EGYPT_CAIRO_INDEX		2.37245	0.01203
SA_JSE_ASI does not Granger Cause RUSSIA_RTS_PI	738	2.25726	0.01712
RUSSIA_RTS_PI does not Granger Cause SA_JSE_ASI		2.22425	0.01892
FRANCE_CAC40_PI does not Granger Cause RUSSIA_RTS_PI	738	0.73560	0.67639
RUSSIA_RTS_PI does not Granger Cause FRANCE_CAC40_PI		2.81327	0.00297
CANADA_TSI_PI does not Granger Cause RUSSIA_RTS_PI	738	1.67037	0.09230
RUSSIA_RTS_PI does not Granger Cause CANADA_TSI_PI		11.1806	1.9E-16
CHINA_SHANG_ASI does not Granger Cause RUSSIA_RTS_PI	738	1.45136	0.16225
RUSSIA_RTS_PI does not Granger Cause CHINA_SHANG_ASI		1.31903	0.22297
SA_JSE_ASI does not Granger Cause EGYPT_CAIRO_INDEX	738	2.99167	0.00165
EGYPT_CAIRO_INDEX does not Granger Cause SA_JSE_ASI		1.74929	0.07458
FRANCE_CAC40_PI does not Granger Cause EGYPT_CAIRO_INDEX	738	3.31213	0.00057
EGYPT_CAIRO_INDEX does not Granger Cause FRANCE_CAC40_PI		1.17238	0.30963
CANADA_TSI_PI does not Granger Cause EGYPT_CAIRO_INDEX	738	1.49459	0.14567
EGYPT_CAIRO_INDEX does not Granger Cause CANADA_TSI_PI		5.20502	7.1E-07
CHINA_SHANG_ASI does not Granger Cause EGYPT_CAIRO_INDEX	738	1.44734	0.16387
EGYPT_CAIRO_INDEX does not Granger Cause CHINA_SHANG_ASI		1.38587	0.19035
FRANCE_CAC40_PI does not Granger Cause SA_JSE_ASI	738	0.79035	0.62540
SA_JSE_ASI does not Granger Cause FRANCE_CAC40_PI		1.31067	0.22735
CANADA_TSI_PI does not Granger Cause SA_JSE_ASI	738	1.30791	0.22881
SA_JSE_ASI does not Granger Cause CANADA_TSI_PI		11.8877	1.4E-17
CHINA_SHANG_ASI does not Granger Cause SA_JSE_ASI	738	0.51798	0.86213
SA_JSE_ASI does not Granger Cause CHINA_SHANG_ASI		1.21909	0.27972
CANADA_TSI_PI does not Granger Cause FRANCE_CAC40_PI	738	0.67616	0.73095

FRANCE_CAC40_PI does not Granger Cause CANADA_TSI_PI		12.6961	7.4E-19
CHINA_SHANG_ASI does not Granger Cause FRANCE_CAC40_PI	738	1.02052	0.42166
FRANCE_CAC40_PI does not Granger Cause CHINA_SHANG_ASI		1.00567	0.43375
CHINA_SHANG_ASI does not Granger Cause CANADA_TSI_PI	738	3.01277	0.00154
CANADA_TSI_PI does not Granger Cause CHINA_SHANG_ASI		1.72405	0.07988

Appendix O - block exogeneity tests to determine which markets Granger cause others

Portfolio A – 2 lags

VEC Granger Causality/Block Exogeneity Wald Tests
Date: 12/15/10 Time: 08:32
Sample: 12/29/1995 4/16/2010
Included observations: 745

Dependent variable: D(USA_NYSE_IND)

Excluded	Chi-sq	df	Prob.
D(GERMANY_DAX30_PI)	0.077908	1	0.7802
D(UK_FTSE_ASI)	1.159700	1	0.2815
D(SA_JSE_ASI)	0.007073	1	0.9330
All	1.250223	3	0.7410

Dependent variable: D(GERMANY_DAX30_PI)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	57.33129	1	0.0000
D(UK_FTSE_ASI)	0.566883	1	0.4515
D(SA_JSE_ASI)	2.179994	1	0.1398
All	57.55980	3	0.0000

Dependent variable: D(UK_FTSE_ASI)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	167.8475	1	0.0000
D(GERMANY_DAX30_PI)	3.841954	1	0.0500
D(SA_JSE_ASI)	0.506963	1	0.4765
All	316.0991	3	0.0000

Dependent variable: D(SA_JSE_ASI)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	22.49039	1	0.0000
D(GERMANY_DAX30_PI)	1.543983	1	0.2140

D(UK_FTSE_ASI)	0.461276	1	0.4970
All	24.00686	3	0.0000

Portfolio A – 4 lags

VEC Granger Causality/Block Exogeneity Wald Tests
Date: 12/15/10 Time: 08:30
Sample: 12/29/1995 4/16/2010
Included observations: 743

Dependent variable: D(USA_NYSE_IND)

Excluded	Chi-sq	df	Prob.
D(GERMANY_DAX30_PI)	1.591713	3	0.6613
D(UK_FTSE_ASI)	5.254017	3	0.1541
D(SA_JSE_ASI)	3.974845	3	0.2642
All	12.02366	9	0.2120

Dependent variable: D(GERMANY_DAX30_PI)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	77.13448	3	0.0000
D(UK_FTSE_ASI)	0.548572	3	0.9081
D(SA_JSE_ASI)	4.497887	3	0.2125
All	78.22391	9	0.0000

Dependent variable: D(UK_FTSE_ASI)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	199.8489	3	0.0000
D(GERMANY_DAX30_PI)	6.869222	3	0.0762
D(SA_JSE_ASI)	1.028760	3	0.7943
All	368.9457	9	0.0000

Dependent variable: D(SA_JSE_ASI)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	32.97827	3	0.0000
D(GERMANY_DAX30_PI)	9.643750	3	0.0219
D(UK_FTSE_ASI)	4.330367	3	0.2279
All	42.45449	9	0.0000

Portfolio B – 2 lags

VEC Granger Causality/Block Exogeneity Wald Tests
Date: 12/15/10 Time: 08:35
Sample: 12/29/1995 4/16/2010
Included observations: 745

Dependent variable: D(SA_JSE_ASI)

Excluded	Chi-sq	df	Prob.
D(HK_HANGSENG_IND)	12.48942	1	0.0004
D(AUS_ASX_ASI)	0.594015	1	0.4409
D(JAPAN_NIKKEI_IND)	5.957530	1	0.0147
All	26.76582	3	0.0000

Dependent variable: D(HK_HANGSENG_IND)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	0.695543	1	0.4043
D(AUS_ASX_ASI)	0.010417	1	0.9187
D(JAPAN_NIKKEI_IND)	6.487149	1	0.0109
All	8.851420	3	0.0313

Dependent variable: D(AUS_ASX_ASI)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	1.989498	1	0.1584
D(HK_HANGSENG_IND)	0.011621	1	0.9142
D(JAPAN_NIKKEI_IND)	12.38602	1	0.0004

All	16.29188	3	0.0010

Dependent variable: D(JAPAN_NIKKEI_IND)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	0.665727	1	0.4145
D(HK_HANGSENG_IND)	0.552950	1	0.4571
D(AUS_ASX_ASI)	0.000575	1	0.9809
All	2.175453	3	0.5368

Portfolio B – 1 lag – block exogeneity tests not possible at 1 lag.

Portfolio C – 2 lags

VEC Granger Causality/Block Exogeneity Wald Tests
Date: 12/15/10 Time: 08:39
Sample: 12/29/1995 4/16/2010
Included observations: 745

Dependent variable: D(CANADA_TSI_PI)

Excluded	Chi-sq	df	Prob.
D(CHINA_SHANG_ASI)	6.184593	1	0.0129
D(FRANCE_CAC40_PI)	41.20741	1	0.0000
D(SA_JSE_ASI)	18.56243	1	0.0000
All	115.6147	3	0.0000

Dependent variable: D(CHINA_SHANG_ASI)

Excluded	Chi-sq	df	Prob.
D(CANADA_TSI_PI)	3.080824	1	0.0792
D(FRANCE_CAC40_PI)	1.389528	1	0.2385
D(SA_JSE_ASI)	0.038119	1	0.8452
All	8.198809	3	0.0421

Dependent variable: D(FRANCE_CAC40_PI)

Excluded	Chi-sq	df	Prob.
D(CANADA_TSI_PI)	0.517826	1	0.4718
D(CHINA_SHANG_ASI)	2.113281	1	0.1460
D(SA_JSE_ASI)	0.000156	1	0.9900
All	2.460217	3	0.4825

Dependent variable: D(SA_JSE_ASI)

Excluded	Chi-sq	df	Prob.
D(CANADA_TSI_PI)	1.361240	1	0.2433
D(CHINA_SHANG_ASI)	0.411534	1	0.5212
D(FRANCE_CAC40_PI)	1.423153	1	0.2329
All	4.144861	3	0.2462

Portfolio C – 4 lags

VEC Granger Causality/Block Exogeneity Wald Tests
Date: 12/15/10 Time: 08:40
Sample: 12/29/1995 4/16/2010
Included observations: 743

Dependent variable: D(CANADA_TSI_PI)

Excluded	Chi-sq	df	Prob.
D(CHINA_SHANG_ASI)	7.002703	3	0.0718
D(FRANCE_CAC40_PI)	56.76492	3	0.0000
D(SA_JSE_ASI)	20.92842	3	0.0001
All	138.4008	9	0.0000

Dependent variable: D(CHINA_SHANG_ASI)

Excluded	Chi-sq	df	Prob.
D(CANADA_TSI_PI)	8.506474	3	0.0366
D(FRANCE_CAC40_PI)	2.093878	3	0.5532
D(SA_JSE_ASI)	0.804676	3	0.8483

All	16.19934	9	0.0628

Dependent variable: D(FRANCE_CAC40_PI)

Excluded	Chi-sq	df	Prob.
D(CANADA_TSI_PI)	3.258599	3	0.3534
D(CHINA_SHANG_ASI)	1.763444	3	0.6229
D(SA_JSE_ASI)	1.851145	3	0.6039
All	6.702255	9	0.6681

Dependent variable: D(SA_JSE_ASI)

Excluded	Chi-sq	df	Prob.
D(CANADA_TSI_PI)	2.167130	3	0.5385
D(CHINA_SHANG_ASI)	0.586561	3	0.8995
D(FRANCE_CAC40_PI)	2.900712	3	0.4072
All	6.650016	9	0.6735

Portfolio D – 2 lags

VEC Granger Causality/Block Exogeneity Wald Tests
Date: 12/15/10 Time: 08:45
Sample: 12/29/1995 4/16/2010
Included observations: 745

Dependent variable: D(USA_NYSE_IND)

Excluded	Chi-sq	df	Prob.
D(UK_FTSE_ASI)	1.330148	1	0.2488
D(SA_JSE_ASI)	0.009850	1	0.9209
D(GERMANY_DAX30_PI)	0.014692	1	0.9035
D(EGYPT_CAIRO_INDEX)	5.702645	1	0.0169
D(JAPAN_NIKKEI_IND)	0.681504	1	0.4091
All	6.934736	5	0.2255

Dependent variable: D(UK_FTSE_ASI)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	84.81055	1	0.0000
D(SA_JSE_ASI)	0.540904	1	0.4621
D(GERMANY_DAX30_PI)	2.157645	1	0.1419
D(EGYPT_CAIRO_INDEX)	1.000937	1	0.3171
D(JAPAN_NIKKEI_IND)	11.14013	1	0.0008
All	285.5400	5	0.0000

Dependent variable: D(SA_JSE_ASI)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	14.55537	1	0.0001
D(UK_FTSE_ASI)	0.039811	1	0.8419
D(GERMANY_DAX30_PI)	0.673678	1	0.4118
D(EGYPT_CAIRO_INDEX)	0.113753	1	0.7359
D(JAPAN_NIKKEI_IND)	1.635509	1	0.2009
All	29.79983	5	0.0000

Dependent variable: D(GERMANY_DAX30_PI)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	33.38401	1	0.0000
D(UK_FTSE_ASI)	1.027296	1	0.3108
D(SA_JSE_ASI)	2.375301	1	0.1233
D(EGYPT_CAIRO_INDEX)	6.483694	1	0.0109
D(JAPAN_NIKKEI_IND)	8.582036	1	0.0034
All	71.27205	5	0.0000

Dependent variable: D(EGYPT_CAIRO_INDEX)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	4.554808	1	0.0328
D(UK_FTSE_ASI)	0.573168	1	0.4490
D(SA_JSE_ASI)	1.845598	1	0.1743
D(GERMANY_DAX30_PI)	0.157593	1	0.6914
D(JAPAN_NIKKEI_IND)	0.084256	1	0.7716

All	15.73419	5	0.0076

Dependent variable: D(JAPAN_NIKKEI_IND)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	1.750042	1	0.1859
D(UK_FTSE_ASI)	0.756297	1	0.3845
D(SA_JSE_ASI)	0.073237	1	0.7867
D(GERMANY_DAX30_PI)	0.978185	1	0.3226
D(EGYPT_CAIRO_INDEX)	7.563191	1	0.0060
All	12.10244	5	0.0334

Portfolio D – 11 lags

VEC Granger Causality/Block Exogeneity Wald Tests

Date: 12/15/10 Time: 08:48

Sample: 12/29/1995 4/16/2010

Included observations: 736

Dependent variable: D(USA_NYSE_IND)

Excluded	Chi-sq	df	Prob.
D(UK_FTSE_ASI)	16.31850	10	0.0909
D(SA_JSE_ASI)	9.508929	10	0.4846
D(GERMANY_DAX30_PI)	7.335710	10	0.6934
D(EGYPT_CAIRO_INDEX)	17.61368	10	0.0618
D(JAPAN_NIKKEI_IND)	10.64906	10	0.3855
All	67.73330	50	0.0481

Dependent variable: D(UK_FTSE_ASI)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	159.7042	10	0.0000
D(SA_JSE_ASI)	7.595388	10	0.6683
D(GERMANY_DAX30_PI)	24.63134	10	0.0061
D(EGYPT_CAIRO_INDEX)	6.230762	10	0.7955
D(JAPAN_NIKKEI_IND)	27.79247	10	0.0019

All	493.7876	50	0.0000

Dependent variable: D(SA_JSE_ASI)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	37.62699	10	0.0000
D(UK_FTSE_ASI)	18.31955	10	0.0498
D(GERMANY_DAX30_PI)	16.32326	10	0.0907
D(EGYPT_CAIRO_INDEX)	6.150395	10	0.8025
D(JAPAN_NIKKEI_IND)	14.38160	10	0.1563
All	103.6652	50	0.0000

Dependent variable: D(GERMANY_DAX30_PI)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	69.40659	10	0.0000
D(UK_FTSE_ASI)	23.07034	10	0.0105
D(SA_JSE_ASI)	13.25726	10	0.2096
D(EGYPT_CAIRO_INDEX)	20.91693	10	0.0217
D(JAPAN_NIKKEI_IND)	29.08520	10	0.0012
All	173.8773	50	0.0000

Dependent variable: D(EGYPT_CAIRO_INDEX)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	23.58527	10	0.0088
D(UK_FTSE_ASI)	15.64858	10	0.1101
D(SA_JSE_ASI)	16.97014	10	0.0750
D(GERMANY_DAX30_PI)	10.18540	10	0.4244
D(JAPAN_NIKKEI_IND)	17.85844	10	0.0574
All	102.3792	50	0.0000

Dependent variable: D(JAPAN_NIKKEI_IND)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	34.05325	10	0.0002
D(UK_FTSE_ASI)	26.97092	10	0.0026

D(SA_JSE_ASI)	28.48488	10	0.0015
D(GERMANY_DAX30_PI)	17.26920	10	0.0686
D(EGYPT_CAIRO_INDEX)	16.53511	10	0.0853
All	112.5705	50	0.0000

Portfolio E – 2 lags

VEC Granger Causality/Block Exogeneity Wald Tests
Date: 12/15/10 Time: 08:52
Sample: 12/29/1995 4/16/2010
Included observations: 745

Dependent variable: D(AUS_ASX_ASI)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	2.280342	1	0.1310
D(HK_HANGSENG_IND)	0.004297	1	0.9477
D(JAPAN_NIKKEI_IND)	6.532946	1	0.0106
D(ARG_MERVAL_IND)	8.436800	1	0.0037
D(PHIL_SE_PI)	3.425185	1	0.0642
All	27.11006	5	0.0001

Dependent variable: D(SA_JSE_ASI)

Excluded	Chi-sq	df	Prob.
D(AUS_ASX_ASI)	0.971879	1	0.3242
D(HK_HANGSENG_IND)	7.750679	1	0.0054
D(JAPAN_NIKKEI_IND)	2.288266	1	0.1304
D(ARG_MERVAL_IND)	19.24074	1	0.0000
D(PHIL_SE_PI)	0.378443	1	0.5384
All	48.44904	5	0.0000

Dependent variable: D(HK_HANGSENG_IND)

Excluded	Chi-sq	df	Prob.
D(AUS_ASX_ASI)	0.003852	1	0.9505
D(SA_JSE_ASI)	0.658283	1	0.4172

D(JAPAN_NIKKEI_IND)	2.519259	1	0.1125
D(ARG_MERVAL_IND)	12.30416	1	0.0005
D(PHIL_SE_PI)	2.058390	1	0.1514
All	22.69669	5	0.0004

Dependent variable: D(JAPAN_NIKKEI_IND)

Excluded	Chi-sq	df	Prob.
D(AUS_ASX_ASI)	0.112725	1	0.7371
D(SA_JSE_ASI)	1.555464	1	0.2123
D(HK_HANGSENG_IND)	1.194055	1	0.2745
D(ARG_MERVAL_IND)	0.341581	1	0.5589
D(PHIL_SE_PI)	6.888061	1	0.0087
All	9.332602	5	0.0965

Dependent variable: D(ARG_MERVAL_IND)

Excluded	Chi-sq	df	Prob.
D(AUS_ASX_ASI)	1.966592	1	0.1608
D(SA_JSE_ASI)	2.143625	1	0.1432
D(HK_HANGSENG_IND)	0.014401	1	0.9045
D(JAPAN_NIKKEI_IND)	2.518563	1	0.1125
D(PHIL_SE_PI)	1.211477	1	0.2710
All	7.512797	5	0.1852

Dependent variable: D(PHIL_SE_PI)

Excluded	Chi-sq	df	Prob.
D(AUS_ASX_ASI)	0.744153	1	0.3883
D(SA_JSE_ASI)	2.317555	1	0.1279
D(HK_HANGSENG_IND)	10.39330	1	0.0013
D(JAPAN_NIKKEI_IND)	3.017810	1	0.0824
D(ARG_MERVAL_IND)	19.68093	1	0.0000
All	71.59909	5	0.0000

Portfolio E – 3 lags

VEC Granger Causality/Block Exogeneity Wald Tests
Date: 12/15/10 Time: 08:53
Sample: 12/29/1995 4/16/2010
Included observations: 744

Dependent variable: D(AUS_ASX_ASI)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	5.023899	2	0.0811
D(HK_HANGSENG_IND)	0.651116	2	0.7221
D(JAPAN_NIKKEI_IND)	7.464825	2	0.0239
D(ARG_MERVAL_IND)	10.00025	2	0.0067
D(PHIL_SE_PI)	4.171046	2	0.1242
All	32.95607	10	0.0003

Dependent variable: D(SA_JSE_ASI)

Excluded	Chi-sq	df	Prob.
D(AUS_ASX_ASI)	0.964642	2	0.6173
D(HK_HANGSENG_IND)	7.298320	2	0.0260
D(JAPAN_NIKKEI_IND)	2.507174	2	0.2855
D(ARG_MERVAL_IND)	19.49102	2	0.0001
D(PHIL_SE_PI)	0.299655	2	0.8609
All	47.67738	10	0.0000

Dependent variable: D(HK_HANGSENG_IND)

Excluded	Chi-sq	df	Prob.
D(AUS_ASX_ASI)	0.011261	2	0.9944
D(SA_JSE_ASI)	1.679251	2	0.4319
D(JAPAN_NIKKEI_IND)	2.920518	2	0.2322
D(ARG_MERVAL_IND)	15.28624	2	0.0005
D(PHIL_SE_PI)	4.793537	2	0.0910
All	29.13255	10	0.0012

Dependent variable: D(JAPAN_NIKKEI_IND)

Excluded	Chi-sq	df	Prob.
D(AUS_ASX_ASI)	0.843905	2	0.6558
D(SA_JSE_ASI)	3.003452	2	0.2227
D(HK_HANGSENG_IND)	1.445888	2	0.4853
D(ARG_MERVAL_IND)	0.958291	2	0.6193
D(PHIL_SE_PI)	7.829908	2	0.0199
All	14.43627	10	0.1540

Dependent variable: D(ARG_MERVAL_IND)

Excluded	Chi-sq	df	Prob.
D(AUS_ASX_ASI)	2.298928	2	0.3168
D(SA_JSE_ASI)	2.652294	2	0.2655
D(HK_HANGSENG_IND)	5.982855	2	0.0502
D(JAPAN_NIKKEI_IND)	2.457104	2	0.2927
D(PHIL_SE_PI)	4.805955	2	0.0904
All	24.06605	10	0.0074

Dependent variable: D(PHIL_SE_PI)

Excluded	Chi-sq	df	Prob.
D(AUS_ASX_ASI)	1.694925	2	0.4285
D(SA_JSE_ASI)	2.125530	2	0.3455
D(HK_HANGSENG_IND)	9.825215	2	0.0074
D(JAPAN_NIKKEI_IND)	4.400439	2	0.1108
D(ARG_MERVAL_IND)	21.85836	2	0.0000
All	86.14808	10	0.0000

Portfolio F – 2 lags

VEC Granger Causality/Block Exogeneity Wald Tests

Date: 12/15/10 Time: 08:57

Sample: 12/29/1995 4/16/2010

Included observations: 745

Dependent variable: D(SA_JSE_ASI)

Excluded	Chi-sq	df	Prob.
D(CANADA_TSI_PI)	0.970991	1	0.3244
D(CHINA_SHANG_ASI)	0.206968	1	0.6492
D(FRANCE_CAC40_PI)	0.377587	1	0.5389
D(SUI_MKT_IND)	5.810487	1	0.0159
D(RUSSIA_RTS_PI)	6.213257	1	0.0127
All	17.72666	5	0.0033

Dependent variable: D(CANADA_TSI_PI)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	5.872058	1	0.0154
D(CHINA_SHANG_ASI)	4.683065	1	0.0305
D(FRANCE_CAC40_PI)	3.057344	1	0.0804
D(SUI_MKT_IND)	35.66125	1	0.0000
D(RUSSIA_RTS_PI)	32.43790	1	0.0000
All	209.4256	5	0.0000

Dependent variable: D(CHINA_SHANG_ASI)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	0.127523	1	0.7210
D(CANADA_TSI_PI)	2.726693	1	0.0987
D(FRANCE_CAC40_PI)	0.049626	1	0.8237
D(SUI_MKT_IND)	4.291452	1	0.0383
D(RUSSIA_RTS_PI)	0.485312	1	0.4860
All	13.48319	5	0.0192

Dependent variable: D(FRANCE_CAC40_PI)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	1.434247	1	0.2311
D(CANADA_TSI_PI)	0.613739	1	0.4334
D(CHINA_SHANG_ASI)	1.265813	1	0.2606
D(SUI_MKT_IND)	27.31802	1	0.0000
D(RUSSIA_RTS_PI)	6.719246	1	0.0095

All	40.72048	5	0.0000

Dependent variable: D(SUI_MKT_IND)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	0.009152	1	0.9238
D(CANADA_TSI_PI)	0.426768	1	0.5136
D(CHINA_SHANG_ASI)	0.105339	1	0.7455
D(FRANCE_CAC40_PI)	1.517021	1	0.2181
D(RUSSIA_RTS_PI)	3.531234	1	0.0602
All	6.128759	5	0.2939

Dependent variable: D(RUSSIA_RTS_PI)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	0.039965	1	0.8415
D(CANADA_TSI_PI)	0.000409	1	0.9839
D(CHINA_SHANG_ASI)	1.379989	1	0.2401
D(FRANCE_CAC40_PI)	0.077888	1	0.7802
D(SUI_MKT_IND)	1.326250	1	0.2495
All	4.842951	5	0.4353

Portfolio F – 4 lags

VEC Granger Causality/Block Exogeneity Wald Tests
Date: 12/15/10   Time: 08:59
Sample: 12/29/1995 4/16/2010
Included observations: 743

Dependent variable: D(SA_JSE_ASI)

Excluded	Chi-sq	df	Prob.
D(CANADA_TSI_PI)	0.328707	3	0.9545
D(CHINA_SHANG_ASI)	0.510049	3	0.9167
D(FRANCE_CAC40_PI)	8.964738	3	0.0298
D(SUI_MKT_IND)	20.31656	3	0.0001

D(RUSSIA_RTS_PI)	7.062495	3	0.0699
All	35.69019	15	0.0020

Dependent variable: D(CANADA_TSI_PI)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	9.357446	3	0.0249
D(CHINA_SHANG_ASI)	7.420318	3	0.0596
D(FRANCE_CAC40_PI)	8.139280	3	0.0432
D(SUI_MKT_IND)	38.43501	3	0.0000
D(RUSSIA_RTS_PI)	30.81826	3	0.0000
All	235.3412	15	0.0000

Dependent variable: D(CHINA_SHANG_ASI)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	0.504848	3	0.9178
D(CANADA_TSI_PI)	9.800398	3	0.0203
D(FRANCE_CAC40_PI)	0.206143	3	0.9766
D(SUI_MKT_IND)	3.827536	3	0.2807
D(RUSSIA_RTS_PI)	6.214857	3	0.1016
All	27.61619	15	0.0241

Dependent variable: D(FRANCE_CAC40_PI)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	2.478344	3	0.4792
D(CANADA_TSI_PI)	0.691266	3	0.8753
D(CHINA_SHANG_ASI)	1.424242	3	0.6999
D(SUI_MKT_IND)	41.91025	3	0.0000
D(RUSSIA_RTS_PI)	8.766418	3	0.0326
All	60.14308	15	0.0000

Dependent variable: D(SUI_MKT_IND)

Excluded	Chi-sq	df	Prob.

D(SA_JSE_ASI)	1.901752	3	0.5930
D(CANADA_TSI_PI)	3.134710	3	0.3713
D(CHINA_SHANG_ASI)	1.697176	3	0.6376
D(FRANCE_CAC40_PI)	3.889316	3	0.2737
D(RUSSIA_RTS_PI)	8.798927	3	0.0321
All	20.27940	15	0.1615

Dependent variable: D(RUSSIA_RTS_PI)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	4.313996	3	0.2295
D(CANADA_TSI_PI)	10.91825	3	0.0122
D(CHINA_SHANG_ASI)	1.475837	3	0.6879
D(FRANCE_CAC40_PI)	5.673348	3	0.1286
D(SUI_MKT_IND)	27.59307	3	0.0000
All	45.96446	15	0.0001

Portfolio G – 2 lags

VEC Granger Causality/Block Exogeneity Wald Tests
Date: 12/15/10 Time: 09:02
Sample: 12/29/1995 4/16/2010
Included observations: 745

Dependent variable: D(USA_NYSE_IND)

Excluded	Chi-sq	df	Prob.
D(UK_FTSE_ASI)	3.306182	1	0.0690
D(SA_JSE_ASI)	0.070844	1	0.7901
D(GERMANY_DAX30_PI)	1.115617	1	0.2909
D(EGYPT_CAIRO_INDEX)	4.716716	1	0.0299
D(HK_HANGSENG_IND)	0.146472	1	0.7019
D(JAPAN_NIKKEI_IND)	0.470997	1	0.4925
D(CANADA_TSI_PI)	1.173613	1	0.2787
D(FRANCE_CAC40_PI)	1.236781	1	0.2661
All	10.18940	8	0.2520

Dependent variable: D(UK_FTSE_ASI)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	68.20305	1	0.0000
D(SA_JSE_ASI)	0.018271	1	0.8925
D(GERMANY_DAX30_PI)	0.944911	1	0.3310
D(EGYPT_CAIRO_INDEX)	0.478437	1	0.4891
D(HK_HANGSENG_IND)	1.631686	1	0.2015
D(JAPAN_NIKKEI_IND)	8.431903	1	0.0037
D(CANADA_TSI_PI)	3.202342	1	0.0735
D(FRANCE_CAC40_PI)	6.175884	1	0.0130
All	254.7558	8	0.0000

Dependent variable: D(SA_JSE_ASI)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	7.297247	1	0.0069
D(UK_FTSE_ASI)	0.065208	1	0.7984
D(GERMANY_DAX30_PI)	2.363369	1	0.1242
D(EGYPT_CAIRO_INDEX)	0.023812	1	0.8774
D(HK_HANGSENG_IND)	11.59388	1	0.0007
D(JAPAN_NIKKEI_IND)	0.557943	1	0.4551
D(CANADA_TSI_PI)	0.169406	1	0.6806
D(FRANCE_CAC40_PI)	0.016993	1	0.8963
All	36.10554	8	0.0000

Dependent variable: D(GERMANY_DAX30_PI)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	27.39007	1	0.0000
D(UK_FTSE_ASI)	2.947556	1	0.0860
D(SA_JSE_ASI)	1.546979	1	0.2136
D(EGYPT_CAIRO_INDEX)	5.584898	1	0.0181
D(HK_HANGSENG_IND)	1.161569	1	0.2811
D(JAPAN_NIKKEI_IND)	6.960139	1	0.0083
D(CANADA_TSI_PI)	0.910735	1	0.3399
D(FRANCE_CAC	0.178735	1	0.6725

40_PI)			
All	68.32849	8	0.0000

Dependent variable: D(EGYPT_CAIRO_INDEX)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	3.141036	1	0.0763
D(UK_FTSE_ASI)	1.667946	1	0.1965
D(SA_JSE_ASI)	2.796293	1	0.0945
D(GERMANY_DAX30_PI)	0.020146	1	0.8871
D(HK_HANGSENG_IND)	0.434210	1	0.5099
D(JAPAN_NIKKEI_IND)	0.228273	1	0.6328
D(CANADA_TSI_PI)	4.281240	1	0.0385
D(FRANCE_CAC40_PI)	0.266833	1	0.6055
All	16.23129	8	0.0392

Dependent variable: D(HK_HANGSENG_IND)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	8.345332	1	0.0039
D(UK_FTSE_ASI)	2.269594	1	0.1319
D(SA_JSE_ASI)	0.581331	1	0.4458
D(GERMANY_DAX30_PI)	1.506295	1	0.2197
D(EGYPT_CAIRO_INDEX)	12.49893	1	0.0004
D(JAPAN_NIKKEI_IND)	2.577053	1	0.1084
D(CANADA_TSI_PI)	0.066955	1	0.7958
D(FRANCE_CAC40_PI)	0.000293	1	0.9863
All	29.49310	8	0.0003

Dependent variable: D(JAPAN_NIKKEI_IND)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	0.564384	1	0.4525
D(UK_FTSE_ASI)	0.649514	1	0.4203
D(SA_JSE_ASI)	0.506250	1	0.4768
D(GERMANY_DAX30_PI)	0.011576	1	0.9143
D(EGYPT_CAIRO_INDEX)	5.970722	1	0.0145

D(HK_HANGSENG_IND)	0.317180	1	0.5733
D(CANADA_TSI_PI)	2.471966	1	0.1159
D(FRANCE_CAC40_PI)	0.092786	1	0.7607
All	12.43386	8	0.1329

Dependent variable: D(CANADA_TSI_PI)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	92.26491	1	0.0000
D(UK_FTSE_ASI)	0.250588	1	0.6167
D(SA_JSE_ASI)	4.415112	1	0.0356
D(GERMANY_DAX30_PI)	0.000255	1	0.9873
D(EGYPT_CAIRO_INDEX)	0.127579	1	0.7210
D(HK_HANGSENG_IND)	1.670852	1	0.1961
D(JAPAN_NIKKEI_IND)	7.340171	1	0.0067
D(FRANCE_CAC40_PI)	0.343615	1	0.5577
All	260.2423	8	0.0000

Dependent variable: D(FRANCE_CAC40_PI)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	21.59718	1	0.0000
D(UK_FTSE_ASI)	0.578218	1	0.4470
D(SA_JSE_ASI)	4.416010	1	0.0356
D(GERMANY_DAX30_PI)	0.013075	1	0.9090
D(EGYPT_CAIRO_INDEX)	1.662754	1	0.1972
D(HK_HANGSENG_IND)	3.277306	1	0.0702
D(JAPAN_NIKKEI_IND)	6.674471	1	0.0098
D(CANADA_TSI_PI)	0.004504	1	0.9465
All	61.42208	8	0.0000

Portfolio G – 8 lags

VEC Granger Causality/Block Exogeneity Wald Tests

Date: 12/15/10 Time: 09:03

Sample: 12/29/1995 4/16/2010

Included observations: 739

Dependent variable: D(USA_NYSE_IND)

Excluded	Chi-sq	df	Prob.
D(UK_FTSE_ASI)	11.32176	7	0.1252
D(SA_JSE_ASI)	8.517592	7	0.2892
D(GERMANY_DAX30_PI)	7.647701	7	0.3647
D(EGYPT_CAIRO_INDEX)	15.62978	7	0.0287
D(HK_HANGSENG_IND)	11.10156	7	0.1342
D(JAPAN_NIKKEI_IND)	8.485402	7	0.2917
D(CANADA_TSI_PI)	12.76808	7	0.0780
D(FRANCE_CAC40_PI)	8.659287	7	0.2781
All	93.09993	56	0.0014

Dependent variable: D(UK_FTSE_ASI)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	133.7096	7	0.0000
D(SA_JSE_ASI)	2.438719	7	0.9316
D(GERMANY_DAX30_PI)	19.58730	7	0.0065
D(EGYPT_CAIRO_INDEX)	8.921927	7	0.2583
D(HK_HANGSENG_IND)	8.756153	7	0.2706
D(JAPAN_NIKKEI_IND)	21.17014	7	0.0035
D(CANADA_TSI_PI)	35.86559	7	0.0000
D(FRANCE_CAC40_PI)	43.99907	7	0.0000
All	565.5616	56	0.0000

Dependent variable: D(SA_JSE_ASI)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	39.33016	7	0.0000
D(UK_FTSE_ASI)	16.14405	7	0.0238
D(GERMANY_DAX30_PI)	7.922101	7	0.3395
D(EGYPT_CAIRO_INDEX)	2.455231	7	0.9304
D(HK_HANGSENG_IND)	24.20585	7	0.0010
D(JAPAN_NIKKEI_IND)	11.02269	7	0.1376
D(CANADA_TSI_PI)	8.985201	7	0.2537

D(FRANCE_CAC40_PI)	10.47645	7	0.1631
All	140.0482	56	0.0000

Dependent variable: D(GERMANY_DAX30_PI)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	76.52141	7	0.0000
D(UK_FTSE_ASI)	18.71611	7	0.0091
D(SA_JSE_ASI)	6.779901	7	0.4522
D(EGYPT_CAIRO_INDEX)	14.43363	7	0.0440
D(HK_HANGSENG_IND)	4.551238	7	0.7145
D(JAPAN_NIKKEI_IND)	25.95845	7	0.0005
D(CANADA_TSI_PI)	12.52831	7	0.0845
D(FRANCE_CAC40_PI)	7.016586	7	0.4272
All	185.6829	56	0.0000

Dependent variable: D(EGYPT_CAIRO_INDEX)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	17.65041	7	0.0137
D(UK_FTSE_ASI)	7.033704	7	0.4254
D(SA_JSE_ASI)	11.78211	7	0.1080
D(GERMANY_DAX30_PI)	1.600750	7	0.9786
D(HK_HANGSENG_IND)	6.017084	7	0.5378
D(JAPAN_NIKKEI_IND)	13.35157	7	0.0640
D(CANADA_TSI_PI)	25.75614	7	0.0006
D(FRANCE_CAC40_PI)	3.778503	7	0.8049
All	115.7344	56	0.0000

Dependent variable: D(HK_HANGSENG_IND)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	41.87008	7	0.0000
D(UK_FTSE_ASI)	10.34597	7	0.1698
D(SA_JSE_ASI)	6.675286	7	0.4635
D(GERMANY_DAX30_PI)	15.08450	7	0.0349
D(EGYPT_CAIRO_INDEX)	19.38892	7	0.0071

D(JAPAN_NIKKEI_IND)	21.80718	7	0.0027
D(CANADA_TSI_PI)	18.50948	7	0.0099
D(FRANCE_CAC40_PI)	15.38108	7	0.0314
All	142.8403	56	0.0000

Dependent variable: D(JAPAN_NIKKEI_IND)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	38.09150	7	0.0000
D(UK_FTSE_ASI)	11.38816	7	0.1226
D(SA_JSE_ASI)	11.78452	7	0.1079
D(GERMANY_DAX30_PI)	18.42831	7	0.0102
D(EGYPT_CAIRO_INDEX)	11.44994	7	0.1202
D(HK_HANGSENG_IND)	5.735305	7	0.5710
D(CANADA_TSI_PI)	15.35868	7	0.0317
D(FRANCE_CAC40_PI)	9.836143	7	0.1981
All	121.6873	56	0.0000

Dependent variable: D(CANADA_TSI_PI)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	143.5445	7	0.0000
D(UK_FTSE_ASI)	21.78912	7	0.0028
D(SA_JSE_ASI)	13.34159	7	0.0642
D(GERMANY_DAX30_PI)	8.509863	7	0.2898
D(EGYPT_CAIRO_INDEX)	8.161780	7	0.3185
D(HK_HANGSENG_IND)	20.16314	7	0.0052
D(JAPAN_NIKKEI_IND)	15.90502	7	0.0260
D(FRANCE_CAC40_PI)	20.90372	7	0.0039
All	525.0433	56	0.0000

Dependent variable: D(FRANCE_CAC40_PI)

Excluded	Chi-sq	df	Prob.
D(USA_NYSE_IND)	69.96689	7	0.0000
D(UK_FTSE_ASI)	16.61180	7	0.0201
D(SA_JSE_ASI)	6.527993	7	0.4796

D(GERMANY_DAX30_PI)	6.313170	7	0.5037
D(EGYPT_CAIRO_INDEX)	8.574932	7	0.2846
D(HK_HANGSENG_IND)	6.507708	7	0.4819
D(JAPAN_NIKKEI_IND)	23.43746	7	0.0014
D(CANADA_TSI_PI)	8.970318	7	0.2548
All	170.6148	56	0.0000

Portfolio H – 2 lags

VEC Granger Causality/Block Exogeneity Wald Tests
Date: 12/15/10 Time: 09:08
Sample: 12/29/1995 4/16/2010
Included observations: 745

Dependent variable: D(SA_JSE_ASI)

Excluded	Chi-sq	df	Prob.
D(AUS_ASX_ASI)	2.461444	1	0.1167
D(HK_HANGSENG_IND)	5.082092	1	0.0242
D(JAPAN_NIKKEI_IND)	0.300022	1	0.5839
D(PHIL_SE_PI)	0.594937	1	0.4405
D(ARG_MERVAL_IND)	12.82744	1	0.0003
D(USA_NYSE_IND)	3.736454	1	0.0532
D(RUSSIA_RTS_PI)	0.544493	1	0.4606
All	48.49779	7	0.0000

Dependent variable: D(AUS_ASX_ASI)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	0.622449	1	0.4301
D(HK_HANGSENG_IND)	0.434751	1	0.5097
D(JAPAN_NIKKEI_IND)	0.589283	1	0.4427
D(PHIL_SE_PI)	2.463250	1	0.1165
D(ARG_MERVAL_IND)	4.252528	1	0.0392
D(USA_NYSE_IND)	25.20172	1	0.0000
D(RUSSIA_RTS_PI)	0.076589	1	0.7820

All	53.29884	7	0.0000

Dependent variable: D(HK_HANGSENG_IND)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	0.366966	1	0.5447
D(AUS_ASX_ASI)	0.861147	1	0.3534
D(JAPAN_NIKKEI_IND)	1.112492	1	0.2915
D(PHIL_SE_PI)	1.655170	1	0.1983
D(ARG_MERVAL_IND)	9.756151	1	0.0018
D(USA_NYSE_IND)	5.360734	1	0.0206
D(RUSSIA_RTS_PI)	0.526378	1	0.4681
All	30.03137	7	0.0001

Dependent variable: D(JAPAN_NIKKEI_IND)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	0.152521	1	0.6961
D(AUS_ASX_ASI)	0.040480	1	0.8405
D(HK_HANGSENG_IND)	0.574463	1	0.4485
D(PHIL_SE_PI)	6.954307	1	0.0084
D(ARG_MERVAL_IND)	0.061073	1	0.8048
D(USA_NYSE_IND)	0.018887	1	0.8907
D(RUSSIA_RTS_PI)	6.628003	1	0.0100
All	16.24975	7	0.0229

Dependent variable: D(PHIL_SE_PI)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	1.382807	1	0.2396
D(AUS_ASX_ASI)	2.616942	1	0.1057
D(HK_HANGSENG_IND)	6.744999	1	0.0094
D(JAPAN_NIKKEI_IND)	1.721174	1	0.1895
D(ARG_MERVAL_IND)	15.30615	1	0.0001
D(USA_NYSE_IND)	3.862218	1	0.0494
D(RUSSIA_RTS_PI)	0.011482	1	0.9147
All	74.98087	7	0.0000

Dependent variable: D(ARG_MERVAL_IND)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	1.927852	1	0.1650
D(AUS_ASX_ASI)	1.297245	1	0.2547
D(HK_HANGSENG_IND)	0.225085	1	0.6352
D(JAPAN_NIKKEI_IND)	1.606381	1	0.2050
D(PHIL_SE_PI)	1.138466	1	0.2860
D(USA_NYSE_IND)	0.001281	1	0.9714
D(RUSSIA_RTS_PI)	0.451066	1	0.5018
All	7.396697	7	0.3888

Dependent variable: D(USA_NYSE_IND)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	0.373072	1	0.5413
D(AUS_ASX_ASI)	0.664434	1	0.4150
D(HK_HANGSENG_IND)	0.005780	1	0.9394
D(JAPAN_NIKKEI_IND)	0.098503	1	0.7536
D(PHIL_SE_PI)	1.253863	1	0.2628
D(ARG_MERVAL_IND)	2.104432	1	0.1469
D(RUSSIA_RTS_PI)	0.642704	1	0.4227
All	5.791516	7	0.5643

Dependent variable: D(RUSSIA_RTS_PI)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	0.300108	1	0.5838
D(AUS_ASX_ASI)	0.074734	1	0.7846
D(HK_HANGSENG_IND)	0.351426	1	0.5533
D(JAPAN_NIKKEI_IND)	0.000374	1	0.9846
D(PHIL_SE_PI)	0.026248	1	0.8713
D(ARG_MERVAL_IND)	9.731635	1	0.0018
D(USA_NYSE_IND)	2.169208	1	0.1408
All	18.70241	7	0.0092

Portfolio H – 4 lags

VEC Granger Causality/Block Exogeneity Wald Tests
Date: 12/15/10 Time: 09:09
Sample: 12/29/1995 4/16/2010
Included observations: 743

Dependent variable: D(SA_JSE_ASI)

Excluded	Chi-sq	df	Prob.
D(AUS_ASX_ASI)	3.404391	3	0.3334
D(HK_HANGSENG_IND)	5.629872	3	0.1311
D(JAPAN_NIKKEI_IND)	2.485317	3	0.4780
D(PHIL_SE_PI)	1.474912	3	0.6881
D(ARG_MERVAL_IND)	12.94625	3	0.0048
D(USA_NYSE_IND)	11.07224	3	0.0113
D(RUSSIA_RTS_PI)	0.489216	3	0.9213
All	59.82653	21	0.0000

Dependent variable: D(AUS_ASX_ASI)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	5.790663	3	0.1223
D(HK_HANGSENG_IND)	5.885203	3	0.1173
D(JAPAN_NIKKEI_IND)	3.061594	3	0.3822
D(PHIL_SE_PI)	4.791189	3	0.1877
D(ARG_MERVAL_IND)	6.326457	3	0.0968
D(USA_NYSE_IND)	36.82015	3	0.0000
D(RUSSIA_RTS_PI)	4.102067	3	0.2507
All	87.76909	21	0.0000

Dependent variable: D(HK_HANGSENG_IND)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	2.198967	3	0.5322
D(AUS_ASX_ASI)	1.782964	3	0.6186
D(JAPAN_NIKKEI_IND)	4.876268	3	0.1811

D(PHIL_SE_PI)	3.443407	3	0.3282
D(ARG_MERVAL_IND)	12.65103	3	0.0055
D(USA_NYSE_IND)	10.04622	3	0.0182
D(RUSSIA_RTS_PI)	9.502498	3	0.0233
All	56.07138	21	0.0000

Dependent variable: D(JAPAN_NIKKEI_IND)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	3.572917	3	0.3114
D(AUS_ASX_ASI)	0.170787	3	0.9822
D(HK_HANGSENG_IND)	1.060784	3	0.7865
D(PHIL_SE_PI)	12.76414	3	0.0052
D(ARG_MERVAL_IND)	4.506445	3	0.2117
D(USA_NYSE_IND)	9.428983	3	0.0241
D(RUSSIA_RTS_PI)	6.406872	3	0.0934
All	44.23327	21	0.0022

Dependent variable: D(PHIL_SE_PI)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	2.141019	3	0.5437
D(AUS_ASX_ASI)	4.968302	3	0.1741
D(HK_HANGSENG_IND)	9.111852	3	0.0278
D(JAPAN_NIKKEI_IND)	2.931966	3	0.4022
D(ARG_MERVAL_IND)	18.93818	3	0.0003
D(USA_NYSE_IND)	10.62502	3	0.0139
D(RUSSIA_RTS_PI)	1.267769	3	0.7368
All	106.1467	21	0.0000

Dependent variable: D(ARG_MERVAL_IND)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	3.359463	3	0.3395
D(AUS_ASX_ASI)	0.822062	3	0.8442
D(HK_HANGSENG_IND)	6.243996	3	0.1003
D(JAPAN_NIKKEI_IND)	2.809866	3	0.4219

D(PHIL_SE_PI)	4.222586	3	0.2384
D(USA_NYSE_IND)	4.545448	3	0.2083
D(RUSSIA_RTS_PI)	4.414482	3	0.2200
All	35.61202	21	0.0242

Dependent variable: D(USA_NYSE_IND)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	4.344351	3	0.2266
D(AUS_ASX_ASI)	2.835871	3	0.4176
D(HK_HANGSENG_IND)	3.124683	3	0.3728
D(JAPAN_NIKKEI_IND)	2.395805	3	0.4944
D(PHIL_SE_PI)	4.475355	3	0.2145
D(ARG_MERVAL_IND)	4.129435	3	0.2478
D(RUSSIA_RTS_PI)	2.607169	3	0.4562
All	29.09574	21	0.1117

Dependent variable: D(RUSSIA_RTS_PI)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	7.997478	3	0.0461
D(AUS_ASX_ASI)	3.735356	3	0.2915
D(HK_HANGSENG_IND)	3.685169	3	0.2975
D(JAPAN_NIKKEI_IND)	0.928837	3	0.8185
D(PHIL_SE_PI)	1.437037	3	0.6969
D(ARG_MERVAL_IND)	16.14027	3	0.0011
D(USA_NYSE_IND)	11.56834	3	0.0090
All	57.83227	21	0.0000

Portfolio I – 2 lags

VEC Granger Causality/Block Exogeneity Wald Tests

Date: 12/15/10 Time: 09:11

Sample: 12/29/1995 4/16/2010

Included observations: 745

Dependent variable: D(SA_JSE_ASI)

Excluded	Chi-sq	df	Prob.
D(CANADA_TSI_PI)	1.092538	1	0.2959
D(CHINA_SHANG_ASI)	0.074446	1	0.7850
D(FRANCE_CAC40_PI)	1.607967	1	0.2048
D(SUI_MKT_IND)	0.460504	1	0.4974
D(RUSSIA_RTS_PI)	3.036931	1	0.0814
D(EGYPT_CAIRO_INDEX)	0.019398	1	0.8892
D(USA_NYSE_IND)	8.382552	1	0.0038
All	25.51564	7	0.0006

Dependent variable: D(CANADA_TSI_PI)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	1.885530	1	0.1697
D(CHINA_SHANG_ASI)	2.706221	1	0.1000
D(FRANCE_CAC40_PI)	0.324784	1	0.5687
D(SUI_MKT_IND)	0.068664	1	0.7933
D(RUSSIA_RTS_PI)	13.12748	1	0.0003
D(EGYPT_CAIRO_INDEX)	0.392803	1	0.5308
D(USA_NYSE_IND)	120.2160	1	0.0000
All	349.7231	7	0.0000

Dependent variable: D(CHINA_SHANG_ASI)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	0.526162	1	0.4682
D(CANADA_TSI_PI)	2.258529	1	0.1329
D(FRANCE_CAC40_PI)	0.744834	1	0.3881
D(SUI_MKT_IND)	0.003793	1	0.9509
D(RUSSIA_RTS_PI)	0.014660	1	0.9036
D(EGYPT_CAIRO_INDEX)	0.004095	1	0.9490
D(USA_NYSE_IND)	11.84000	1	0.0006
All	25.26214	7	0.0007

Dependent variable: D(FRANCE_CAC40_PI)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	4.006104	1	0.0453
D(CANADA_TSI_PI)	1.354709	1	0.2445
D(CHINA_SHANG_ASI)	0.598580	1	0.4391
D(SUI_MKT_IND)	7.901764	1	0.0049
D(RUSSIA_RTS_PI)	2.554132	1	0.1100
D(EGYPT_CAIRO_INDEX)	1.822619	1	0.1770
D(USA_NYSE_IND)	17.13625	1	0.0000
All	61.44192	7	0.0000

Dependent variable: D(SUI_MKT_IND)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	0.205610	1	0.6502
D(CANADA_TSI_PI)	0.057901	1	0.8098
D(CHINA_SHANG_ASI)	0.060371	1	0.8059
D(FRANCE_CAC40_PI)	0.434535	1	0.5098
D(RUSSIA_RTS_PI)	1.739810	1	0.1872
D(EGYPT_CAIRO_INDEX)	8.026303	1	0.0046
D(USA_NYSE_IND)	1.484321	1	0.2231
All	11.82969	7	0.1063

Dependent variable: D(RUSSIA_RTS_PI)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	0.105522	1	0.7453
D(CANADA_TSI_PI)	0.129788	1	0.7187
D(CHINA_SHANG_ASI)	1.510326	1	0.2191
D(FRANCE_CAC40_PI)	0.222097	1	0.6374
D(SUI_MKT_IND)	0.049359	1	0.8242
D(EGYPT_CAIRO_INDEX)	2.850094	1	0.0914
D(USA_NYSE_IND)	3.645154	1	0.0562
All	10.16290	7	0.1795

Dependent variable: D(EGYPT_CAIRO_INDEX)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	1.244912	1	0.2645
D(CANADA_TSI_PI)	4.536652	1	0.0332
D(CHINA_SHANG_ASI)	0.597987	1	0.4393
D(FRANCE_CAC40_PI)	4.946297	1	0.0261
D(SUI_MKT_IND)	18.67902	1	0.0000
D(RUSSIA_RTS_PI)	2.570601	1	0.1089
D(USA_NYSE_IND)	12.93098	1	0.0003
All	38.24677	7	0.0000

Dependent variable: D(USA_NYSE_IND)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	0.000189	1	0.9890
D(CANADA_TSI_PI)	0.115247	1	0.7342
D(CHINA_SHANG_ASI)	3.295349	1	0.0695
D(FRANCE_CAC40_PI)	0.536117	1	0.4640
D(SUI_MKT_IND)	0.091523	1	0.7623
D(RUSSIA_RTS_PI)	1.593229	1	0.2069
D(EGYPT_CAIRO_INDEX)	7.090262	1	0.0078
All	12.45921	7	0.0864

Portfolio I – 9 lags

VEC Granger Causality/Block Exogeneity Wald Tests

Date: 12/15/10 Time: 09:11

Sample: 12/29/1995 4/16/2010

Included observations: 738

Dependent variable: D(SA_JSE_ASI)

Excluded	Chi-sq	df	Prob.
D(CANADA_TSI_PI)	12.96516	8	0.1131
D(CHINA_SHANG_ASI)	3.065908	8	0.9302
D(FRANCE_CAC40_PI)	20.50865	8	0.0086
D(SUI_MKT_IND)	13.02037	8	0.1112
D(RUSSIA_RTS_PI)	11.71840	8	0.1642

D(EGYPT_CAIRO_INDEX)	4.082620	8	0.8496
D(USA_NYSE_IND)	21.24380	8	0.0065
All	102.1824	56	0.0002

Dependent variable: D(CANADA_TSI_PI)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	17.48774	8	0.0254
D(CHINA_SHANG_ASI)	12.33677	8	0.1368
D(FRANCE_CAC40_PI)	24.89520	8	0.0016
D(SUI_MKT_IND)	6.922607	8	0.5450
D(RUSSIA_RTS_PI)	16.78926	8	0.0324
D(EGYPT_CAIRO_INDEX)	12.06671	8	0.1483
D(USA_NYSE_IND)	146.5008	8	0.0000
All	521.2398	56	0.0000

Dependent variable: D(CHINA_SHANG_ASI)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	3.282790	8	0.9154
D(CANADA_TSI_PI)	11.72179	8	0.1641
D(FRANCE_CAC40_PI)	5.313844	8	0.7236
D(SUI_MKT_IND)	5.796126	8	0.6701
D(RUSSIA_RTS_PI)	11.66454	8	0.1668
D(EGYPT_CAIRO_INDEX)	10.51574	8	0.2307
D(USA_NYSE_IND)	15.85967	8	0.0444
All	70.09754	56	0.0975

Dependent variable: D(FRANCE_CAC40_PI)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	5.485740	8	0.7046
D(CANADA_TSI_PI)	10.56938	8	0.2273
D(CHINA_SHANG_ASI)	6.047849	8	0.6419
D(SUI_MKT_IND)	26.22590	8	0.0010
D(RUSSIA_RTS_PI)	20.42280	8	0.0088
D(EGYPT_CAIRO_INDEX)	7.722412	8	0.4610

D(USA_NYSE_IND)	34.33604	8	0.0000
All	158.8249	56	0.0000

Dependent variable: D(SUI_MKT_IND)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	6.301479	8	0.6135
D(CANADA_TSI_PI)	18.39356	8	0.0185
D(CHINA_SHANG_ASI)	13.86540	8	0.0853
D(FRANCE_CAC40_PI)	12.69190	8	0.1229
D(RUSSIA_RTS_PI)	19.69325	8	0.0116
D(EGYPT_CAIRO_INDEX)	19.09582	8	0.0144
D(USA_NYSE_IND)	19.07939	8	0.0144
All	107.5982	56	0.0000

Dependent variable: D(RUSSIA_RTS_PI)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	17.36159	8	0.0266
D(CANADA_TSI_PI)	26.71087	8	0.0008
D(CHINA_SHANG_ASI)	8.573741	8	0.3795
D(FRANCE_CAC40_PI)	22.51981	8	0.0040
D(SUI_MKT_IND)	16.48915	8	0.0359
D(EGYPT_CAIRO_INDEX)	9.291323	8	0.3183
D(USA_NYSE_IND)	30.81782	8	0.0002
All	133.5180	56	0.0000

Dependent variable: D(EGYPT_CAIRO_INDEX)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	12.38730	8	0.1347
D(CANADA_TSI_PI)	33.53028	8	0.0000
D(CHINA_SHANG_ASI)	10.74736	8	0.2164
D(FRANCE_CAC40_PI)	15.37069	8	0.0523
D(SUI_MKT_IND)	16.69924	8	0.0334
D(RUSSIA_RTS_PI)	9.341833	8	0.3143
D(USA_NYSE_IND)	24.43136	8	0.0019

All	138.2779	56	0.0000

Dependent variable: D(USA_NYSE_IND)

Excluded	Chi-sq	df	Prob.
D(SA_JSE_ASI)	6.982853	8	0.5385
D(CANADA_TSI_PI)	9.591113	8	0.2949
D(CHINA_SHANG_ASI)	20.06519	8	0.0101
D(FRANCE_CAC40_PI)	14.14660	8	0.0780
D(SUI_MKT_IND)	7.078284	8	0.5282
D(RUSSIA_RTS_PI)	13.40087	8	0.0988
D(EGYPT_CAIRO_INDEX)	14.91947	8	0.0607
All	94.01586	56	0.0011

Portfolio P – multivariate cointegration results using lags as selected by criteria (2 lags) and lags at which autocorrelation of residuals disappears

2 lags	Trace test (no trend/intercept in the C.E. or VAR): Hypothesized number of C.E.s							
Portfolio	none	≤ 1	≤ 2	≤ 3	≤ 4	≤ 5	≤ 6	≤ 7
A	0.2343	0.7431	0.8424	0.8001				
B	0.5101	0.9299	0.8176	0.5537				
C	0.3049	0.6481	0.7014	0.6922				
D	0.0022	0.0987	0.2982	0.3052	0.2804	0.1876		
E	0.7047	0.8332	0.8668	0.7745	0.6813	0.5117		
F	0.1224	0.5320	0.7413	0.6937	0.6282	0.6847		
G	0.0142	0.1509	0.4240	0.5254	0.5110	0.3638	0.3392	0.2059
H	0.0251	0.2687	0.7263	0.8076	0.7746	0.6929	0.5404	0.3147
I	0.0146	0.1567	0.2946	0.5676	0.5977	0.6262	0.5015	0.5092

2 lags	Trace test (intercept in C.E. and VAR): Hypothesized number of C.E.s							
Portfolio	none	≤ 1	≤ 2	≤ 3	≤ 4	≤ 5	≤ 6	≤ 7
A	0.1868	0.6788	0.8178	0.6883				
B	0.7174	0.9625	0.8234	0.3546				
C	0.3206	0.6767	0.5883	0.7457				
D	0.0035	0.1797	0.4239	0.5298	0.4040	0.4413		
E	0.8064	0.8507	0.8465	0.7830	0.7609	0.5715		
F	0.0949	0.4915	0.7518	0.6758	0.6140	0.7771		
G	0.0168	0.1996	0.5342	0.6207	0.6466	0.5393	0.5813	0.3254
H	0.0282	0.2689	0.6879	0.8057	0.8086	0.6973	0.6119	0.5163
I	0.0100	0.1135	0.2482	0.5525	0.6179	0.5991	0.4770	0.8730

2 lags	Trace test (intercept and trend in C.E., no trend in VAR): Hypothesized number of C.E.s						
Portfolio	none	≤ 1	≤ 2	≤ 3	≤ 4	≤ 5	≤ 6	≤ 7
A	0.0386	0.7317	0.6525	0.6660				
B	0.3047	0.7677	0.9389	0.7914				
C	0.5400	0.7271	0.8512	0.6762				
D	0.0098	0.1919	0.4512	0.3803	0.3659	0.2562		
E	0.4689	0.7797	0.8231	0.8539	0.8381	0.5906		
F	0.2193	0.7171	0.9121	0.9106	0.8719	0.6979		
G	0.0443	0.2709	0.5210	0.7018	0.6486	0.6485	0.5318	0.4813
H	0.0040	0.0384	0.1899	0.6121	0.7613	0.8003	0.7227	0.6933
I	0.0577	0.2869	0.4592	0.7440	0.8731	0.8804	0.7171	0.5447

2 lags	Max. eigenvalue test (no trend/intercept in the C.E. or VAR): Hypothesized number of C.E.s							
Portfolio	none	≤ 1	≤ 2	≤ 3	≤ 4	≤ 5	≤ 6	≤ 7
A	0.1122	0.6586	0.8005	0.8001				
B	0.1989	0.9627	0.8939	0.5537				
C	0.2538	0.6699	0.6766	0.6922				
D	0.0061	0.2041	0.6556	0.6010	0.5368	0.1876		
E	0.7071	0.8572	0.9544	0.8622	0.7660	0.5117		
F	0.0849	0.5187	0.8745	0.8027	0.5894	0.6847		
G	0.0463	0.2341	0.7047	0.8369	0.9012	0.6253	0.6077	0.2059
H	0.0300	0.1313	0.8017	0.9273	0.9136	0.8710	0.7547	0.3147
I	0.0443	0.4808	0.3560	0.7955	0.7448	0.8260	0.5442	0.5092

2 lags	Max. eigenvalue test (intercept in C.E. and VAR): Hypothesized number of C.E.s						
Portfolio	none	≤ 1	≤ 2	≤ 3	≤ 4	≤ 5	≤ 6	≤ 7
A	0.1155	0.5917	0.7726	0.6883				
B	0.4079	0.9812	0.8589	0.3546				
C	0.2713	0.7822	0.5126	0.7457				
D	0.0050	0.2902	0.5826	0.7543	0.3784	0.4413		
E	0.8798	0.9158	0.9223	0.7884	0.7272	0.5715		
F	0.0807	0.4580	0.8940	0.7612	0.5363	0.7771		
G	0.0394	0.2408	0.7762	0.8207	0.8846	0.6079	0.6130	0.3254
H	0.0459	0.1932	0.7511	0.8947	0.9364	0.7898	0.5768	0.5163
I	0.0575	0.4291	0.3082	0.7542	0.7983	0.7758	0.3924	0.8730

2 lags	Max. eigenvalue test (intercept and trend in C.E., no trend in VAR): Hypothesized number of C.E.s							
Portfolio	none	≤ 1	≤ 2	≤ 3	≤ 4	≤ 5	≤ 6	≤ 7
A	0.0060	0.8702	0.6678	0.6660				
B	0.1774	0.5645	0.9558	0.7914				
C	0.5656	0.6538	0.9040	0.6762				
D	0.0188	0.3025	0.8605	0.6813	0.6473	0.2562		
E	0.3937	0.8650	0.8529	0.8731	0.9275	0.5906		
F	0.1047	0.5422	0.9248	0.9267	0.9166	0.6979		
G	0.0979	0.4453	0.6482	0.9409	0.8377	0.8703	0.6530	0.4813
H	0.1041	0.1602	0.1443	0.6771	0.8259	0.8967	0.7386	0.6933
I	0.1347	0.6063	0.4426	0.7053	0.8989	0.9717	0.8302	0.5447

	Trace test (no trend/intercept in the C.E. or VAR): Hypothesized number of C.E.s							
Portfolio	none	≤ 1	≤ 2	≤ 3	≤ 4	≤ 5	≤ 6	≤ 7
A (4 lags)	0.2977	0.7286	0.9050	0.5866				
B (1 lag)	0.5407	0.9147	0.8401	0.6048				
C (4 lags)	0.1757	0.4734	0.5039	0.6851				
D(11 lags)	0.0041	0.1045	0.3350	0.2751	0.3003	0.2650		
E (3 lags)	0.5605	0.7606	0.8014	0.6770	0.5819	0.4439		
F (4 lags)	0.0567	0.3470	0.7157	0.7606	0.5504	0.6810		
G (8 lags)	0.0061	0.0478	0.1909	0.1935	0.2479	0.2503	0.2330	0.1253
H (4 lags)	0.0072	0.0893	0.5383	0.6422	0.6192	0.6358	0.4423	0.2197
I (9 lags)	0.0001	0.0183	0.0615	0.0752	0.1327	0.2989	0.4162	0.6642

	Trace test (intercept in C.E. and VAR): Hypothesized number of C.E.s							
Portfolio	none	≤ 1	≤ 2	≤ 3	≤ 4	≤ 5	≤ 6	≤ 7
A (4 lags)	0.2377	0.6600	0.9167	0.6563				
B (1 lag)	0.6393	0.9593	0.7561	0.3896				
C (4 lags)	0.1457	0.4603	0.3759	0.7426				
D(11 lags)	0.0111	0.1783	0.5834	0.5217	0.5142	0.5825		
E (3 lags)	0.7087	0.7544	0.7989	0.7127	0.7175	0.4933		
F (4 lags)	0.0335	0.2807	0.6939	0.7440	0.5680	0.6860		
G (8 lags)	0.0097	0.0831	0.3434	0.3685	0.5202	0.3763	0.4091	0.2975
H (4 lags)	0.0119	0.1199	0.5309	0.6738	0.6982	0.7427	0.6670	0.6112
I (9 lags)	0.0001	0.0123	0.0489	0.0651	0.1041	0.2877	0.3543	0.9572

	Trace test (intercept and trend in C.E., no trend in VAR): Hypothesized number of C.E.s							
Portfolio	none	≤ 1	≤ 2	≤ 3	≤ 4	≤ 5	≤ 6	≤ 7
A (4 lags)	0.1959	0.6391	0.6773	0.8605				
B (1 lag)	0.1086	0.6465	0.9568	0.7822				
C (4 lags)	0.2674	0.4657	0.6956	0.6416				
D(11 lags)	0.0288	0.2343	0.4894	0.4891	0.4258	0.4649		
E (3 lags)	0.3693	0.6826	0.7616	0.8556	0.8078	0.6068		
F (4 lags)	0.0744	0.4154	0.8782	0.9304	0.8197	0.6952		
G (8 lags)	0.0348	0.1562	0.3943	0.4589	0.4746	0.6012	0.4892	0.4224
H (4 lags)	0.0018	0.0225	0.1392	0.6172	0.6100	0.6786	0.7320	0.7605
I (9 lags)	0.0005	0.0424	0.0965	0.2054	0.3475	0.5403	0.5483	0.5049

	Max. eigenvalue test (no trend/intercept in the C.E. or VAR): Hypothesized number of C.E.s							
Portfolio	none	≤ 1	≤ 2	≤ 3	≤ 4	≤ 5	≤ 6	≤ 7
A (4 lags)	0.1823	0.5476	0.9618	0.5866				
B (1 lag)	0.2541	0.9331	0.8942	0.6048				
C (4 lags)	0.1981	0.6122	0.4404	0.6851				
D(11 lags)	0.0140	0.1828	0.7737	0.5149	0.4700	0.2650		
E (3 lags)	0.5679	0.8312	0.9482	0.8205	0.6941	0.4439		
F (4 lags)	0.0683	0.2514	0.7655	0.9293	0.4971	0.6810		
G (8 lags)	0.1073	0.1858	0.7794	0.5874	0.6399	0.5649	0.5640	0.1253
H (4 lags)	0.0465	0.0411	0.7368	0.8748	0.7660	0.8836	0.7389	0.2197
I (9 lags)	0.0024	0.2719	0.6286	0.4040	0.2665	0.4233	0.3526	0.6642

	Max. eigenvalue test (intercept in C.E. and VAR): Hypothesized number of C.E.s							
Portfolio	none	≤ 1	≤ 2	≤ 3	≤ 4	≤ 5	≤ 6	≤ 7
A (4 lags)	0.1797	0.4617	0.8959	0.6563				
B (1 lag)	0.3124	0.9896	0.7745	0.3896				
C (4 lags)	0.1725	0.6897	0.3050	0.7426				
D(11 lags)	0.0269	0.1520	0.8283	0.6425	0.4598	0.5825		
E (3 lags)	0.8651	0.8319	0.9180	0.7275	0.6979	0.4933		
F (4 lags)	0.0564	0.2080	0.7527	0.8735	0.4987	0.6860		
G (8 lags)	0.0969	0.1573	0.8031	0.5634	0.8871	0.5320	0.4363	0.2975
H (4 lags)	0.0671	0.0950	0.6902	0.8365	0.7606	0.8058	0.6155	0.6112
I (9 lags)	0.0021	0.2478	0.5948	0.4509	0.2157	0.4453	0.2764	0.9572

	Max. eigenvalue test (intercept and trend in C.E., no trend in VAR): Hypothesized number of C.E.s							
Portfolio	none	≤ 1	≤ 2	≤ 3	≤ 4	≤ 5	≤ 6	≤ 7
A (4 lags)	0.1412	0.7263	0.5519	0.8605				
B (1 lag)	0.0515	0.3425	0.9765	0.7822				
C (4 lags)	0.4165	0.4505	0.7399	0.6416				
D(11 lags)	0.0656	0.3504	0.7919	0.7749	0.5245	0.4649		
E (3 lags)	0.3742	0.7998	0.7428	0.9015	0.8915	0.6068		
F (4 lags)	0.0814	0.1665	0.8219	0.9760	0.8585	0.6952		
G (8 lags)	0.2090	0.3305	0.7990	0.8283	0.6270	0.8532	0.6472	0.4224
H (4 lags)	0.0836	0.1284	0.0757	0.8883	0.7477	0.7255	0.7031	0.7605
I (9 lags)	0.0046	0.4675	0.4331	0.4908	0.4788	0.7187	0.6553	0.5049

Appendix Q – multivariate VECM rates at lag lengths at which autocorrelation of residuals first disappears and at lag lengths selected by the various criteria (2)

2 lags	no trend/intercept in the C.E. or VAR							
Portfolio	Country 1	Country 2	Country 3	Country 4	Country 5	Country 6	Country 7	Country 8
A	USA	Germany	SA	UK				
	-0.007602	-0.015999	-0.009385	0.005425				
B	Japan	HK	Australia	SA				
	0.005519	0.005455	-0.001016	-0.009091				
C	SA	France	Canada	China				
	0.006401	-0.011124	0.007542	0.013861				
D	USA	Japan	UK	Germany	Egypt	SA		
	-0.013645	-0.032519	0.022309	-0.019027	-0.012721	-0.027245		
E	Japan	Argentina	HK	Australia	SA	Philippines		
	0.007336	-0.000088	0.006395	0.000740	-0.011365	0.005684		
F	Switz.	Russia	SA	Canada	France	China		
	0.013421	-0.047456	-0.002709	-0.008504	0.014752	-0.007177		
G	USA	Japan	Egypt	France	Germany	SA	UK	Canada
	-0.024464	-0.046289	-0.008820	-0.016176	-0.027599	-0.039427	0.035086	0.018764
H	USA	Argentina	Japan	HK	Russia	Australia	SA	Philippines
	-0.033115	-0.057707	0.031473	-0.014836	-0.182595	0.003222	-0.026546	-0.020818
I	USA	Switzerland	Russia	Egypt	SA	France	Canada	China
	0.000897	0.000746	0.0003315	0.001548	0.000640	0.000207	0.001488	0.000365

2 lags	intercept in C.E. and VAR							
Portfolio	Country 1	Country 2	Country 3	Country 4	Country 5	Country 6	Country 7	Country 8
A	USA	Germany	SA	UK				
	-0.007766	-0.016951	-0.008027	0.006565				
B	Japan	HK	Australia	SA				
	0.005355	0.009991	0.000836	-0.008665				
C	SA	France	Canada	China				
	0.003094	-0.014235	0.006012	0.009459				
D	USA	Japan	UK	Germany	Egypt	SA		
	-0.012598	-0.033693	0.023593	-0.017407	-0.009845	-0.026075		
E	Japan	Argentina	HK	Australia	SA	Philippines		
	0.001565	-0.001371	0.010324	0.004713	-0.017250	0.008854		
F	Switz.	Russia	SA	Canada	France	China		
	0.014786	-0.046180	-0.000877	-0.008107	0.016330	-0.005051		
G	USA	Japan	Egypt	France	Germany	SA	UK	Canada
	-0.022894	-0.046256	-0.004767	-0.014527	-0.025286	-0.037237	0.036453	0.020829
H	USA	Argentina	Japan	HK	Russia	Australia	SA	Philippines
	-0.036121	-0.064957	0.020755	-0.029124	-0.200013	0.004876	-0.018979	-0.038314
I	USA	Switzerland	Russia	Egypt	SA	France	Canada	China
	0.000228	0.000183	0.000849	0.000371	0.000133	0.000033	0.000400	0.000057

2 lags	intercept and trend in C.E., no trend in VAR							
Portfolio	Country 1	Country 2	Country 3	Country 4	Country 5	Country 6	Country 7	Country 8
A	USA	Germany	SA	UK				
	-0.029179	-0.039532	-0.041059	0.012809				
B	Japan	HK	Australia	SA				
	0.009249	0.054797	0.018591	0.005702				
C	SA	France	Canada	China				
	0.002924	-0.014529	0.006190	0.01000				
D	USA	Japan	UK	Germany	Egypt	SA		
	-0.013998	-0.034261	0.023295	-0.018976	-0.011994	-0.027987		
E	Japan	Argentina	HK	Australia	SA	Philippines		
	-0.004513	0.010165	0.068426	0.020499	0.016960	0.026152		
F	Switz.	Russia	SA	Canada	France	China		
	0.014912	-0.064996	0.007418	-0.008942	0.022283	-0.009906		
G	USA	Japan	Egypt	France	Germany	SA	UK	Canada
	-0.021038	-0.048748	-0.000369	-0.011052	-0.023014	-0.034264	0.037410	0.021502
H	USA	Argentina	Japan	HK	Russia	Australia	SA	Philippines
	-0.041858	-0.079568	0.026279	-0.0539879	-0.191686	-0.002372	-0.034400	-0.042851
I	USA	Switzerland	Russia	Egypt	SA	France	Canada	China
	0.000769	0.000623	0.003415	0.001347	0.000389	0.000026	0.001494	0.000293

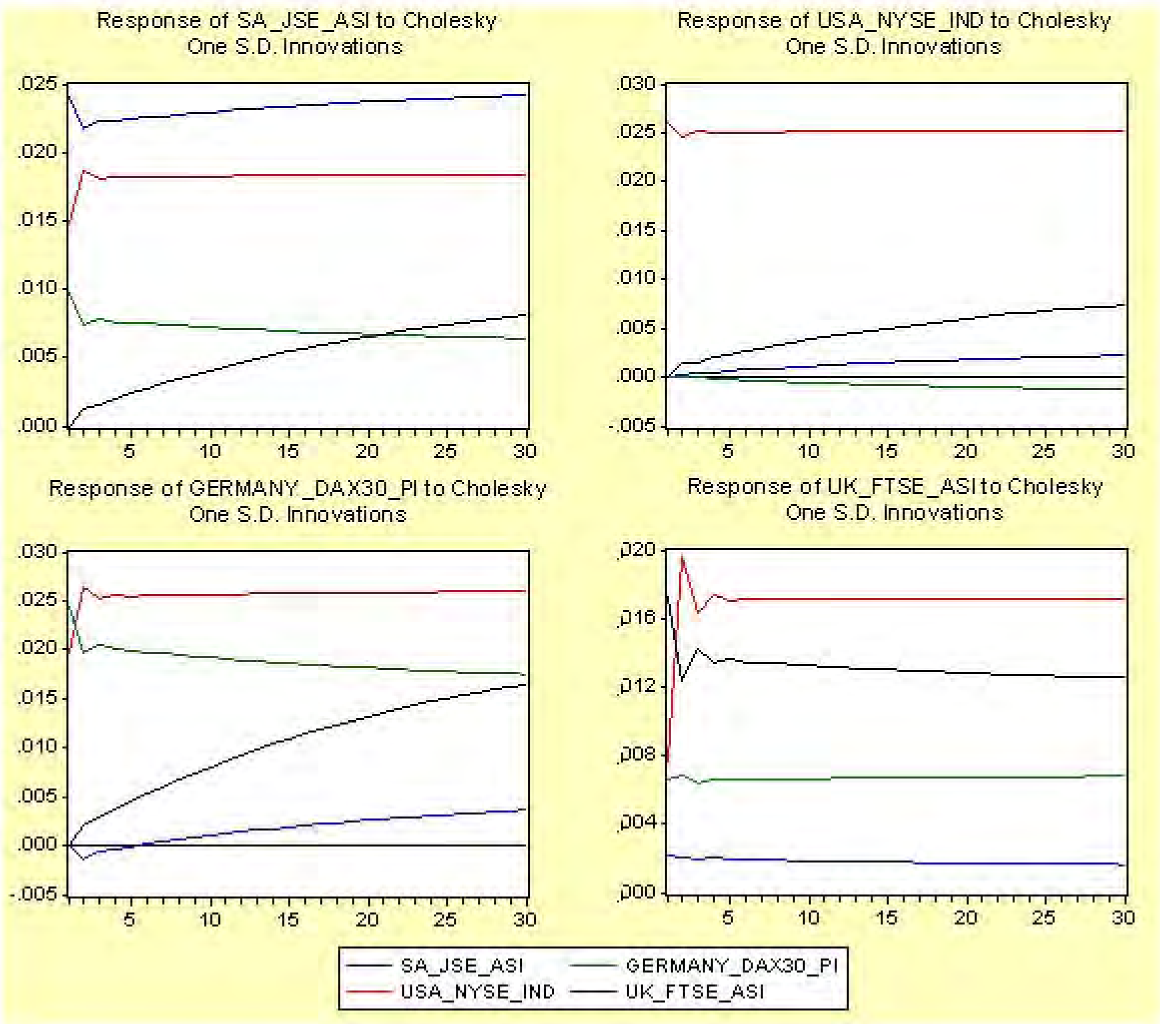
	no trend/intercept in the C.E. or VAR							
Portfolio	Country 1	Country 2	Country 3	Country 4	Country 5	Country 6	Country 7	Country 8
A	USA	Germany	SA	UK				
4 lags	-0.005873	-0.01434	-0.005906	0.004070				
B	SA	HK	Japan	Australia				
1 lag	-0.014809	0.013353	0.007167	0.000611				
C	France	SA	Canada	China				
4 lags	-0.016527	0.003128	0.009854	0.008311				
D	USA	Japan	SA	Germany	Egypt	UK		
11 lags	-0.022248	-0.049580	-0.012716	-0.037704	-0.004445	-0.013575		
E	Japan	HK	Argentina	SA	Australia	Philippines		
3 lags	0.006452	0.003878	0.002739	-0.006593	-0.000102	0.004054		
F	Switz.	Russia	SA	France	Canada	China		
4 lags	0.013484	-0.045239	-0.001618	0.011517	-0.011674	-0.000921		
G	USA	Japan	France	Germany	SA	Egypt	UK	Canada
8 lags	-0.025023	-0.067107	-0.032916	-0.044131	-0.044064	-0.022951	-0.004466	-0.006376
H	USA	Argentina	Japan	HK	SA	Russia	Australia	Philippines
4 lags	-0.034089	-0.051514	0.033581	-0.003353	-0.021595	-0.132705	0.000753	0.006000
I	USA	Switzerland	Russia	SA	France	China	Egypt	Canada
9 lags	0.000712	0.001274	0.006618	0.000735	0.000284	-0.000410	0.002253	0.002643

	intercept in C.E. and VAR							
Portfolio	Country 1	Country 2	Country 3	Country 4	Country 5	Country 6	Country 7	Country 8
A	USA	Germany	SA	UK				
4 lags	-0.005813	-0.015063	-0.004626	0.004447				
B	SA	HK	Japan	Australia				
1 lag	-0.012629	0.017085	0.005785	0.002796				
C	France	SA	Canada	China				
4 lags	-0.017508	0.003806	0.007394	0.011634				
D	USA	Japan	SA	Germany	Egypt	UK		
11 lags	-0.026182	-0.049596	-0.018302	-0.042238	-0.011875	-0.013739		
E	Japan	HK	Argentina	SA	Australia	Philippines		
3 lags	0.006664	0.009304	0.005253	-0.012872	0.002863	0.007977		
F	Switz.	Russia	SA	France	Canada	China		
4 lags	0.013902	-0.044180	-0.000998	0.011816	-0.011399	-0.000142		
G	USA	Japan	France	Germany	SA	Egypt	UK	Canada
8 lags	-0.026254	-0.066076	-0.033784	-0.045787	-0.046557	-0.025315	-0.004246	-0.006463
H	USA	Argentina	Japan	HK	SA	Russia	Australia	Philippines
4 lags	-0.051699	-0.077233	0.006787	-0.037661	-0.014066	-0.196811	0.003045	-0.035491
I	USA	Switzerland	Russia	SA	France	China	Egypt	Canada
9 lags	0.000228	0.000183	0.000849	0.000133	0.000033	0.000057	0.000371	0.000400

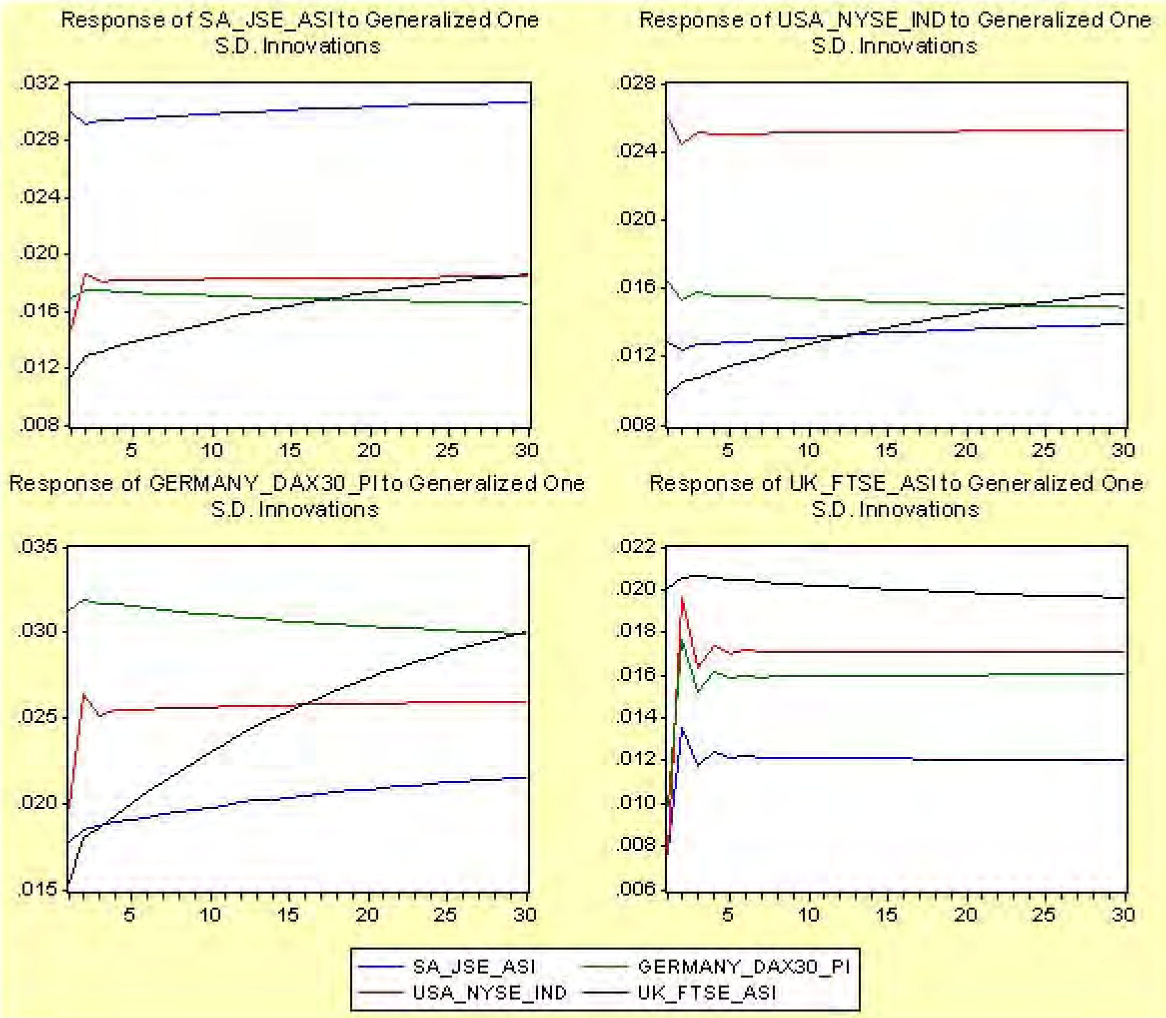
	intercept and trend in C.E., no trend in VAR							
Portfolio	Country 1	Country 2	Country 3	Country 4	Country 5	Country 6	Country 7	Country 8
A	USA	Germany	SA	UK				
4 lags	-0.019484	-0.036500	-0.027418	0.004924				
B	SA	HK	Japan	Australia				
1 lag	-0.009008	-0.027968	-0.000041	-0.010721				
C	France	SA	Canada	China				
4 lags	-0.017856	0.001140	0.008968	0.005336				
D	USA	Japan	SA	Germany	Egypt	UK		
11 lags	-0.030728	-0.052430	-0.024595	-0.048387	-0.016770	-0.017155		
E	Japan	HK	Argentina	SA	Australia	Philippines		
3 lags	-0.003113	0.064231	0.011170	0.021411	0.015776	0.024984		
F	Switz.	Russia	SA	France	Canada	China		
4 lags	0.009869	-0.074639	0.010436	0.018105	-0.015653	-0.004182		
G	USA	Japan	France	Germany	SA	Egypt	UK	Canada
8 lags	-0.026408	-0.062346	-0.035305	-0.045669	-0.046631	-0.027954	-0.005234	-0.007039
H	USA	Argentina	Japan	HK	SA	Russia	Australia	Philippines
4 lags	-0.039849	-0.087614	0.028795	-0.065743	-0.050221	-0.146455	-0.004938	-0.032138
I	USA	Switzerland	Russia	SA	France	China	Egypt	Canada
9 lags	0.000649	0.002103	0.012733	0.000378	-0.000049	-0.000615	0.003681	0.004508

Appendix R – multivariate IRFs at both lags at which autocorrelation first disappears and the number selected by the various criteria (2). Both GIRF and Cholesky ordering are used. Cholesky ordering in parenthesis.

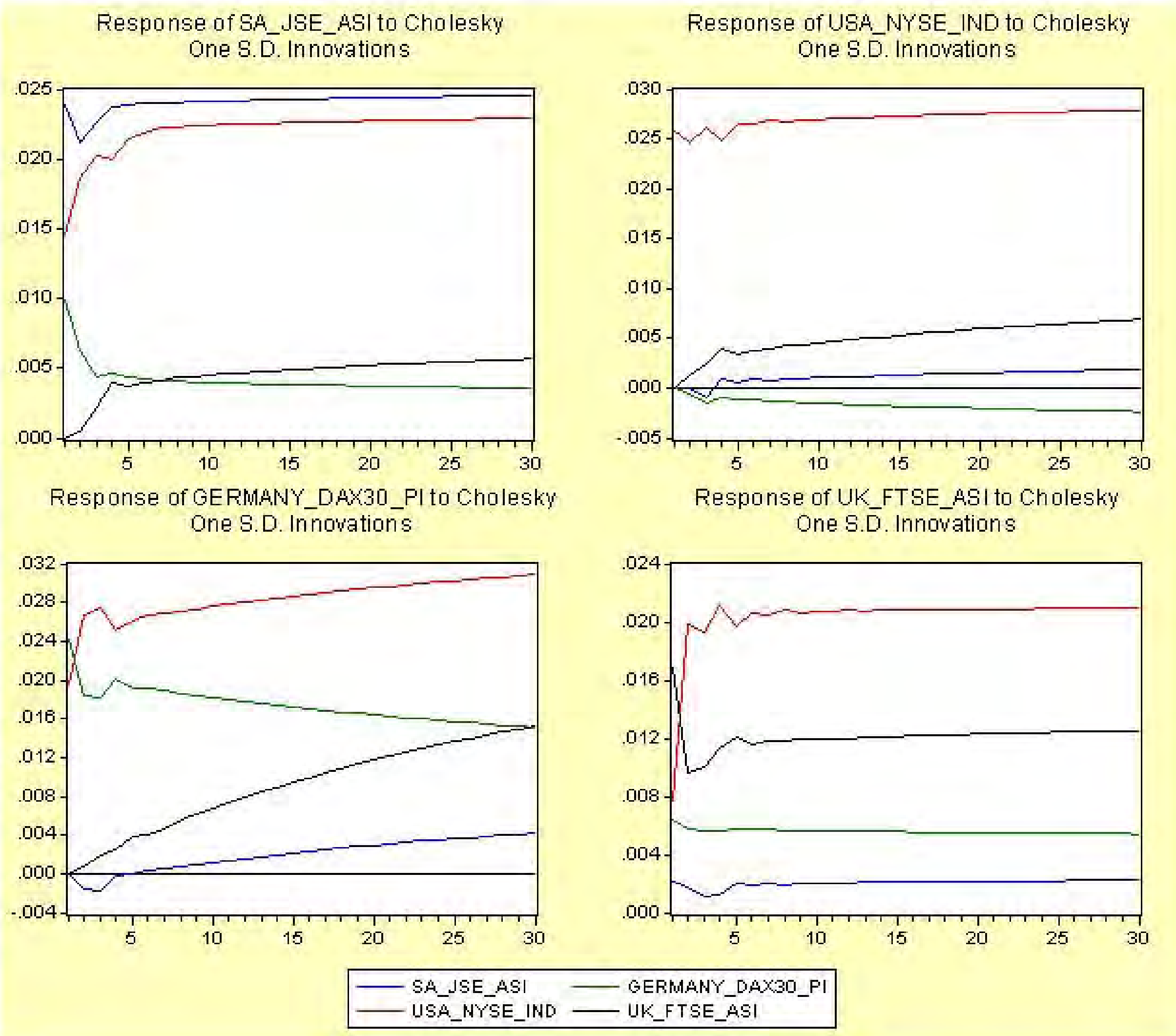
Portfolio A – 2 lags Cholesky (USA – Germany – SA – UK)



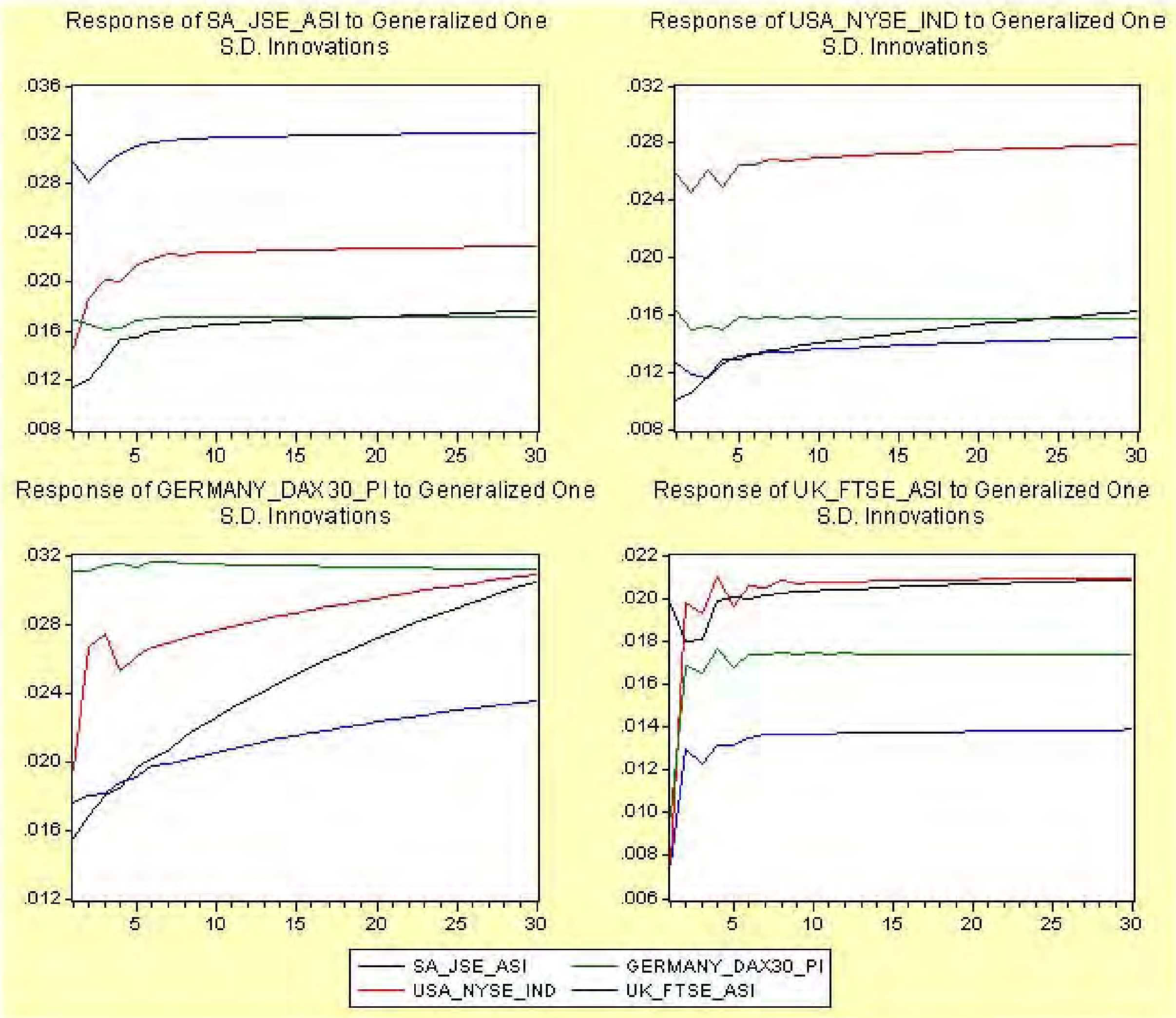
Portfolio A – 2 lags GIRF



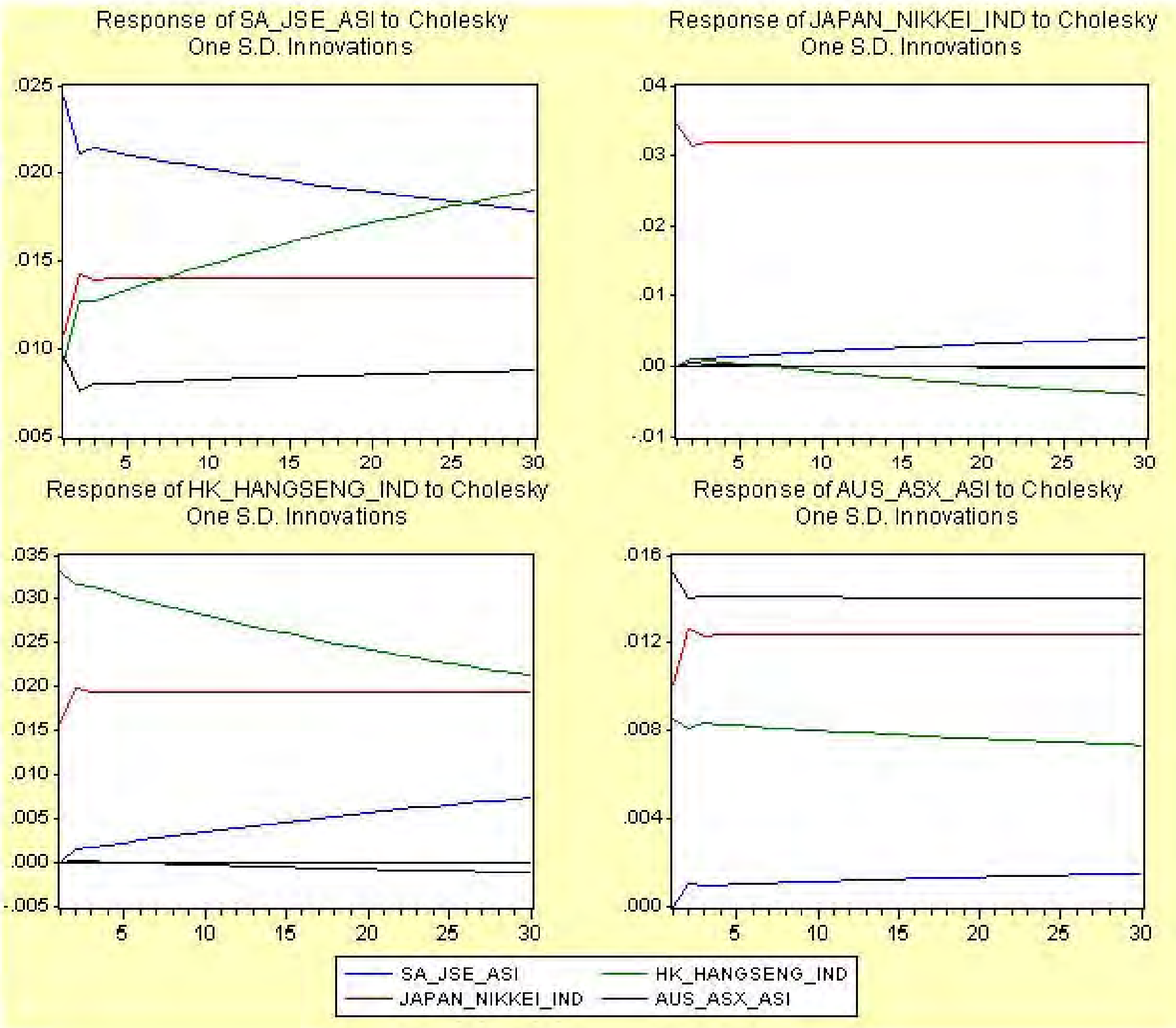
Portfolio A – 4 lags Cholesky (USA – Germany – SA – UK)



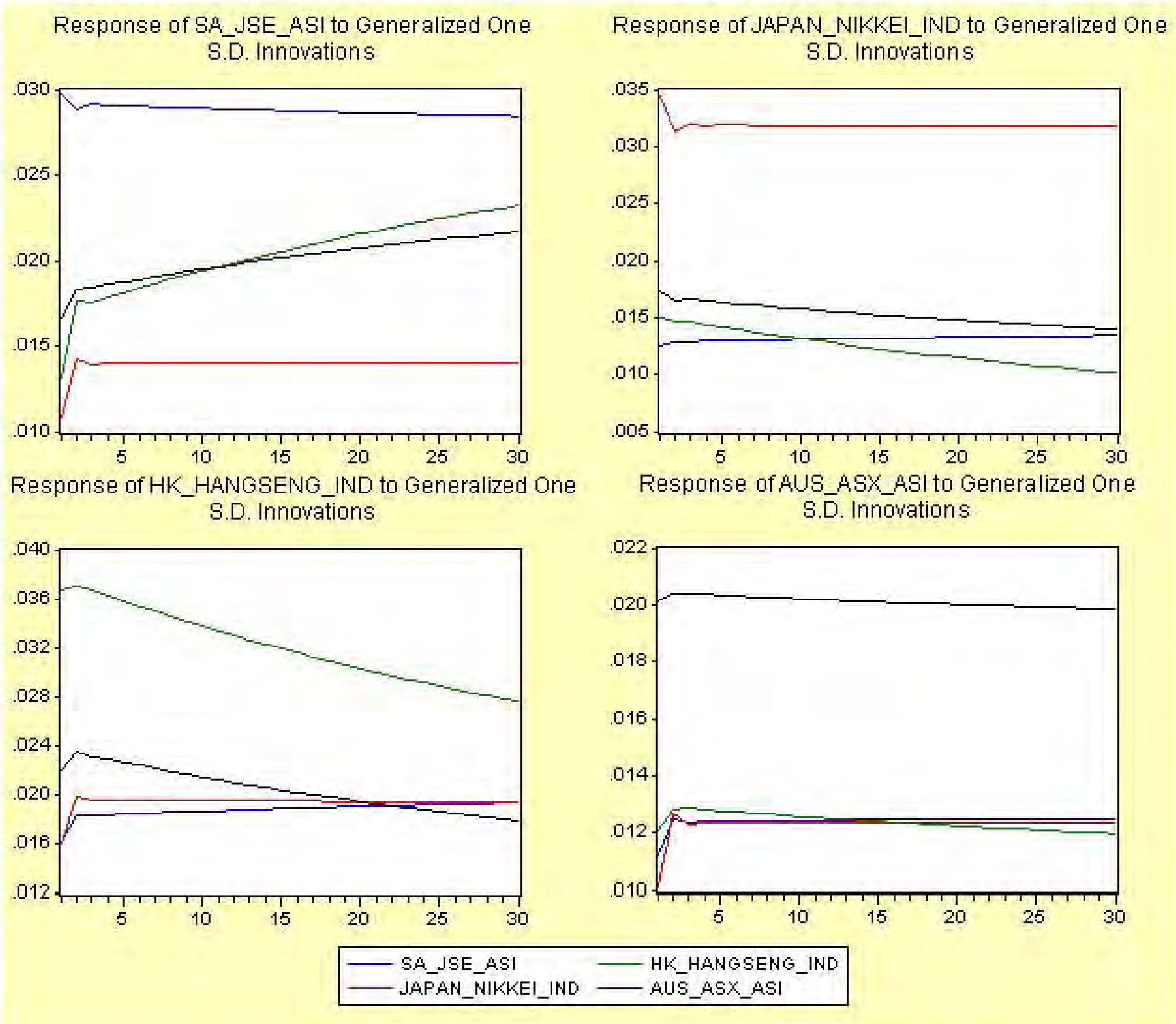
Portfolio A – 4 lags GIRF



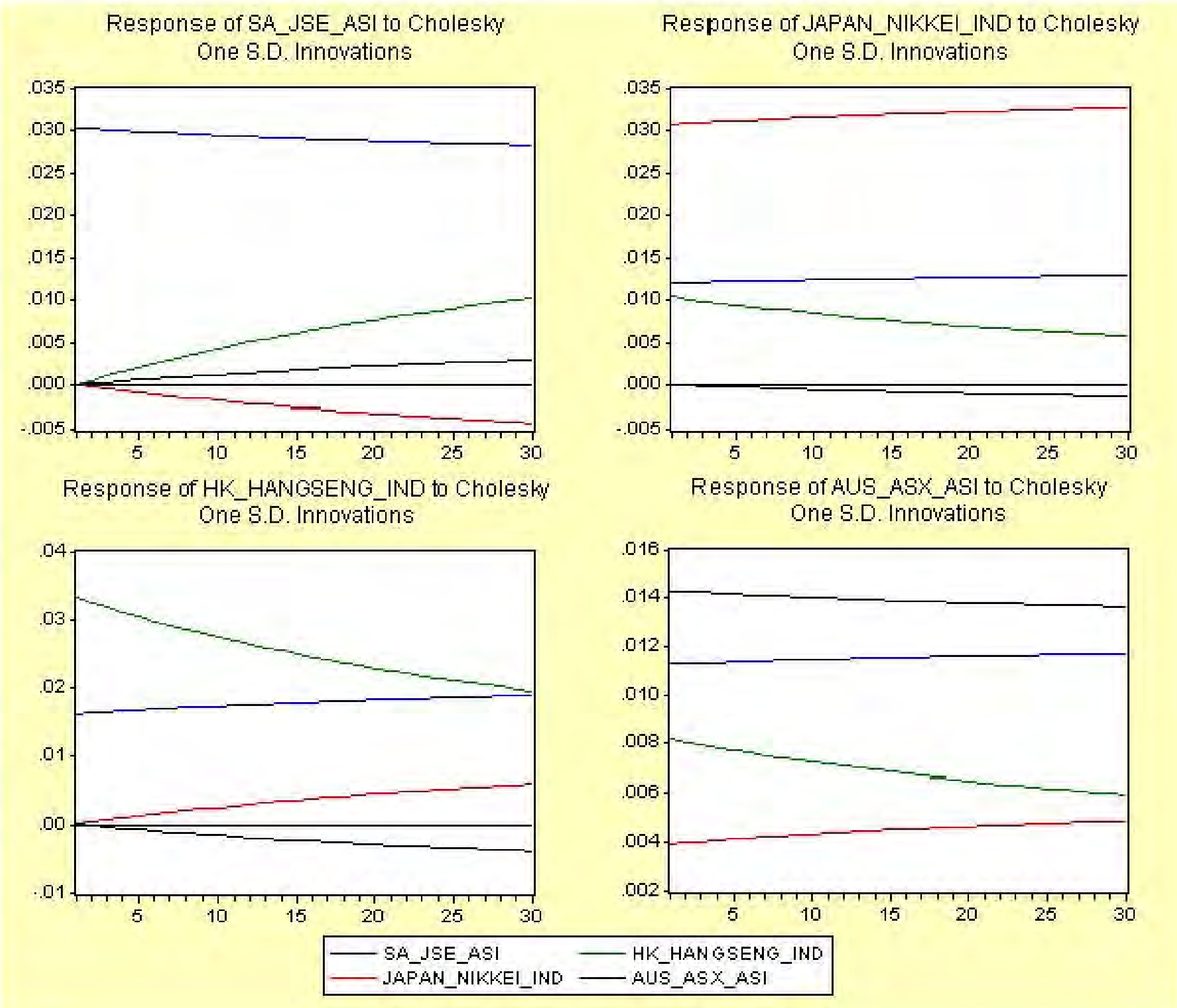
Portfolio B – 2 lags Cholesky (Japan – HK – Australia – SA)



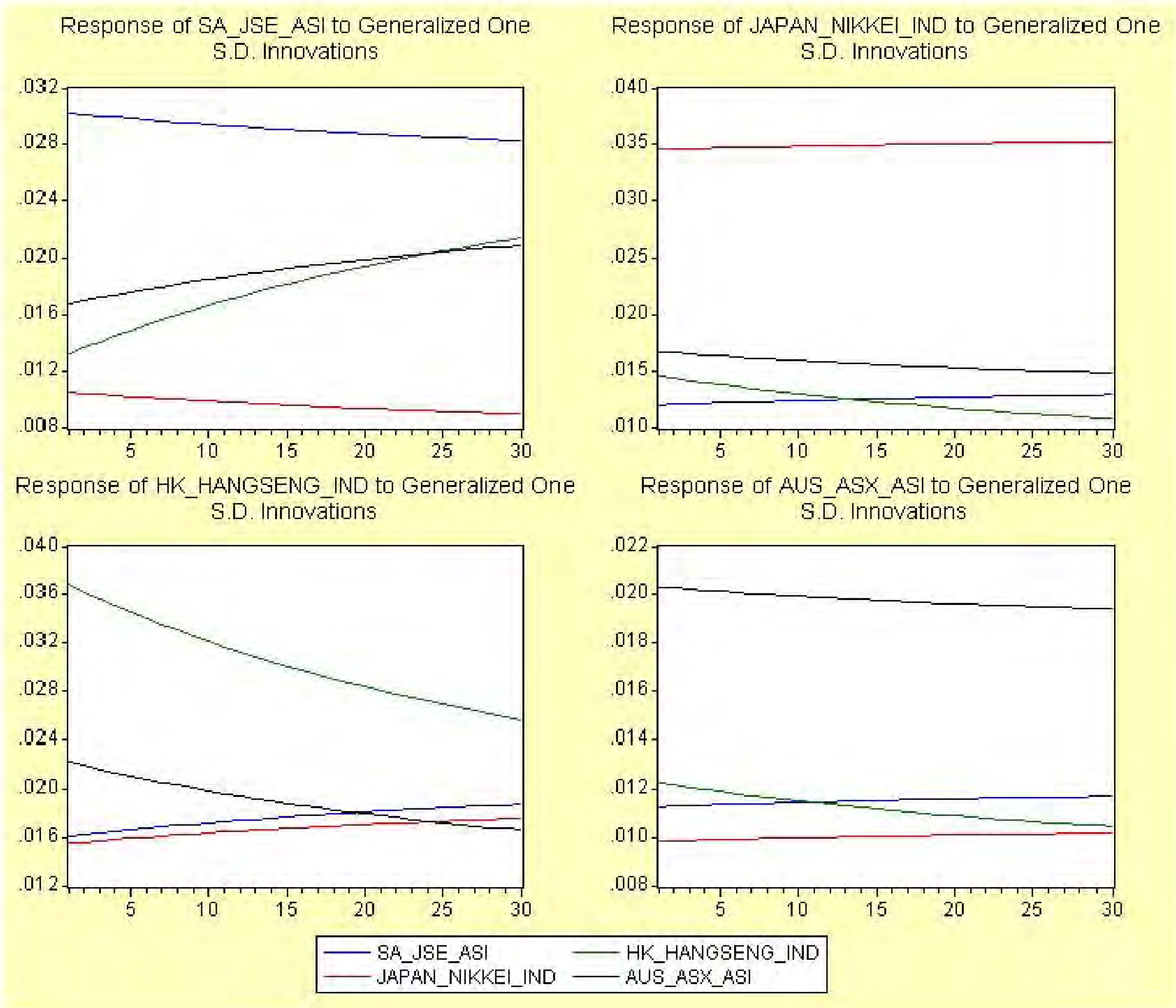
Portfolio B – 2 lags GIRF



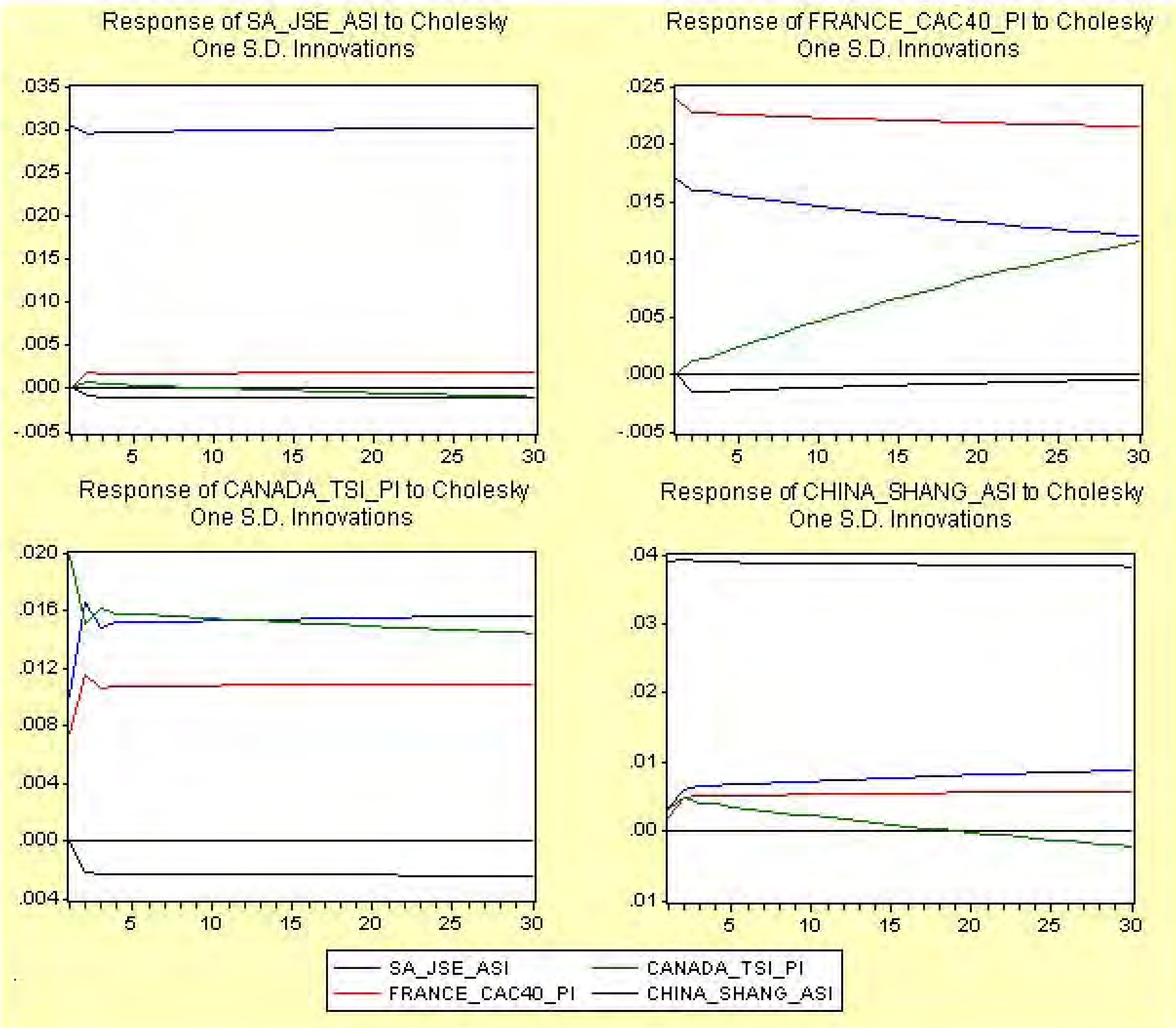
Portfolio B – 1 lag Cholesky (SA – HK – Japan – Australia)



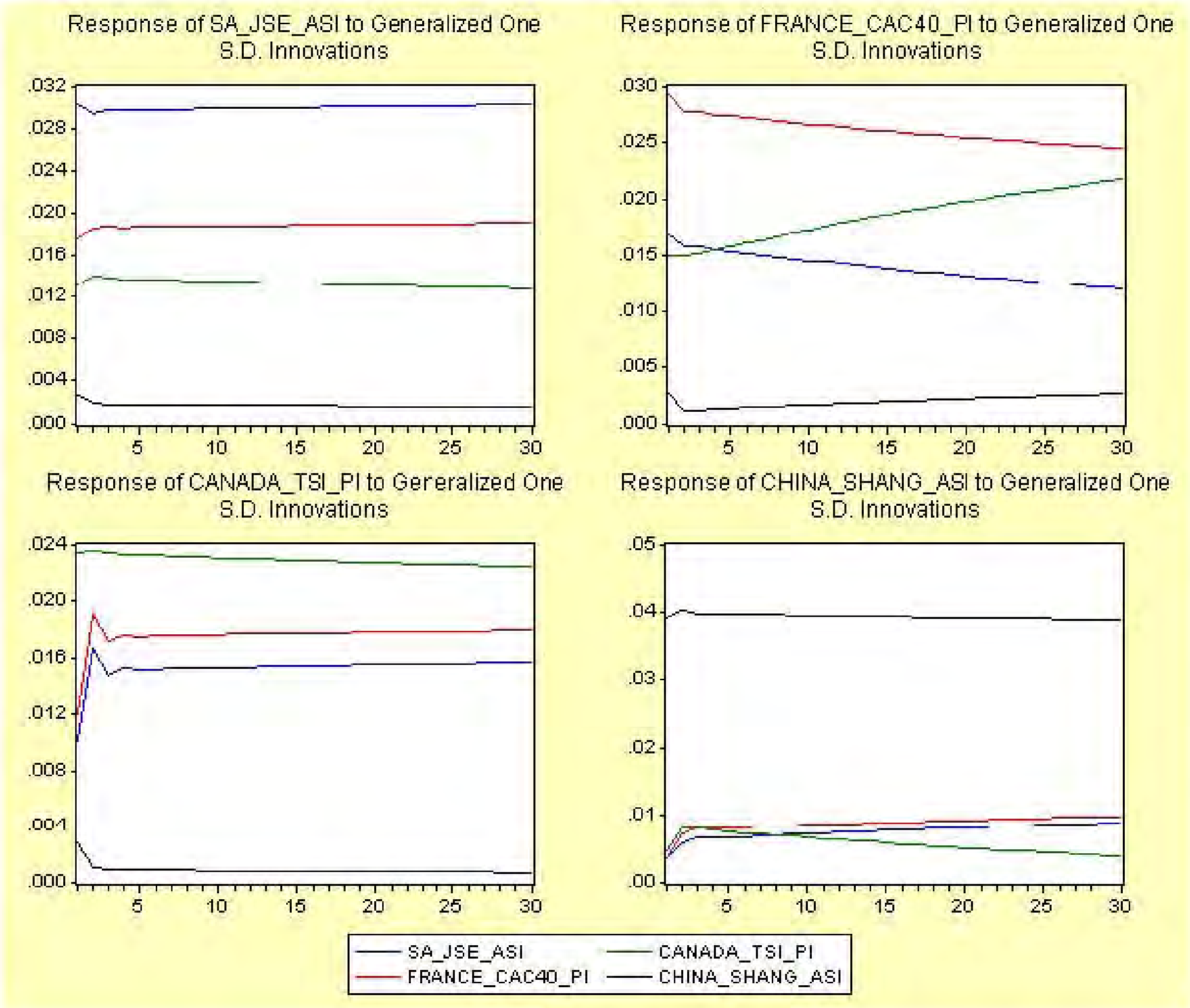
Portfolio B – 1 lag GIRF



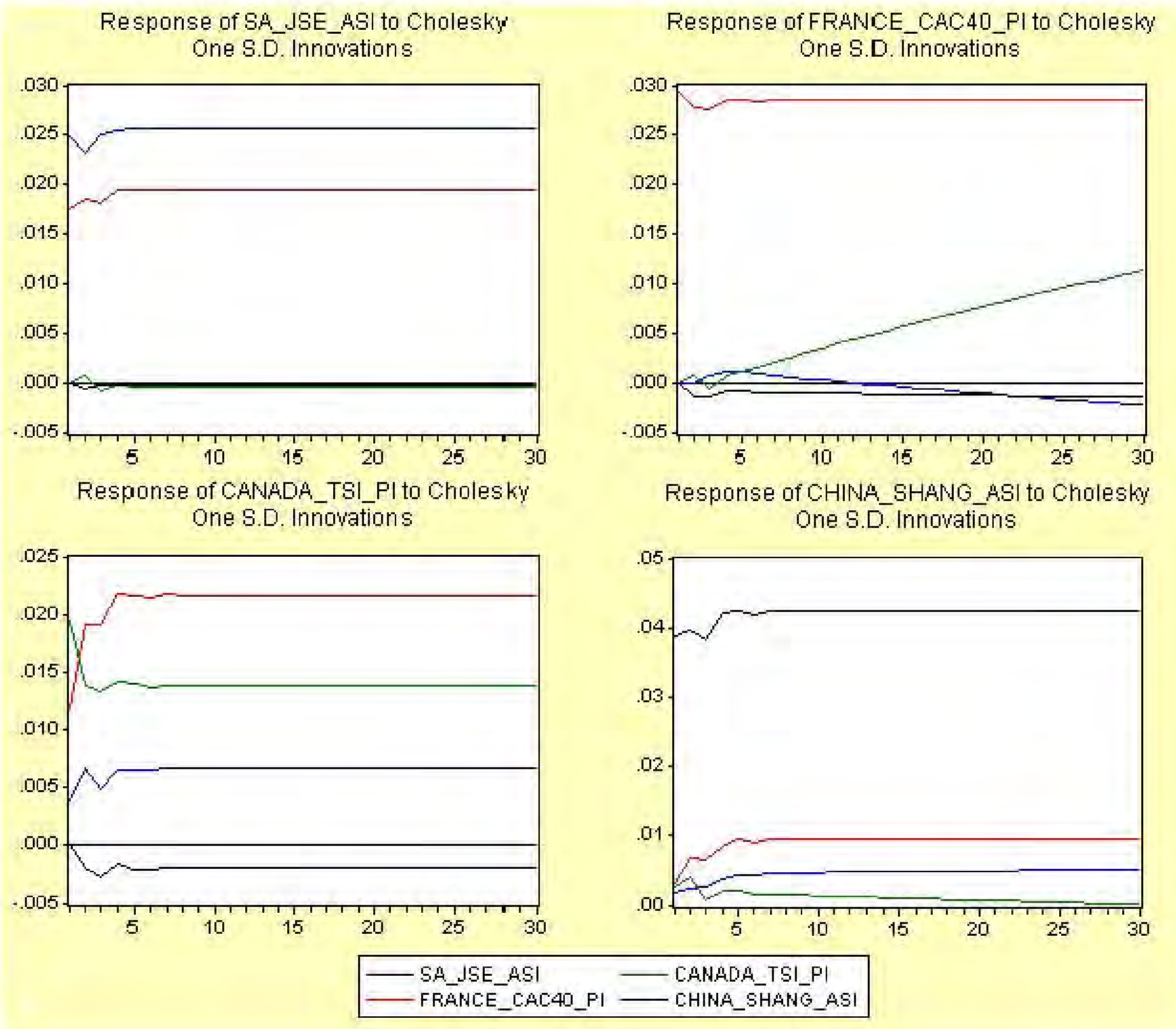
Portfolio C – 2 lags Cholesky (SA – France – Canada – China)



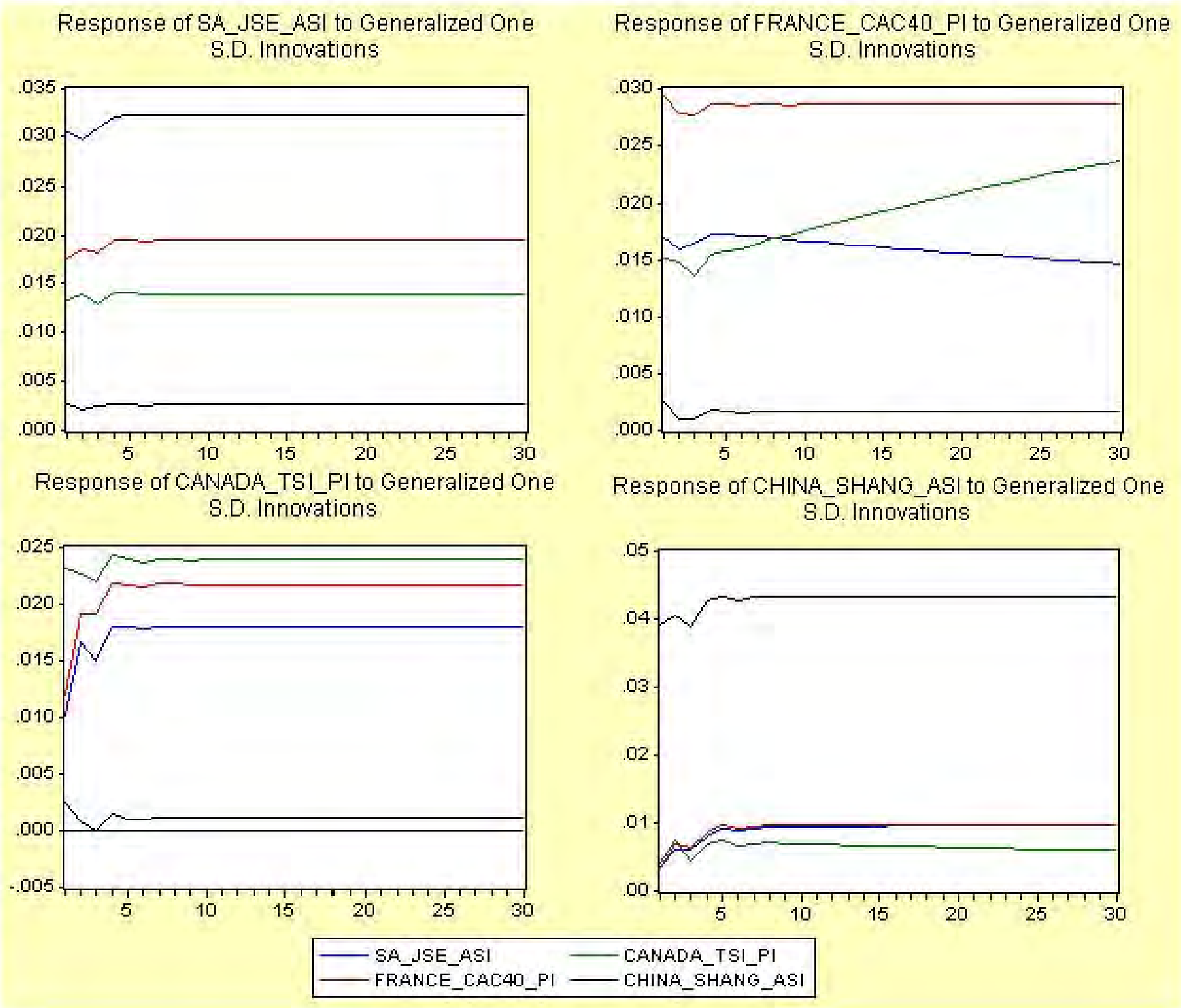
Portfolio C – 2 lags GIRF



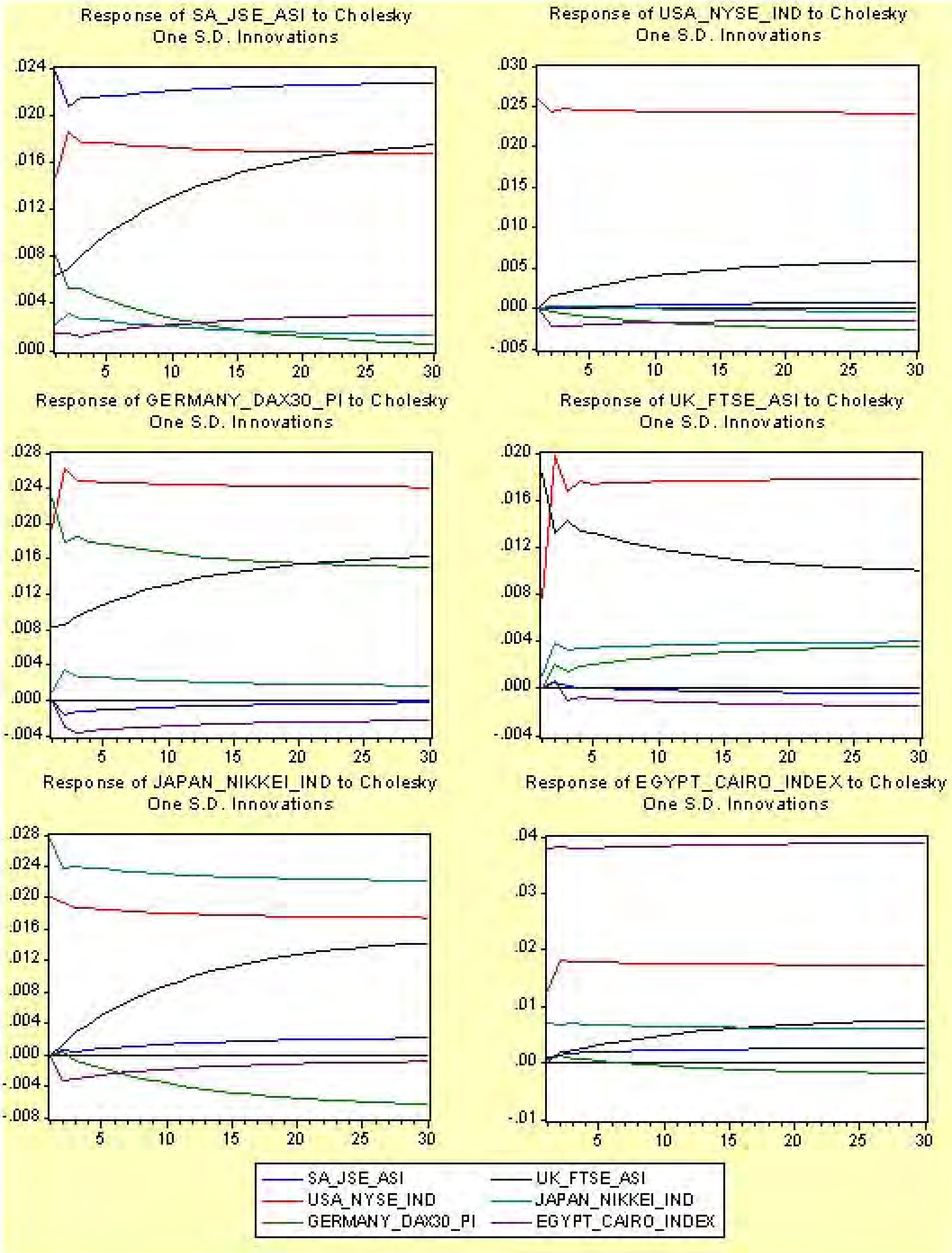
Portfolio C – 4 lags Cholesky (France – SA – Canada – China)



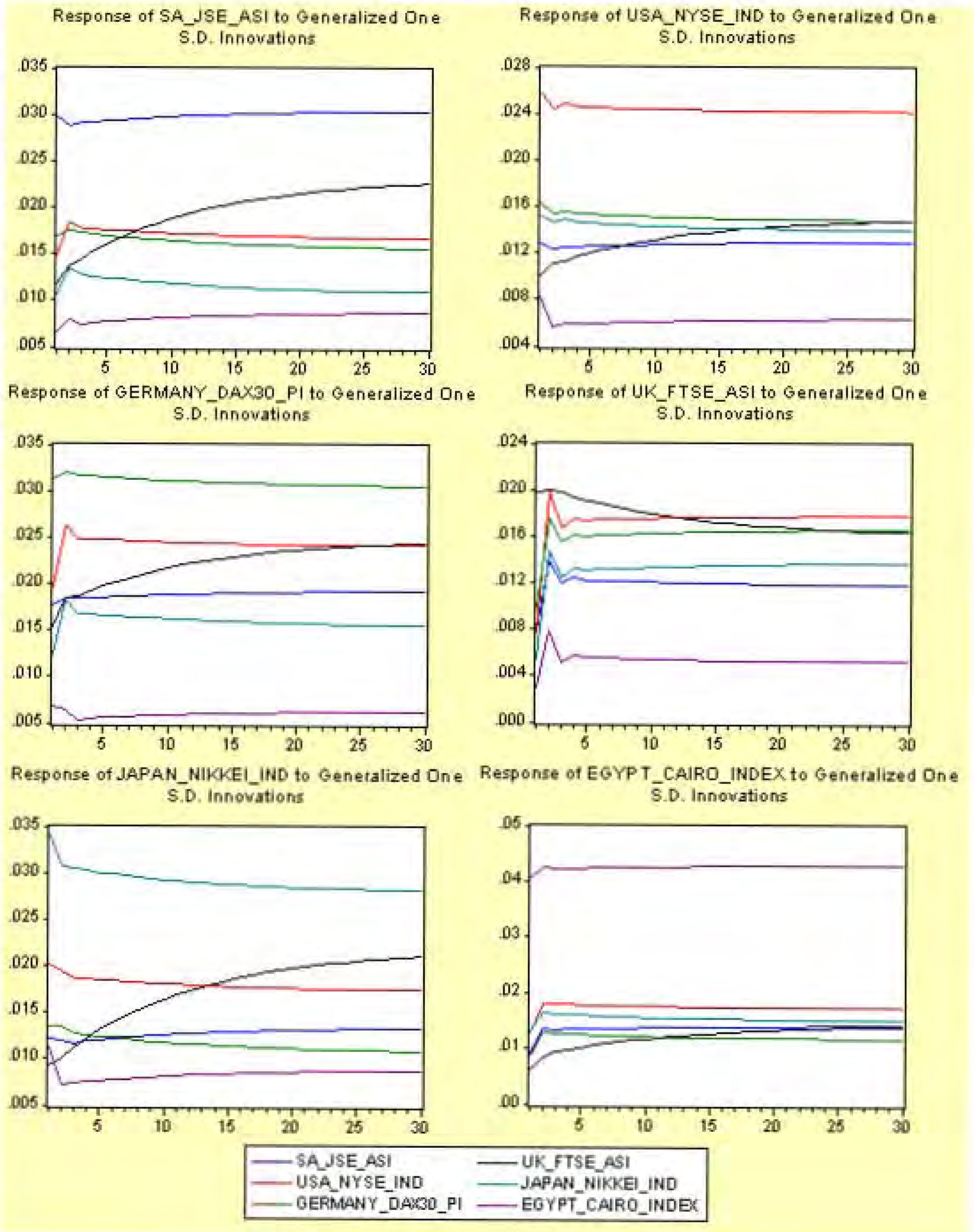
Portfolio C – 4 lags GIRF



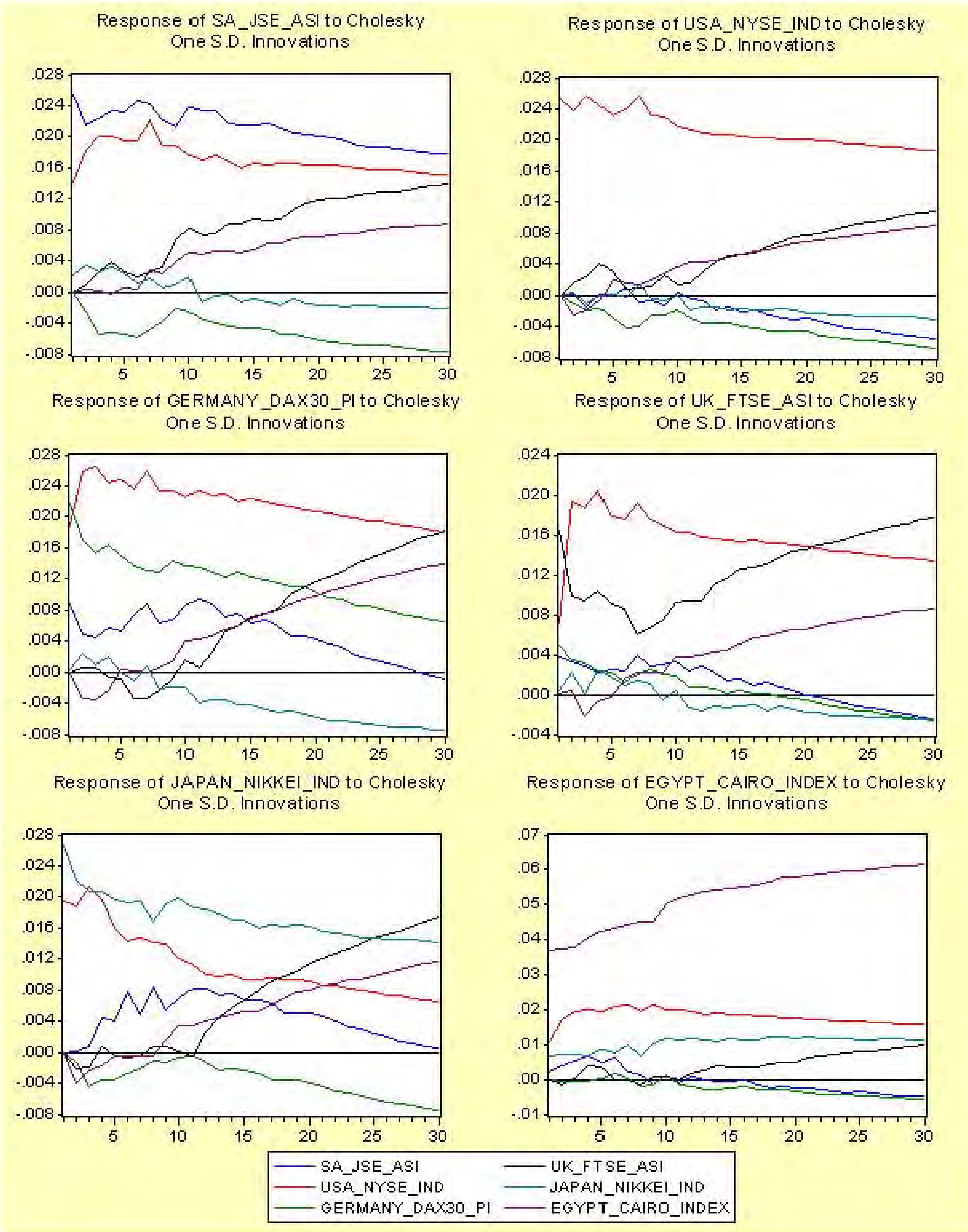
Portfolio D – 2 lags Cholesky (USA – Japan – UK – Germany – Egypt – SA)



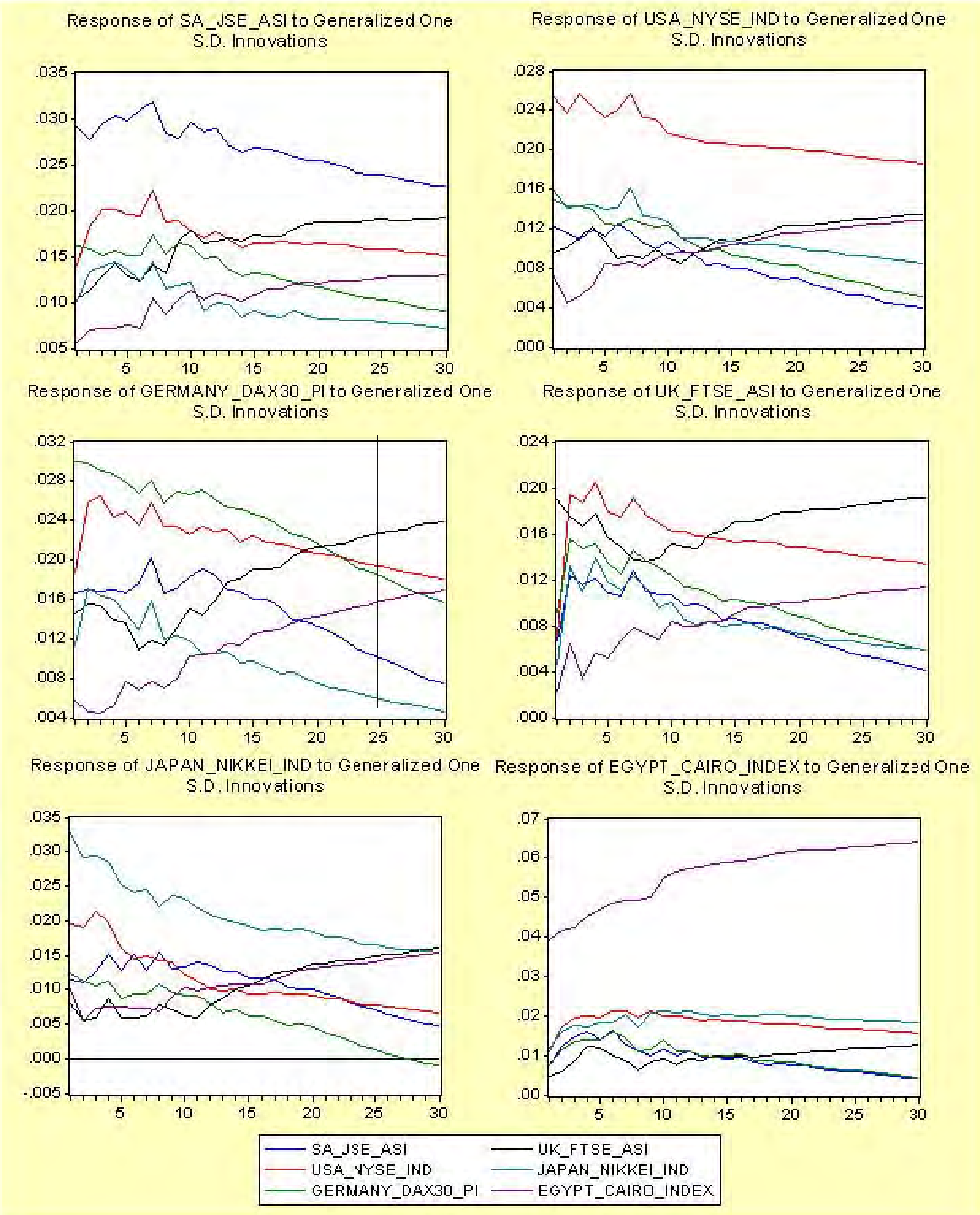
Portfolio D – 2 lags GIRF



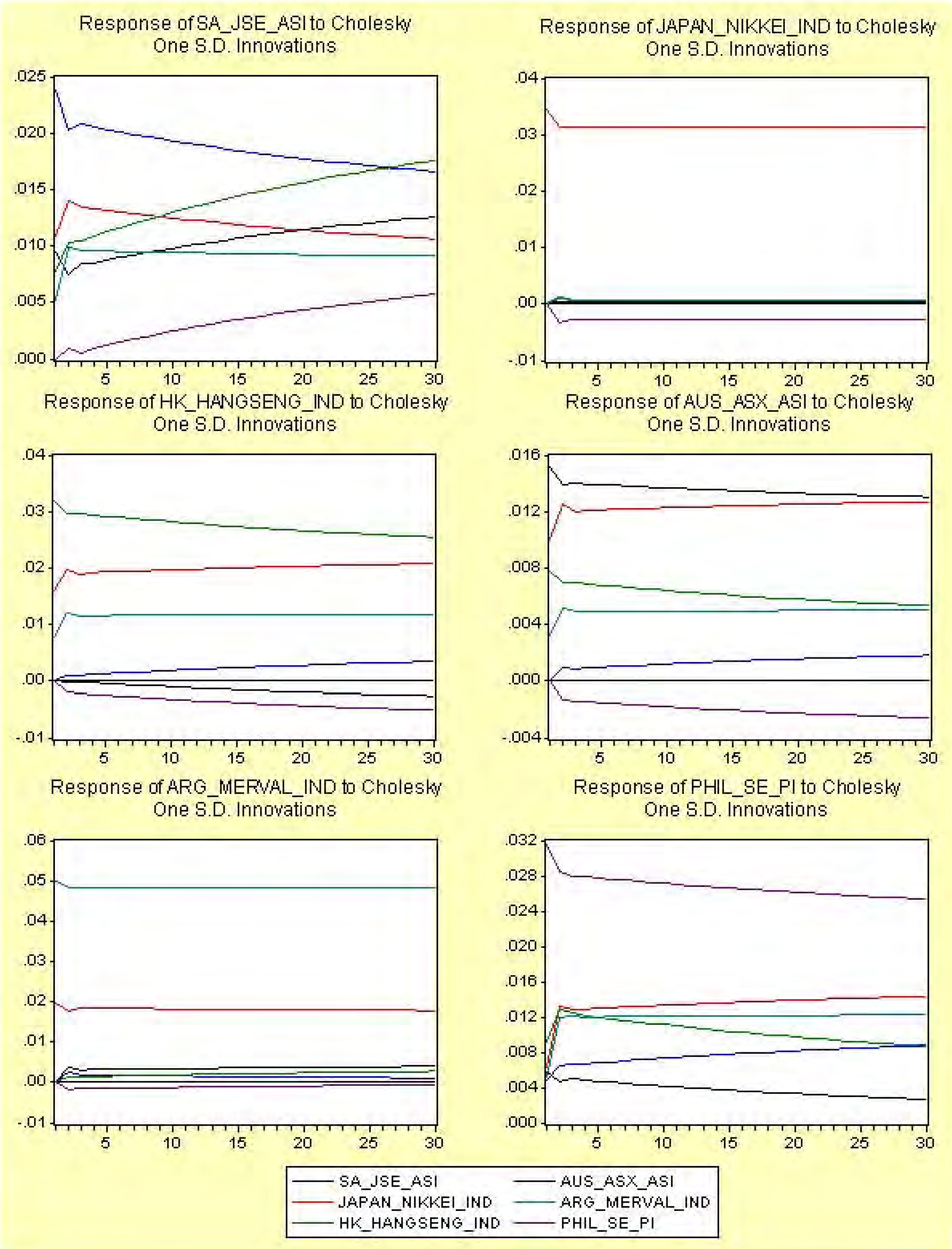
Portfolio D – 11 lags Cholesky (USA – Japan – UK – Germany – Egypt – SA)



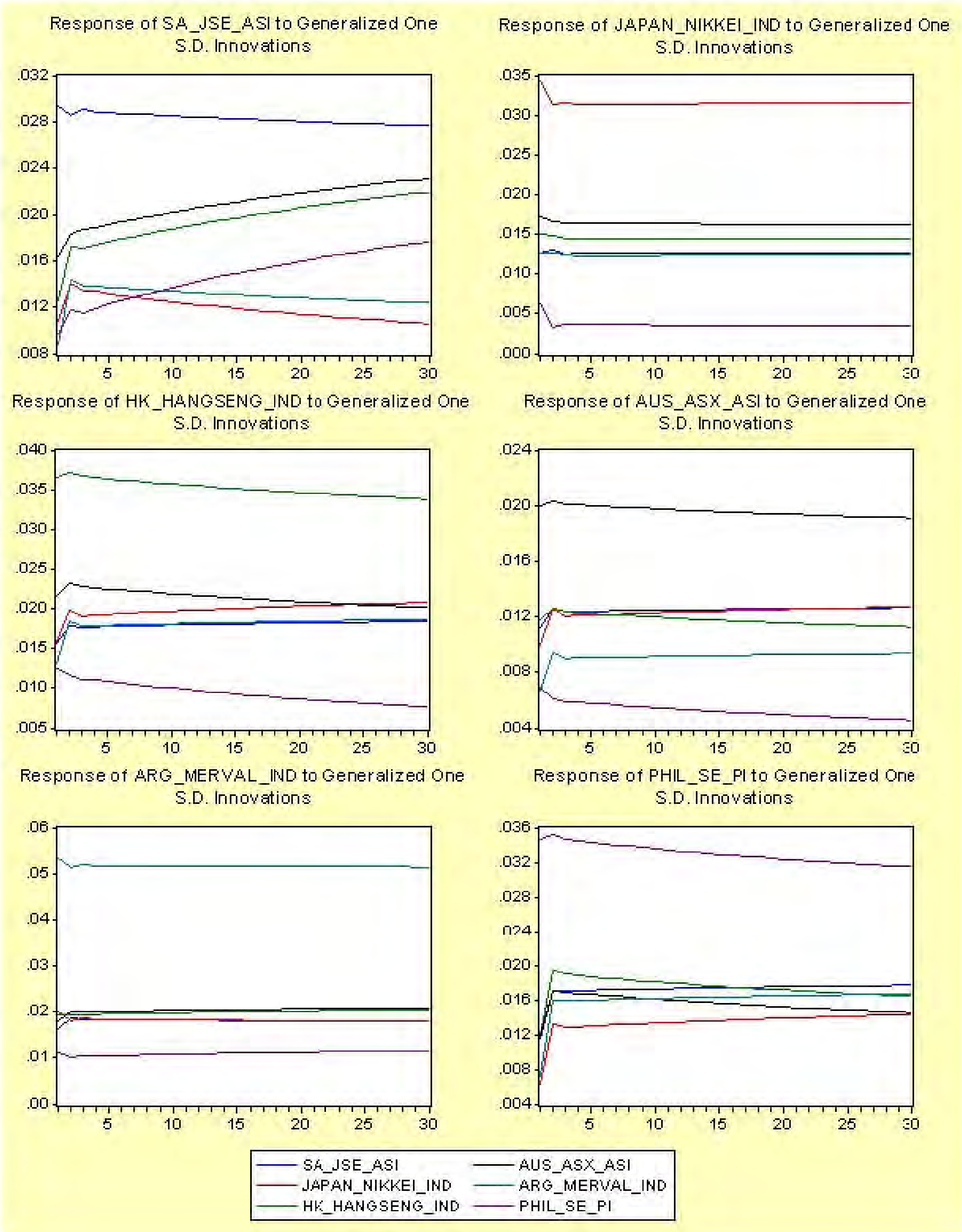
Portfolio D – 11 lags GIRF



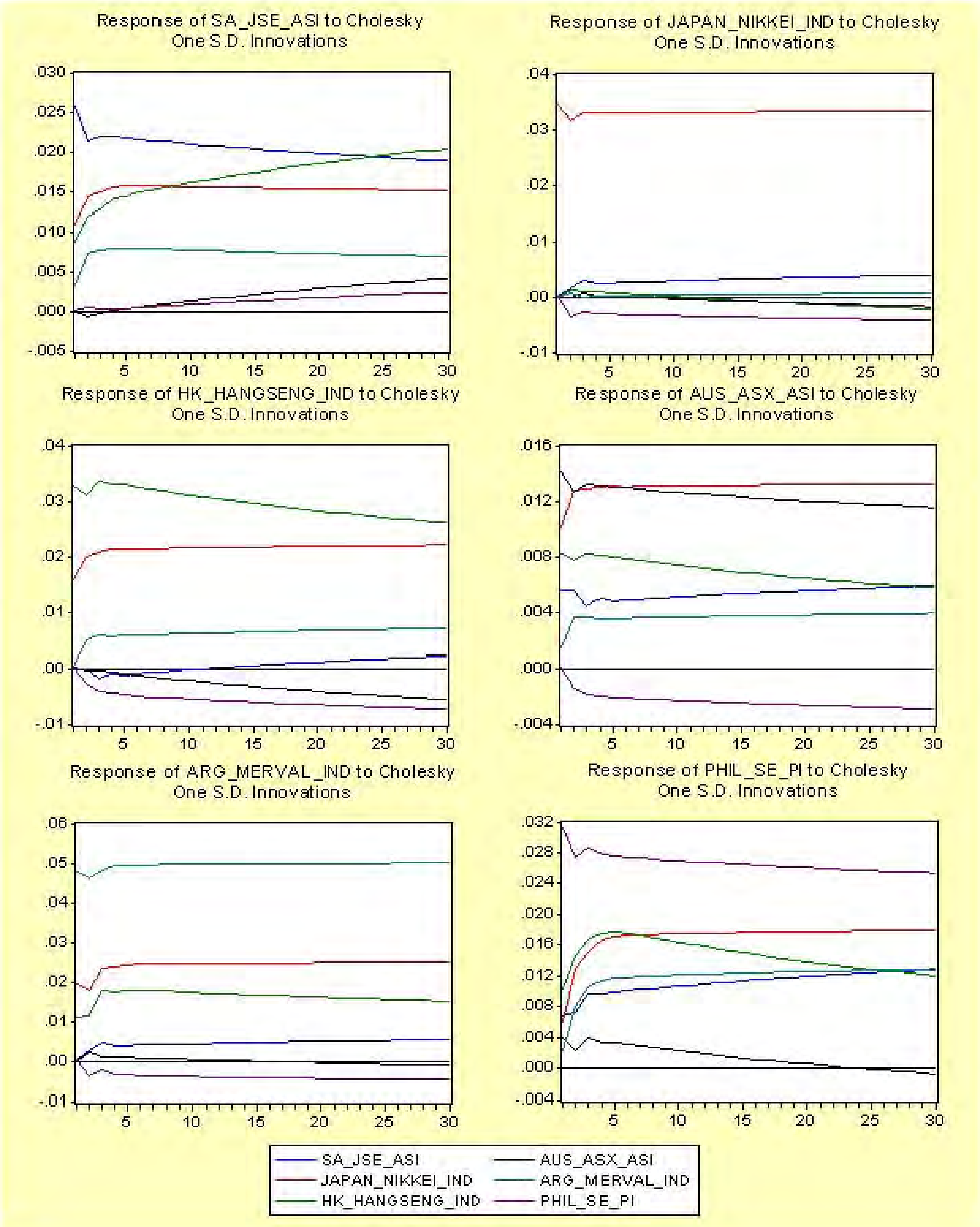
Portfolio E – 2 lags – Cholesky (Japan – Argentina – HK – Australia – SA – Philippines)



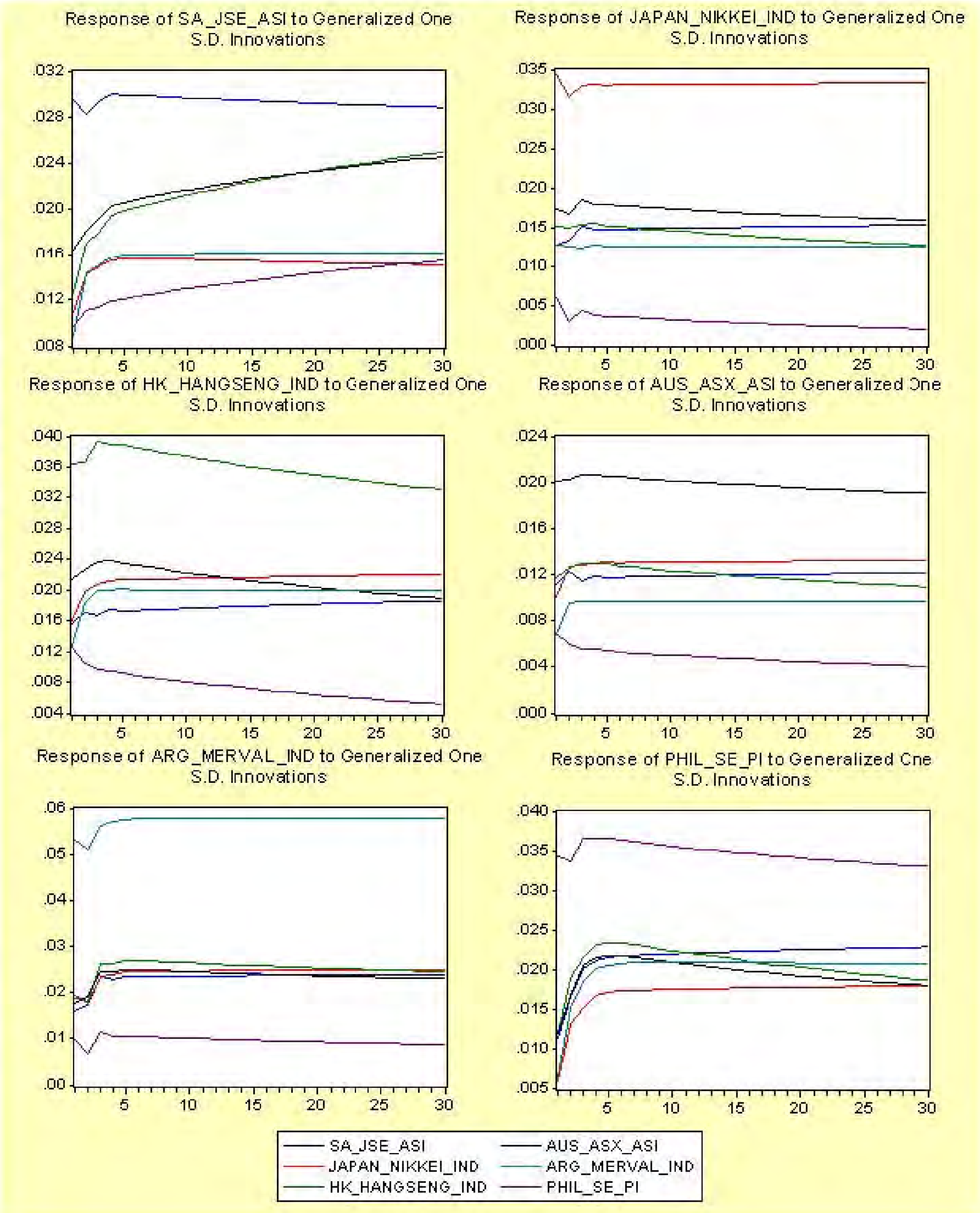
Portfolio E – 2 lags GIRF



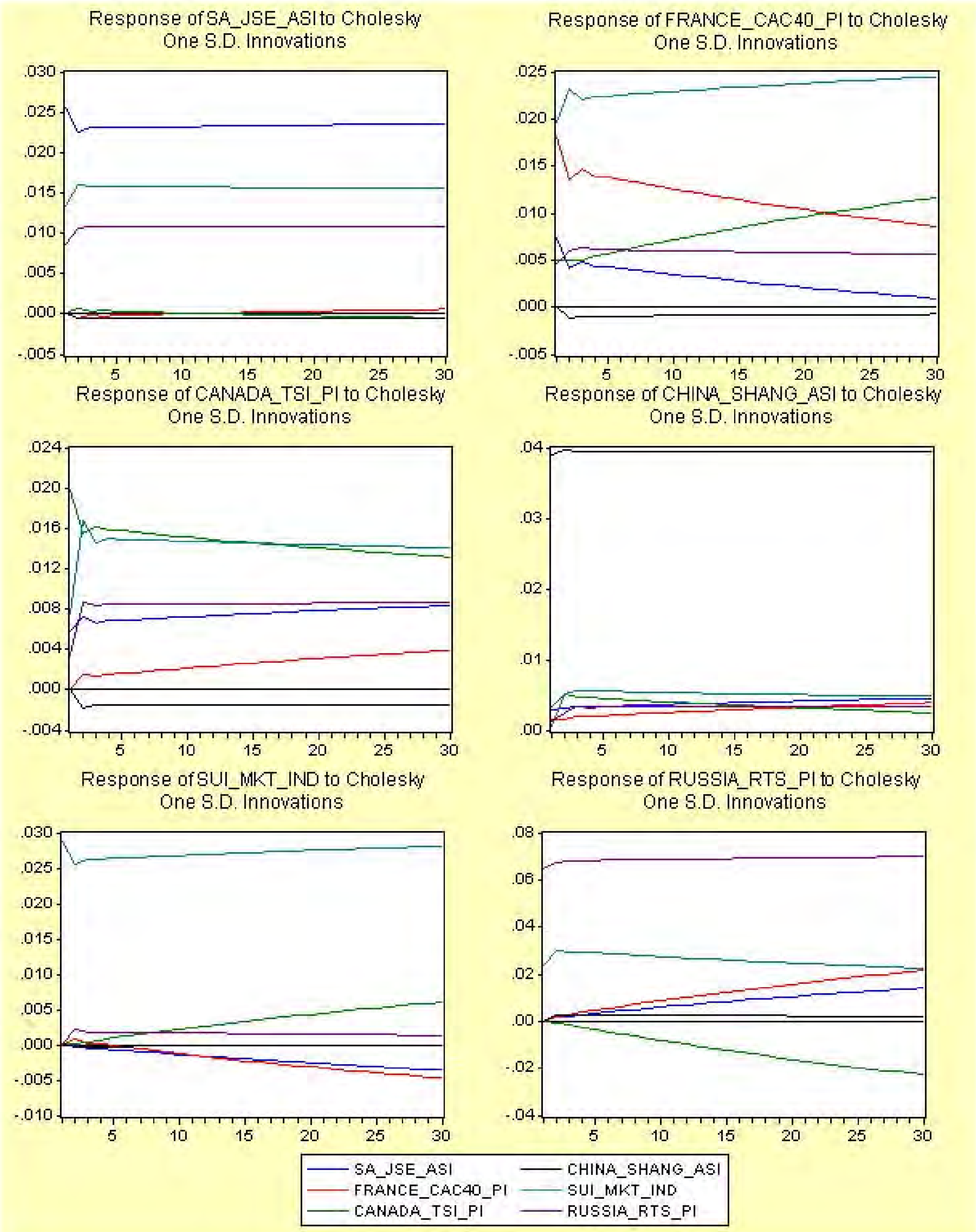
Portfolio E – 3 lags Cholesky (Japan – HK – Argentina – SA – Australia – Philippines)



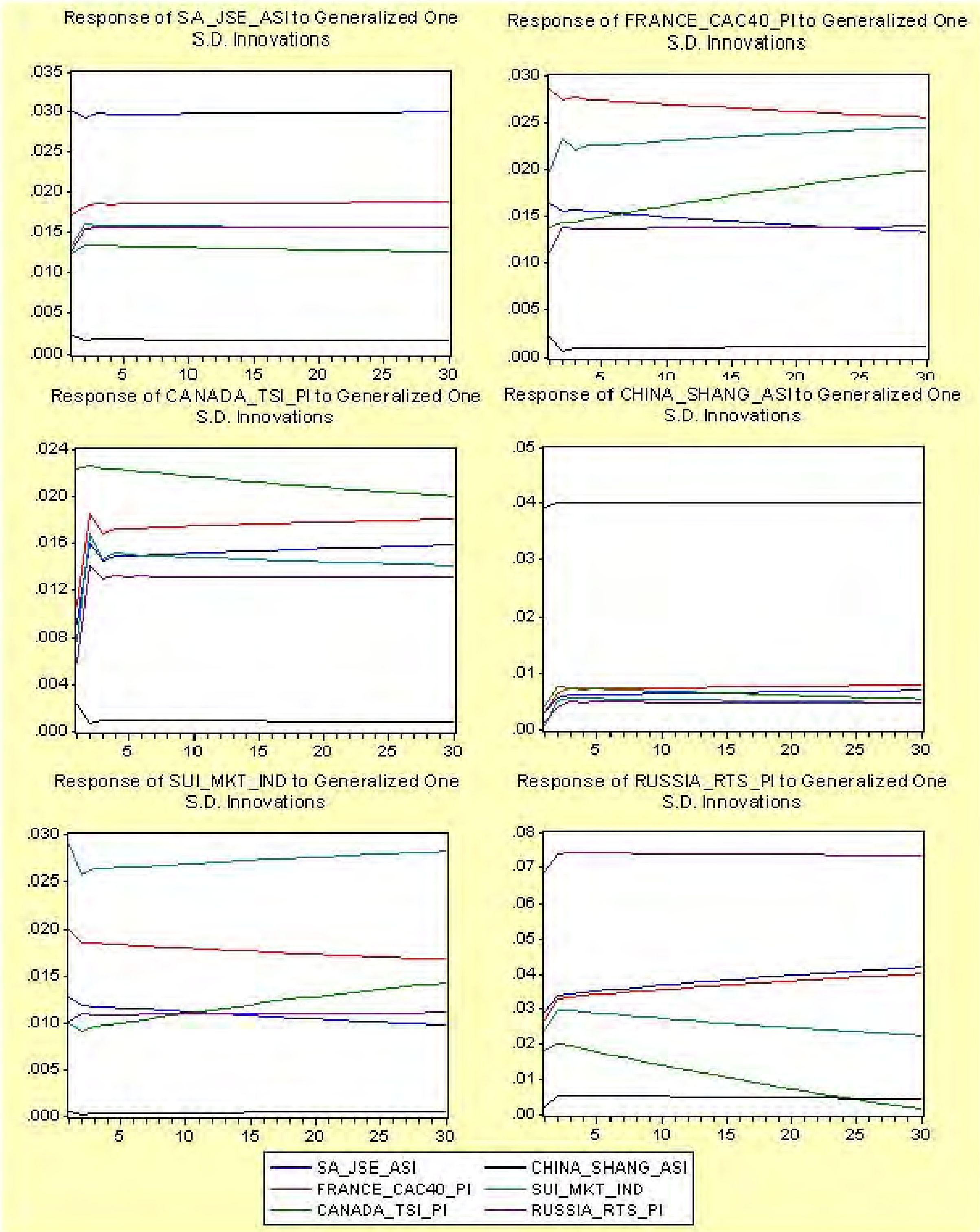
Portfolio E – 3 lags GIRF



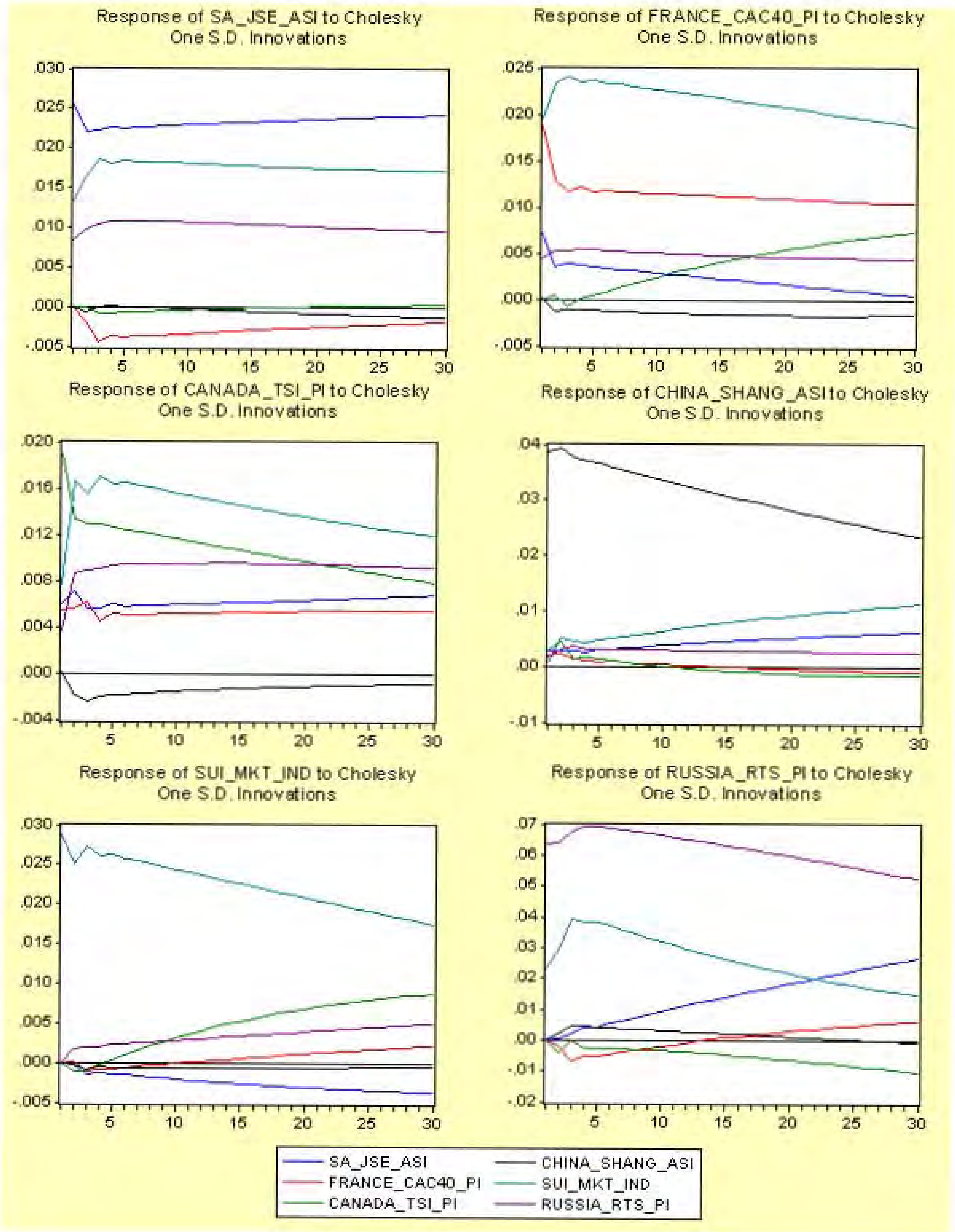
Portfolio F – 2 lags Cholesky (Switzerland – Russia – SA – Canada – France – China)



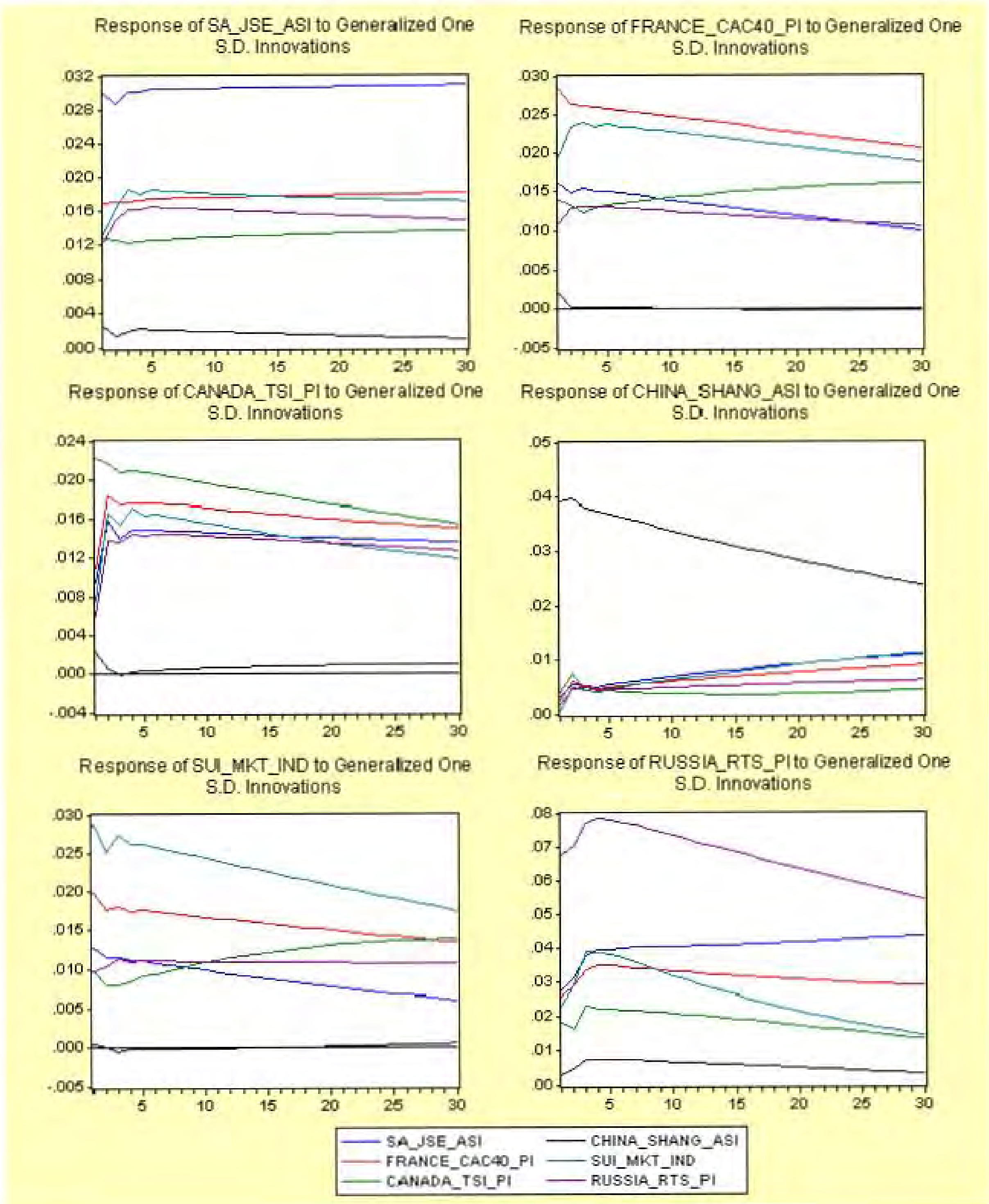
Portfolio F – 2 lags GIRF



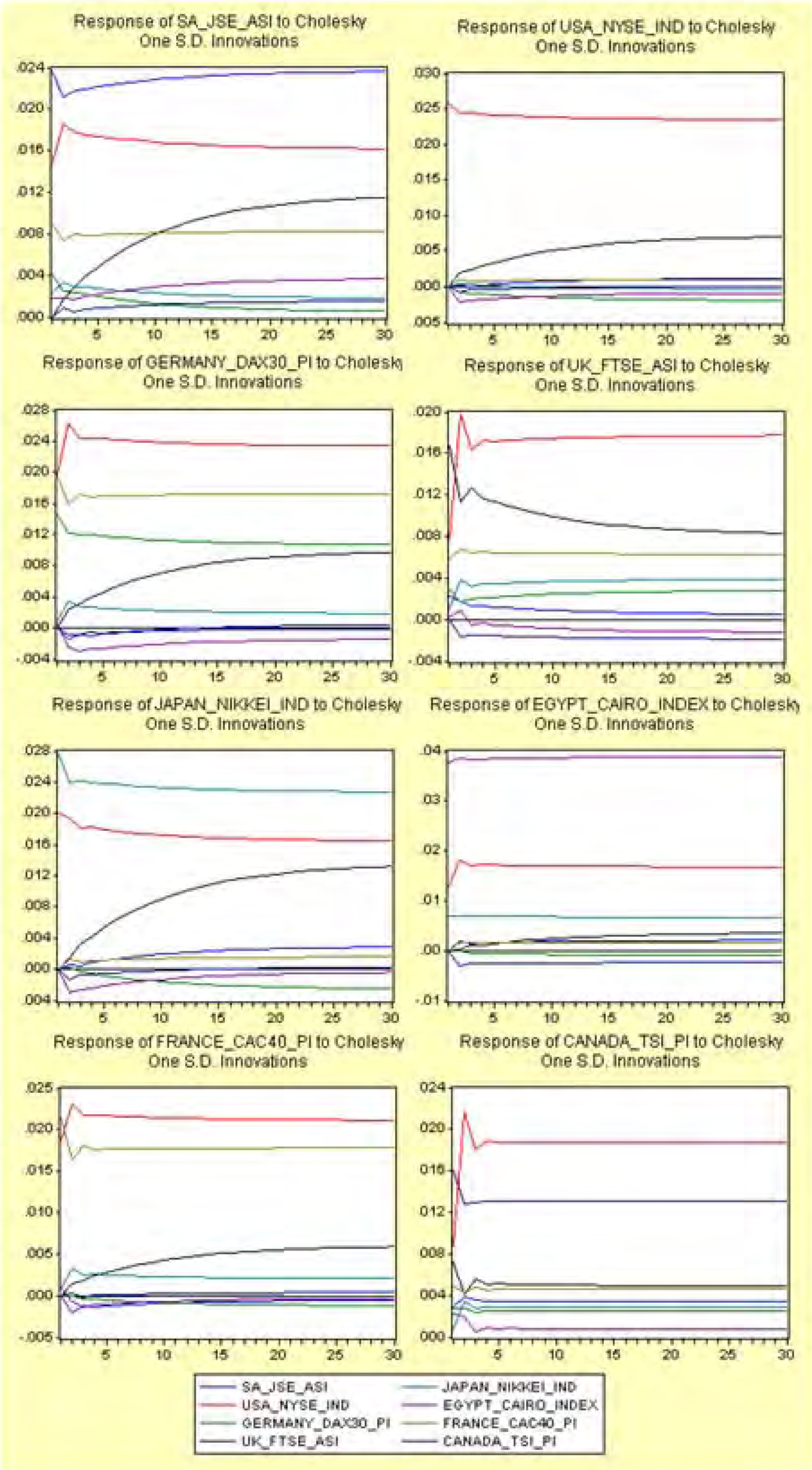
Portfolio F – 4 lags Cholesky (Switzerland – Russia – SA – France – Canada – China)



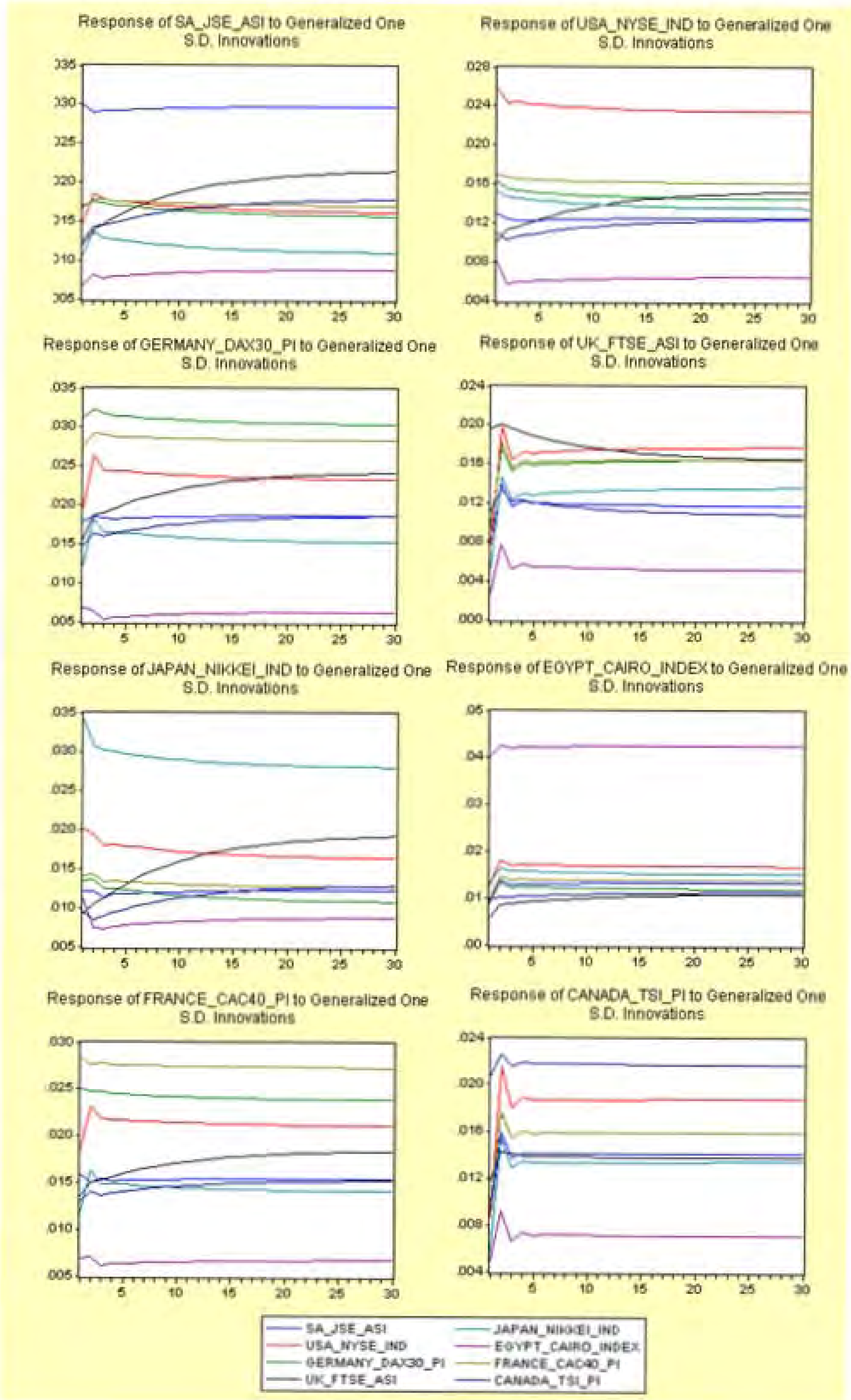
Portfolio F – 4 lags GIRF



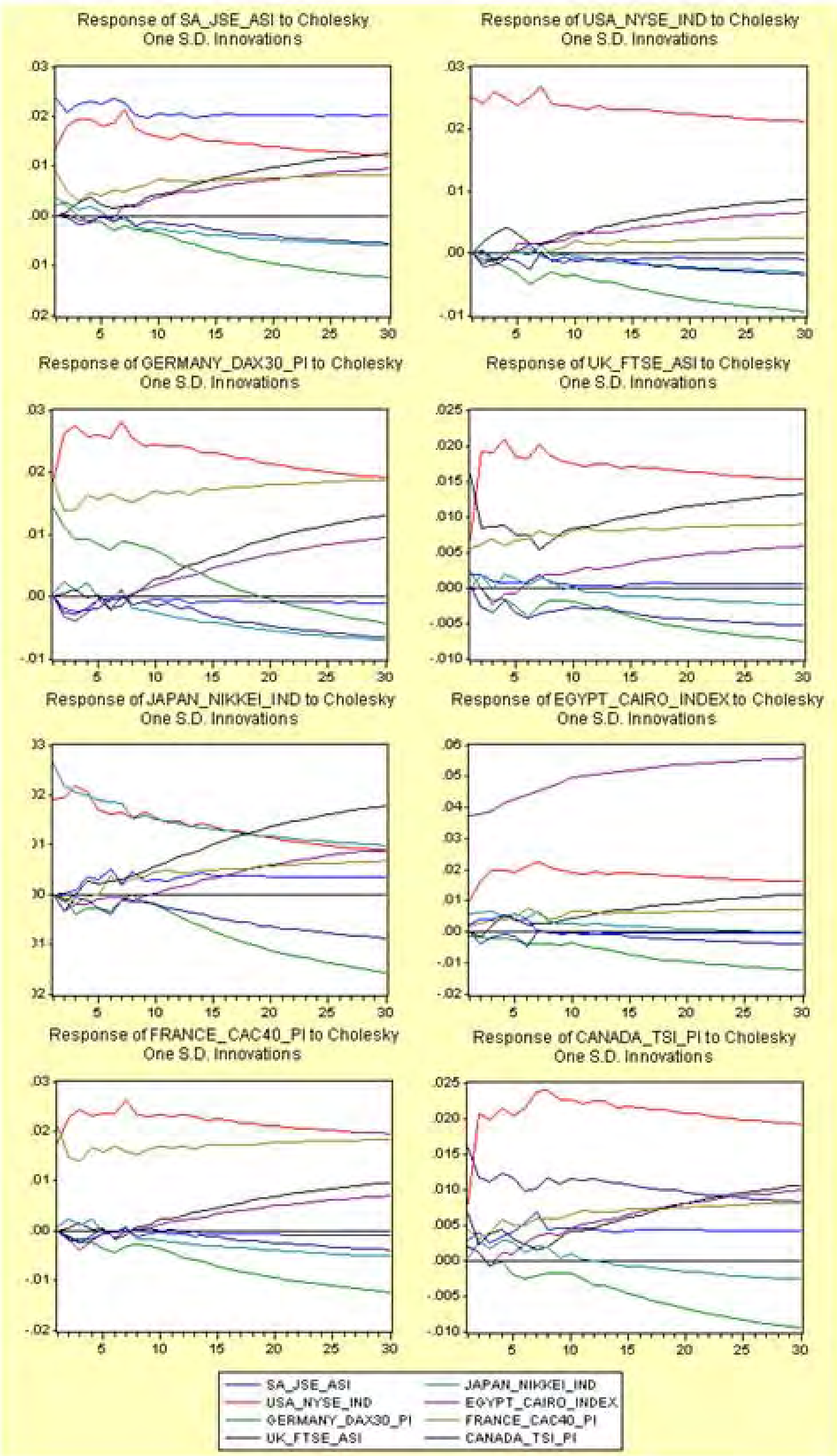
Portfolio G – 2 lags Cholesky (USA – Japan – Egypt – France – Germany – SA – UK – Canada)



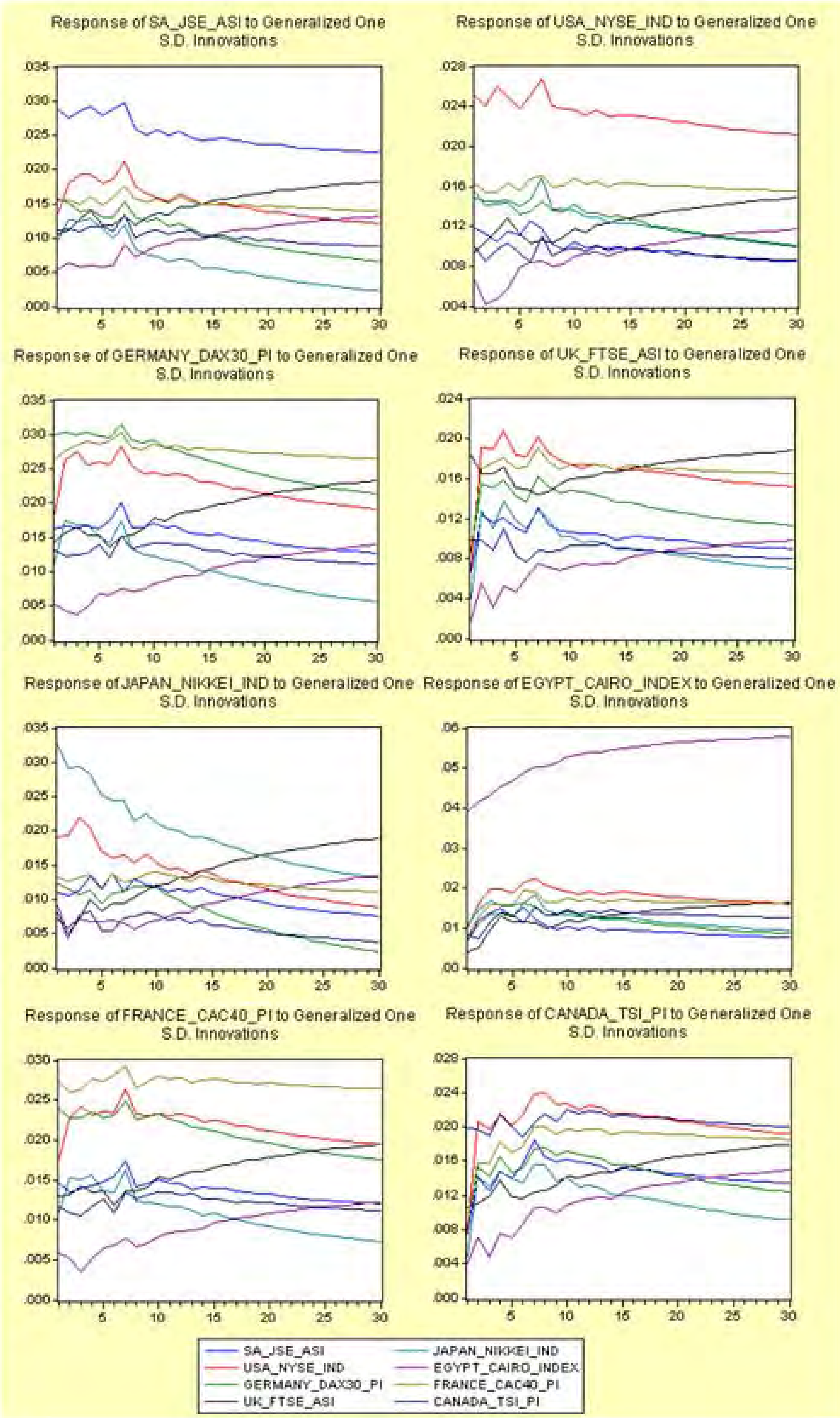
Portfolio G – 2 lags GIRF



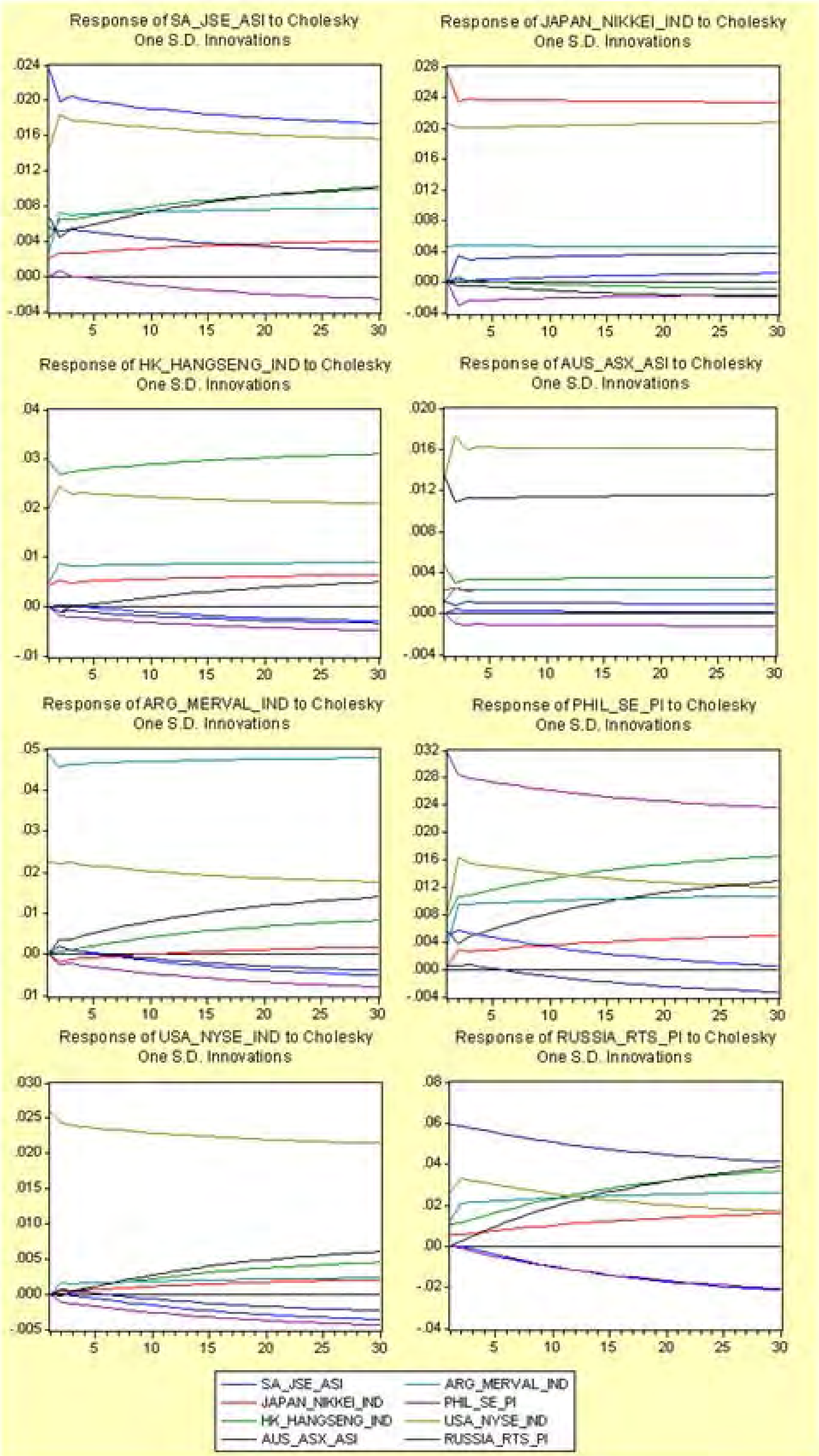
Portfolio G – 8 lags Cholesky (USA – Japan – France – Germany – SA – Egypt – UK – Canada)



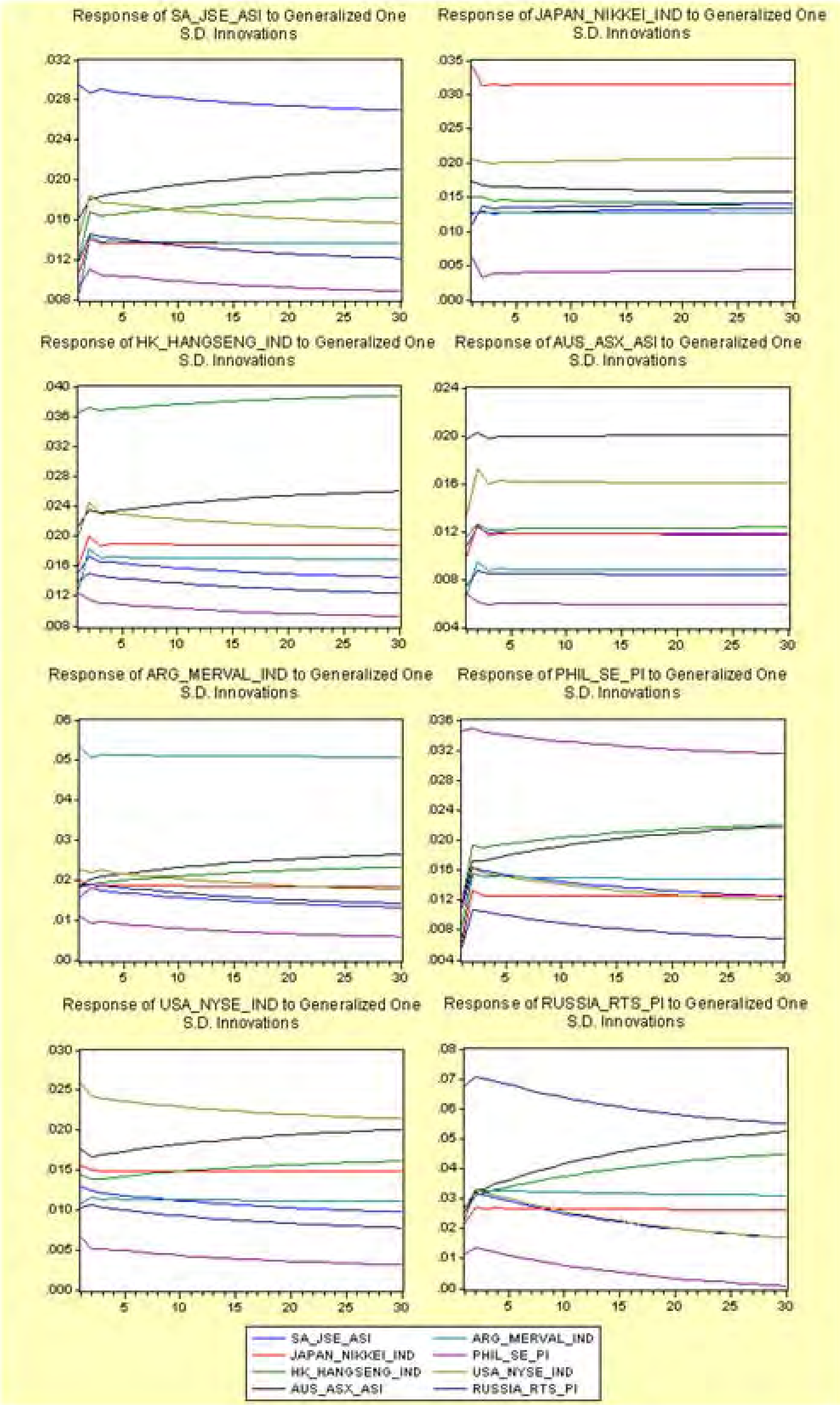
Portfolio G – 8 lags GIRF



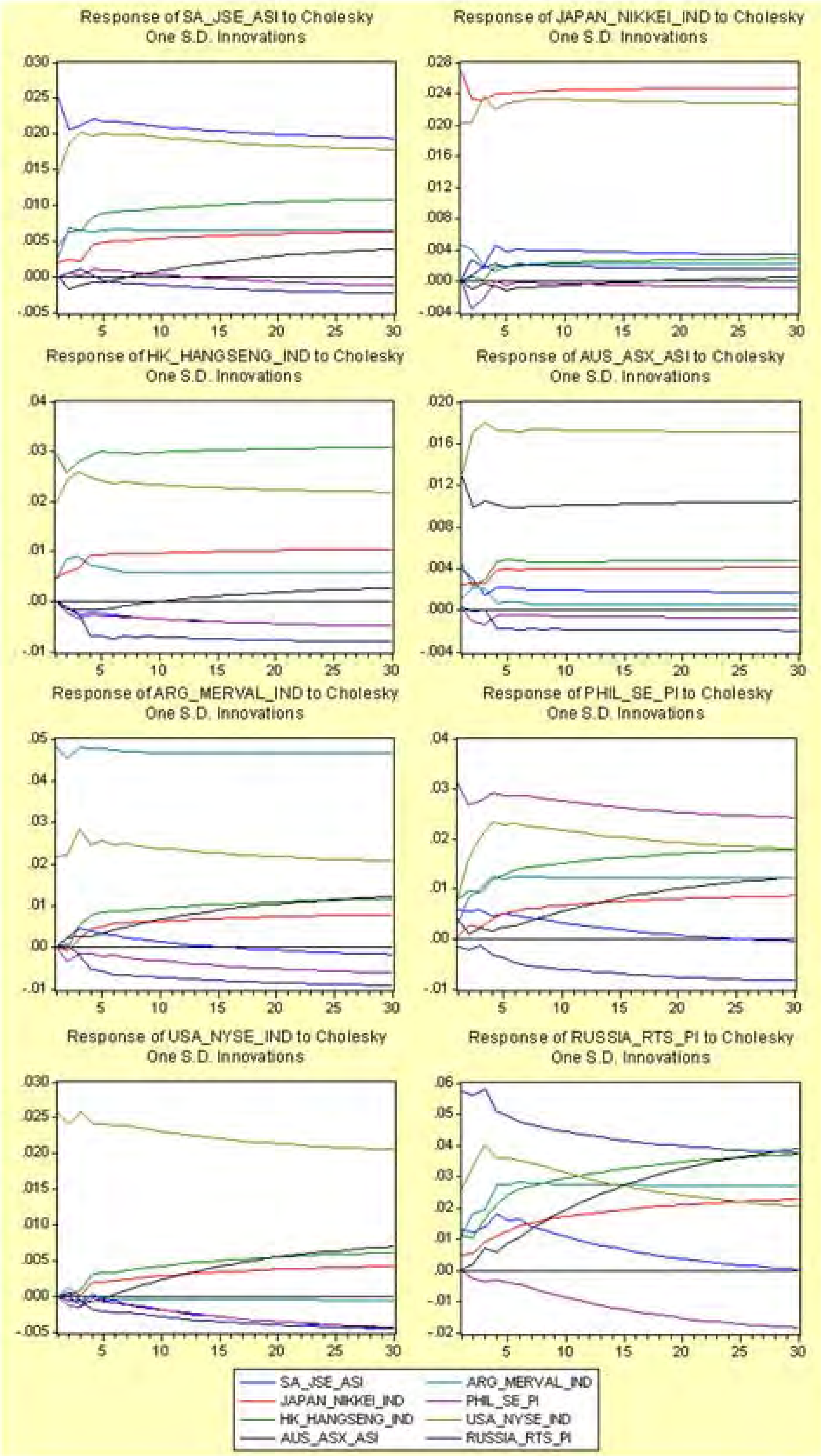
Portfolio H – 2 lags Cholesky (USA – Argentina – Japan – HK – Russia – Australia – SA – Philippines)



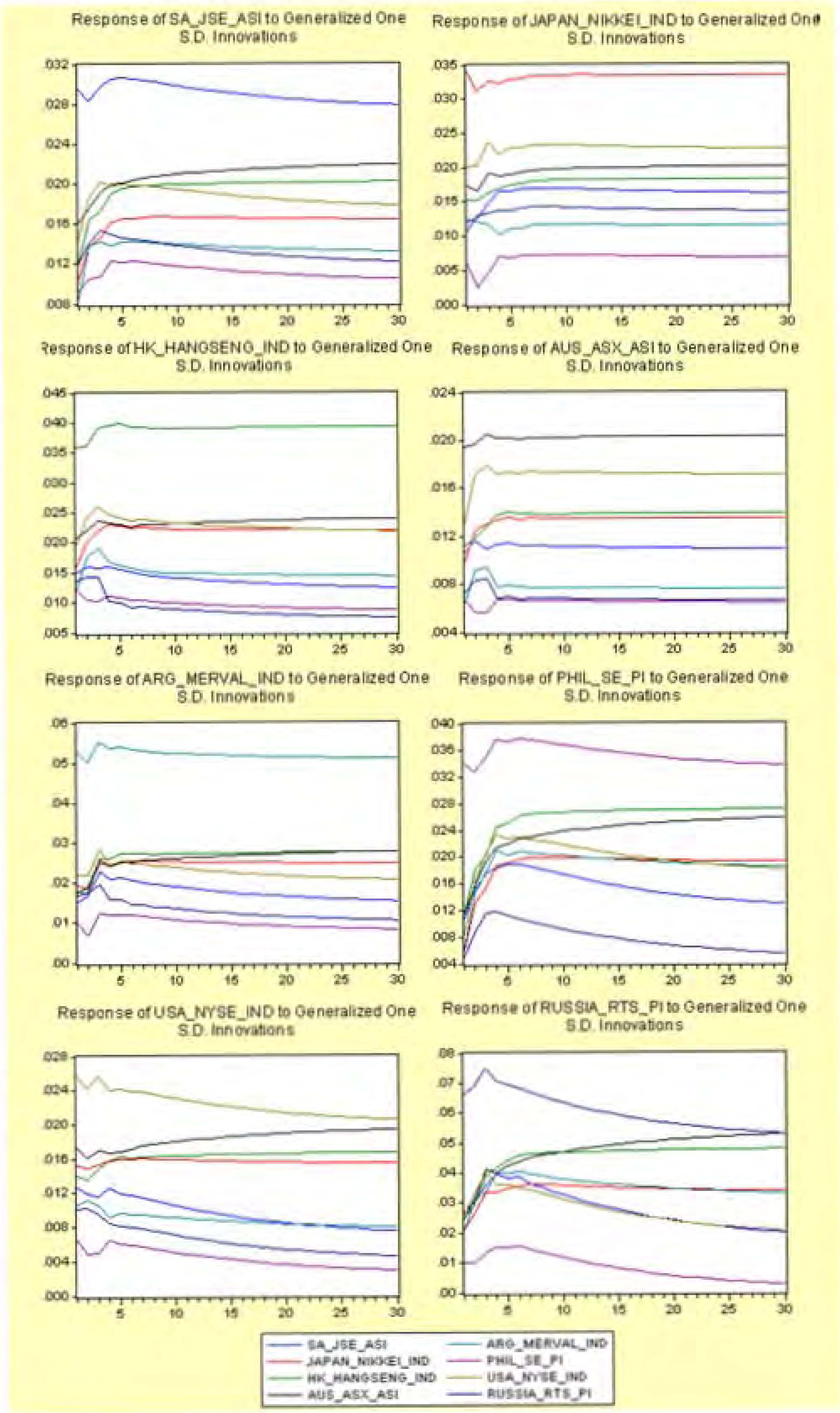
Portfolio H – 2 lags GIRF



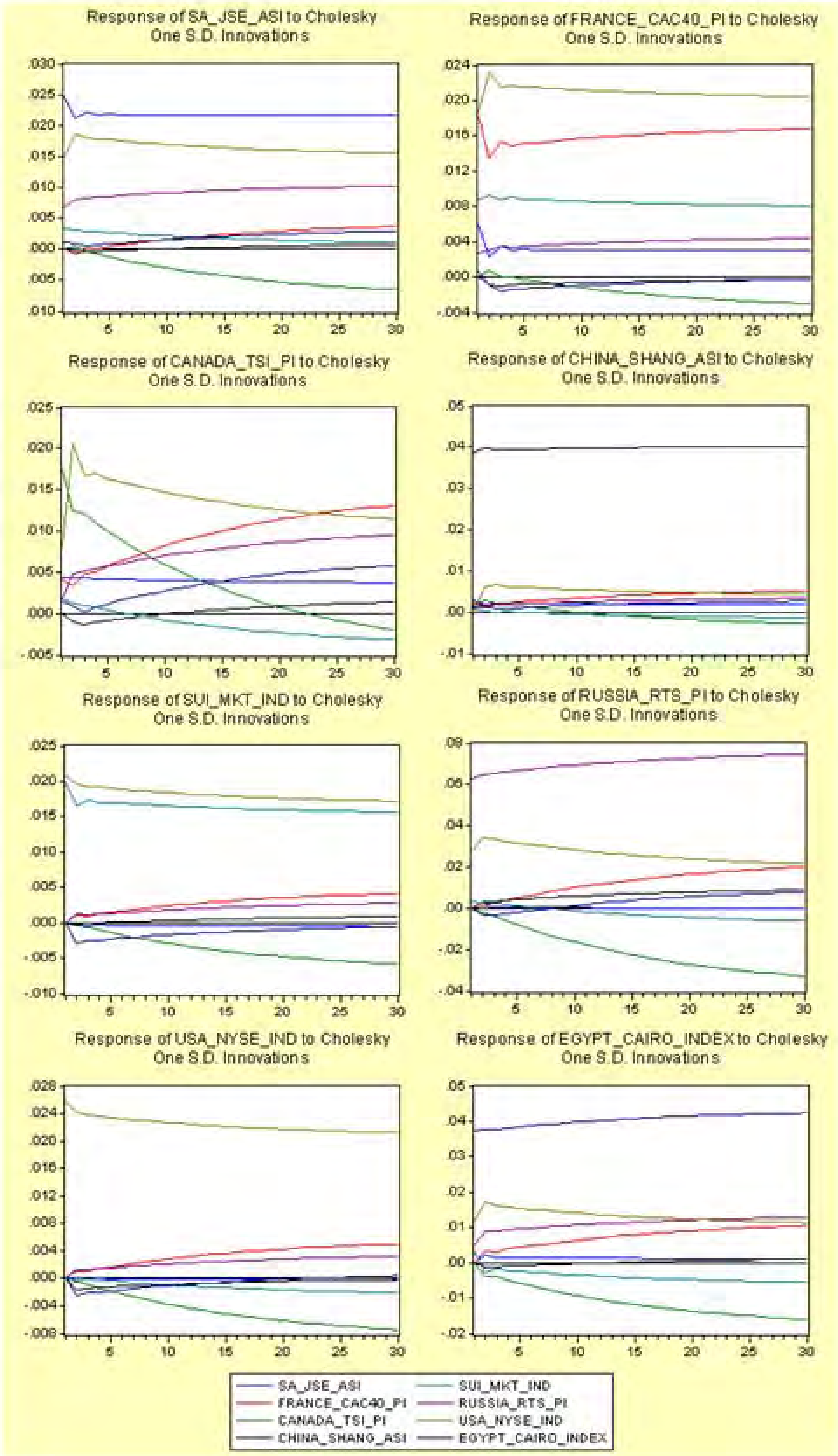
Portfolio H – 4 lags Cholesky (USA – Argentina – Japan – HK– SA – Russia – Australia – Philippines)



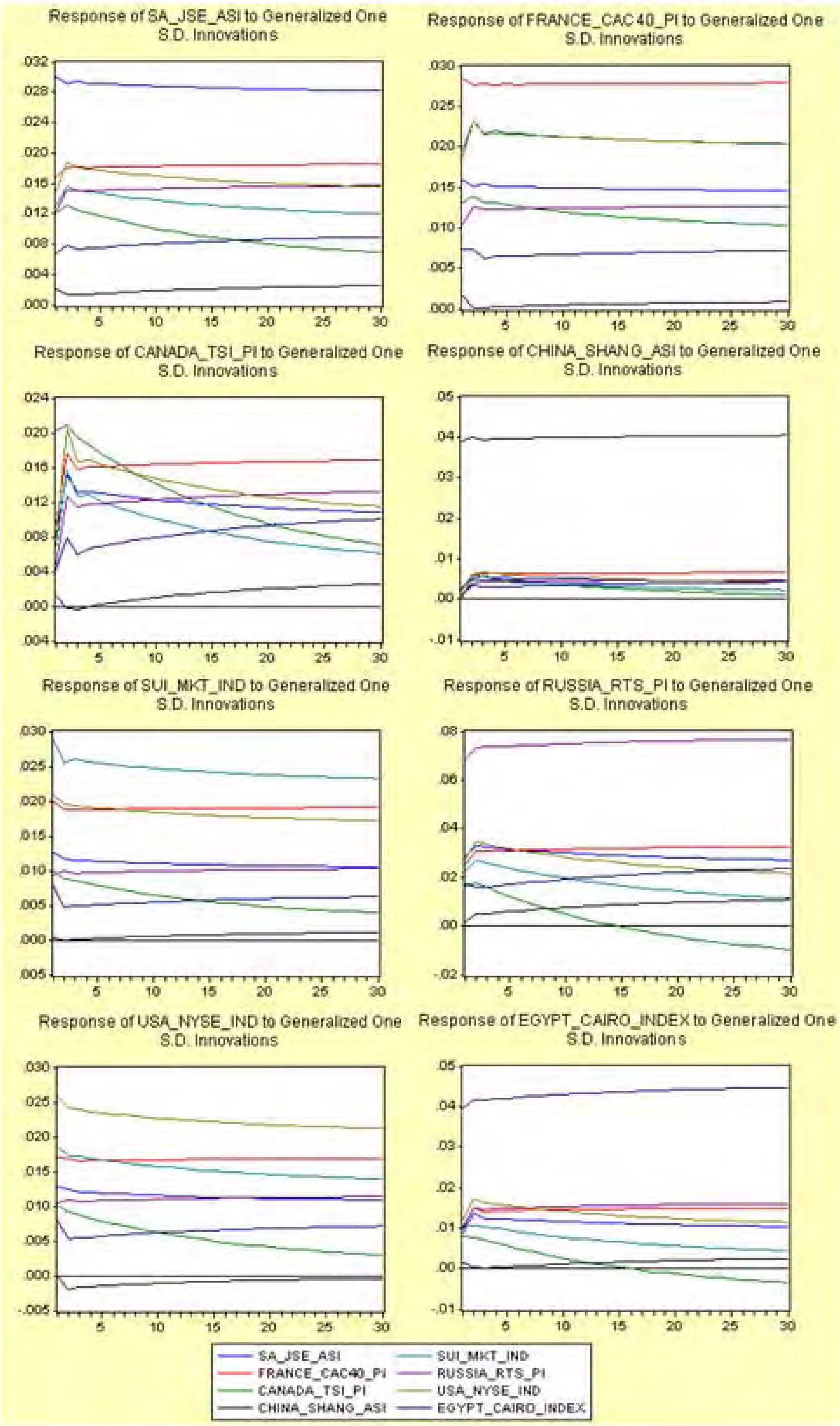
Portfolio H – 4 lags GIRF



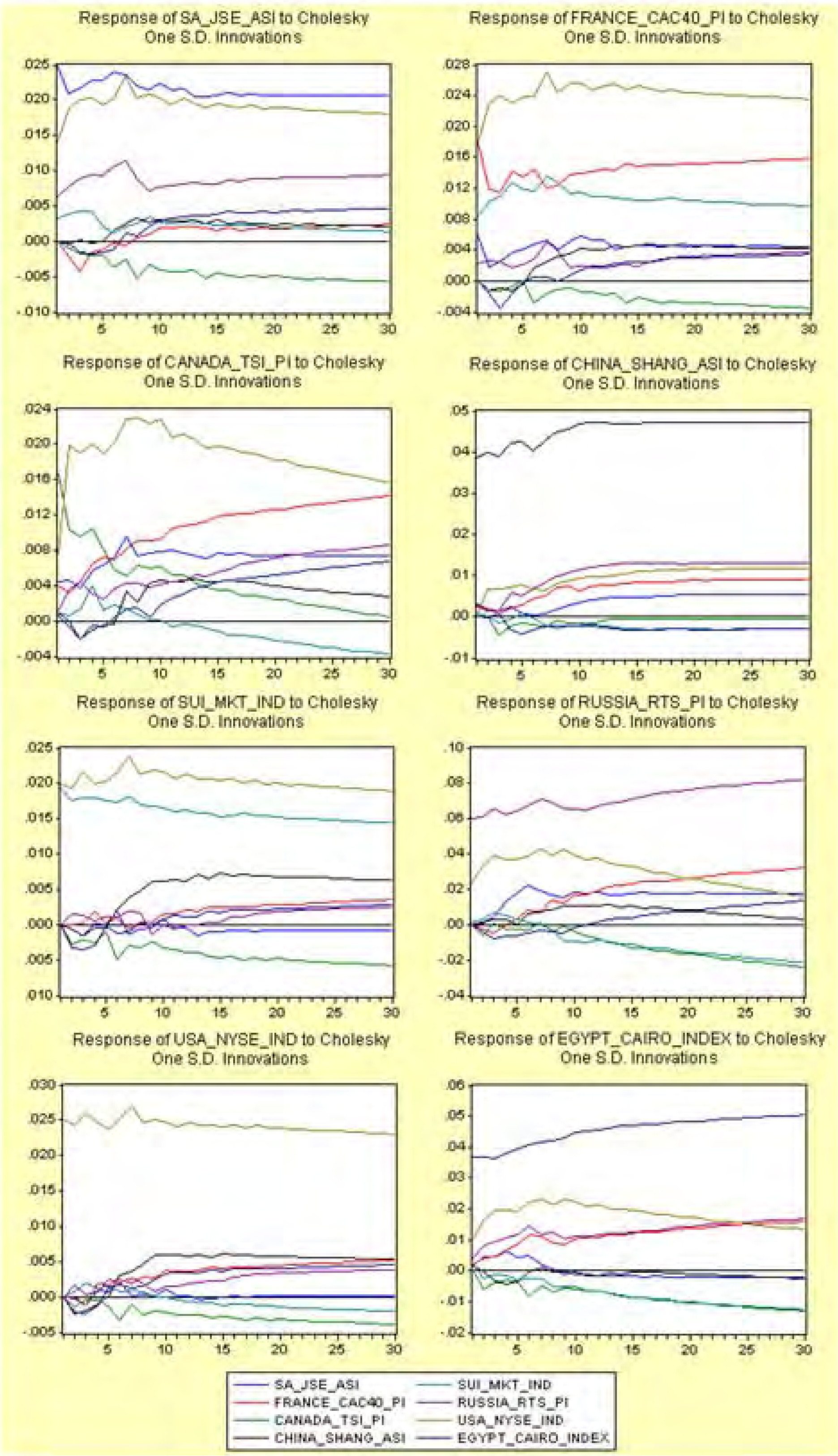
Portfolio I – 2 lags Cholesky (USA – Switzerland – Russia – Egypt – SA – France – Canada – China)



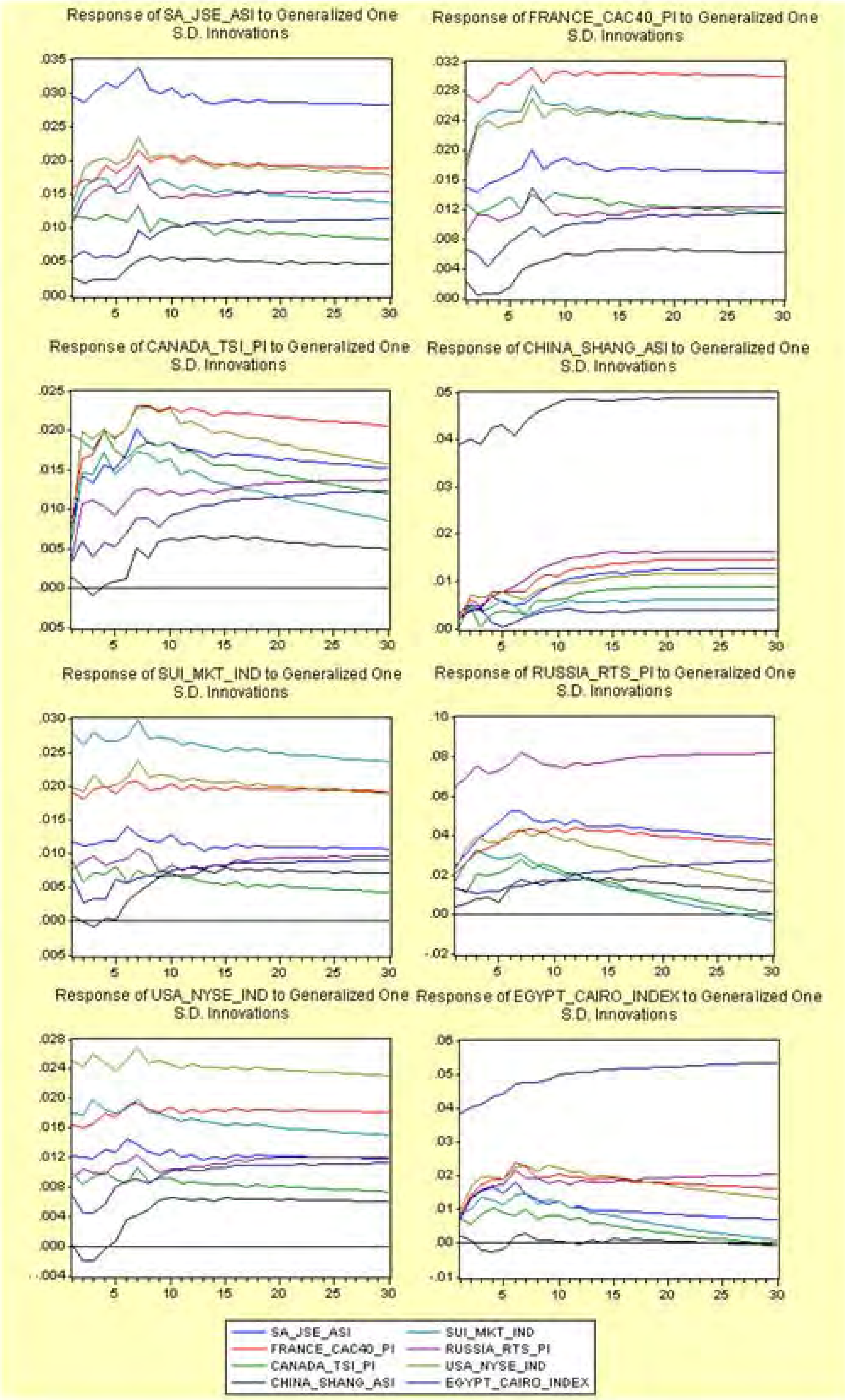
Portfolio I – 2 lags GIRF



Portfolio I – 9 lags Cholesky (USA – Switzerland – Russia – SA – France – China – Egypt – Canada)

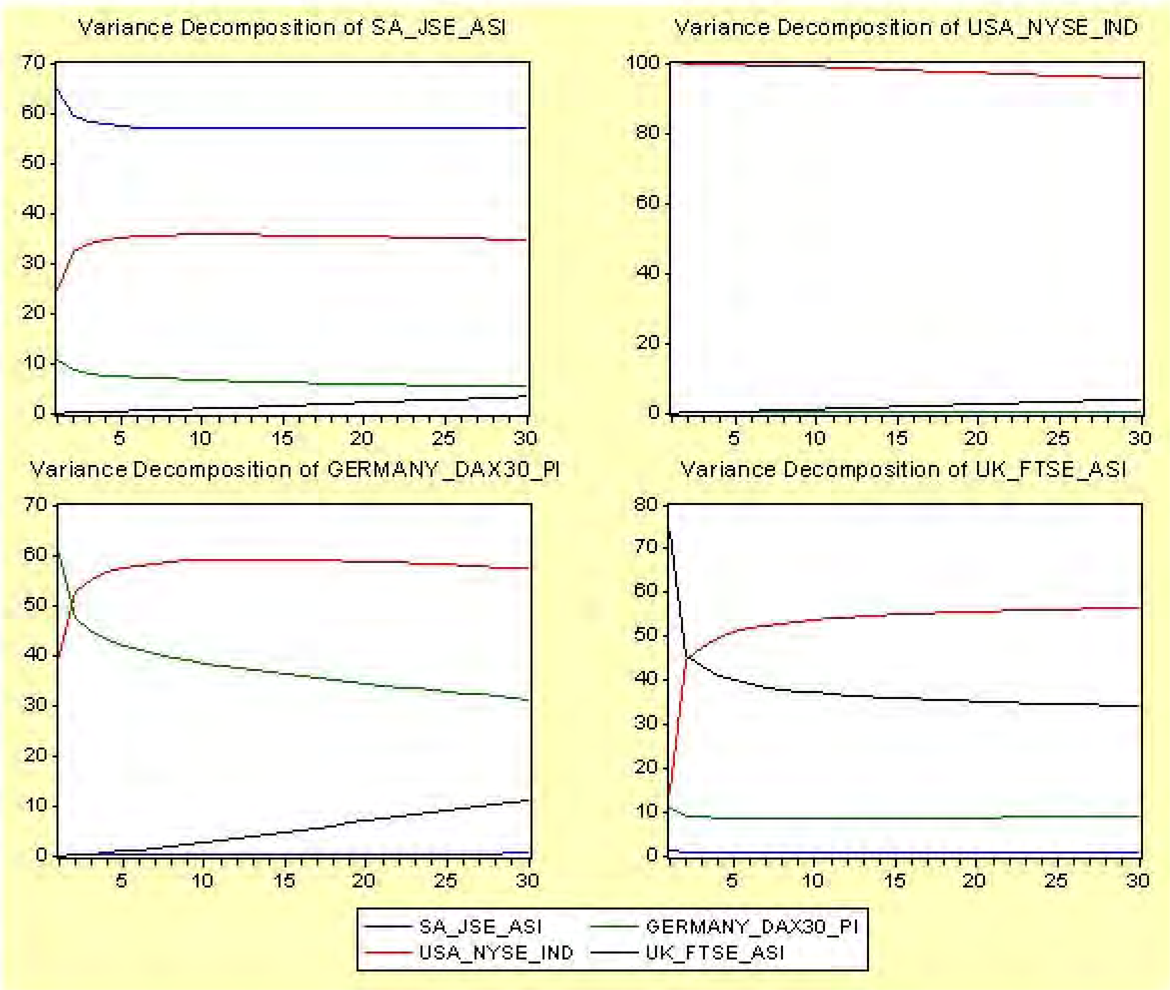


Portfolio I – 9 lags GIRF

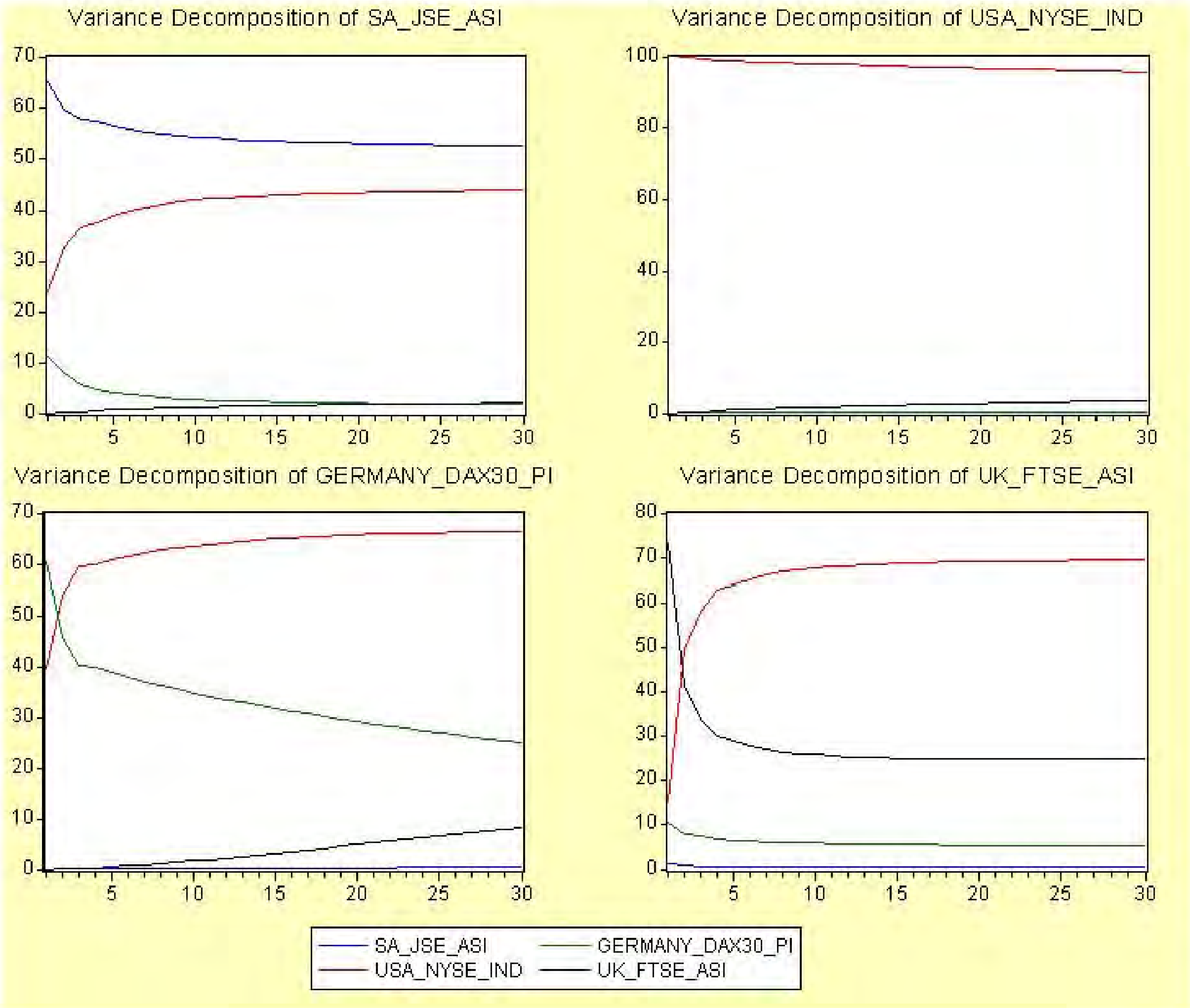


Appendix S – multivariate variance decomposition at both lags at which autocorrelation first disappears and the number selected by the various criteria (2). Both GIRF and Cholesky ordering are used. Cholesky ordering in parenthesis.

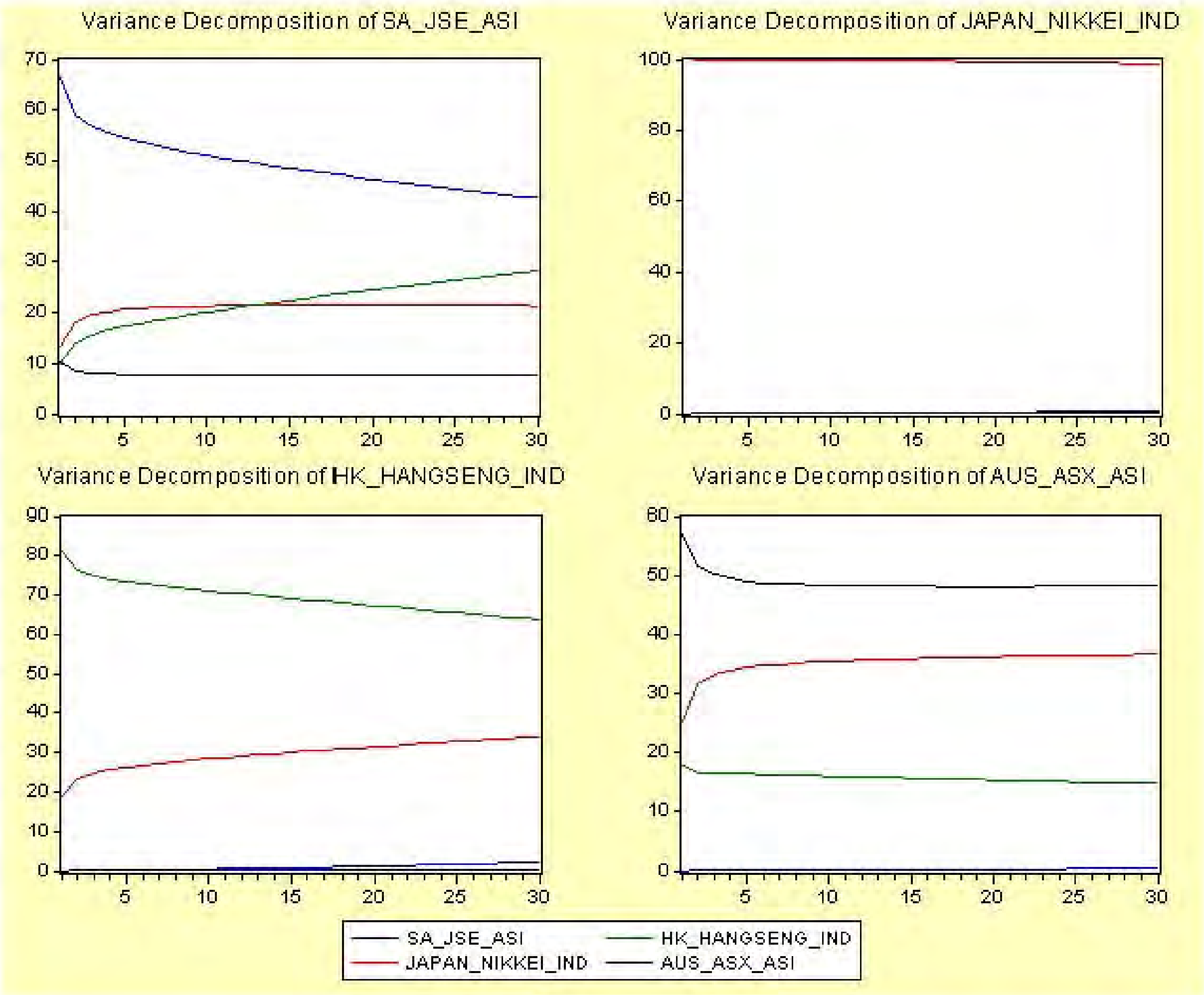
Portfolio A – 2 lags Cholesky (USA – Germany – SA – UK)



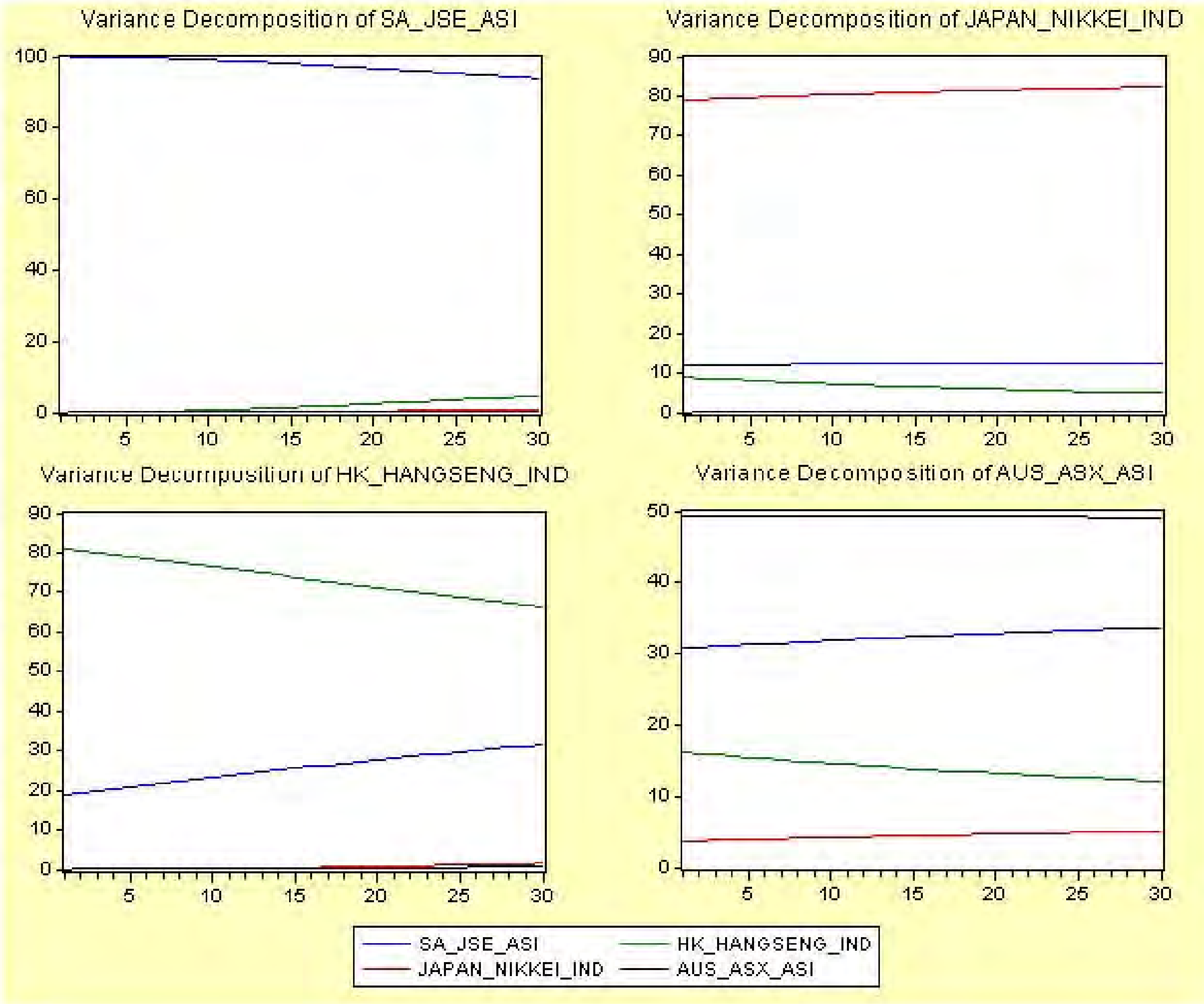
Portfolio A – 4 lags Cholesky (USA – Germany – SA – UK)



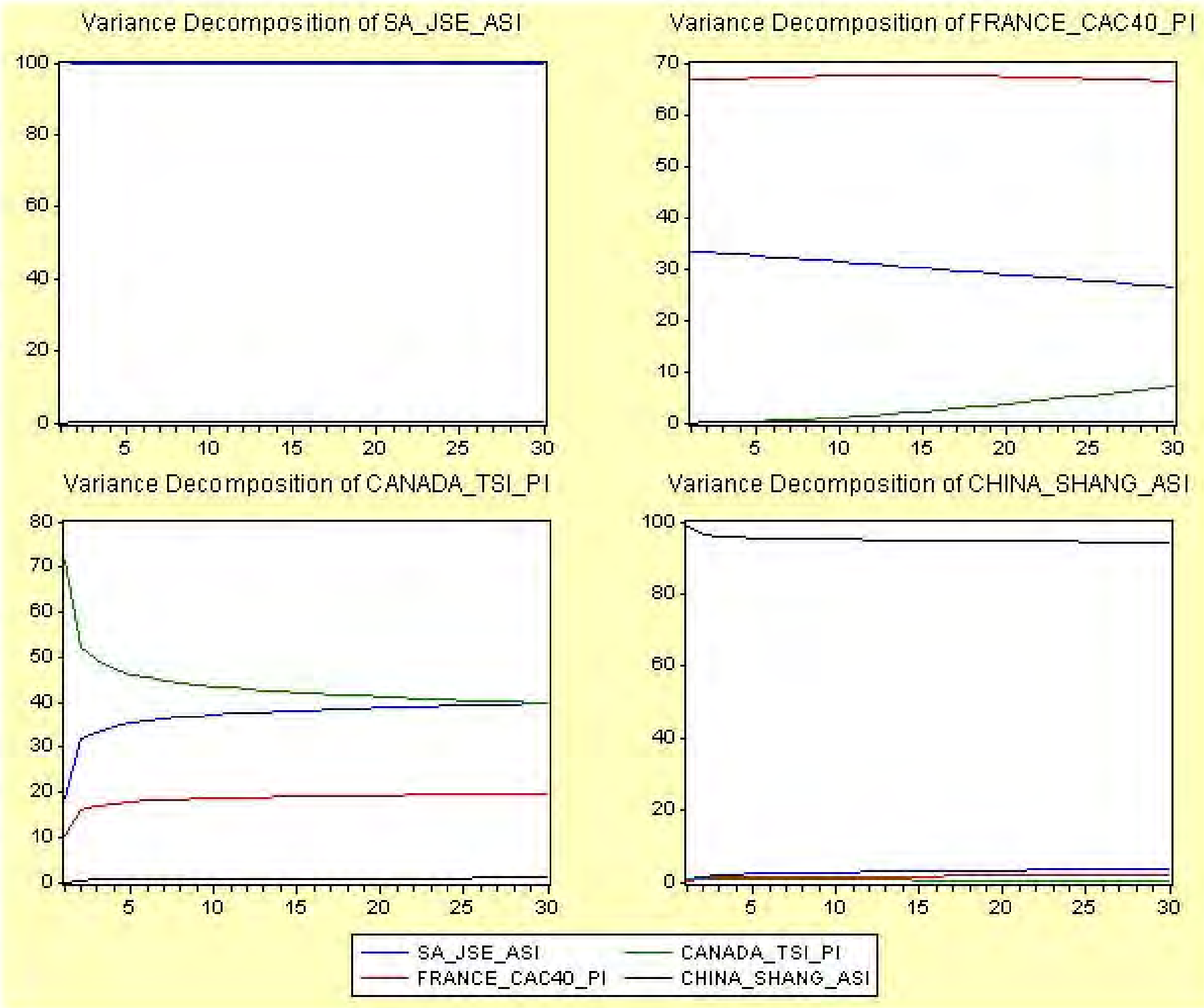
Portfolio B – 2 lags Cholesky (Japan – HK – Australia – SA)



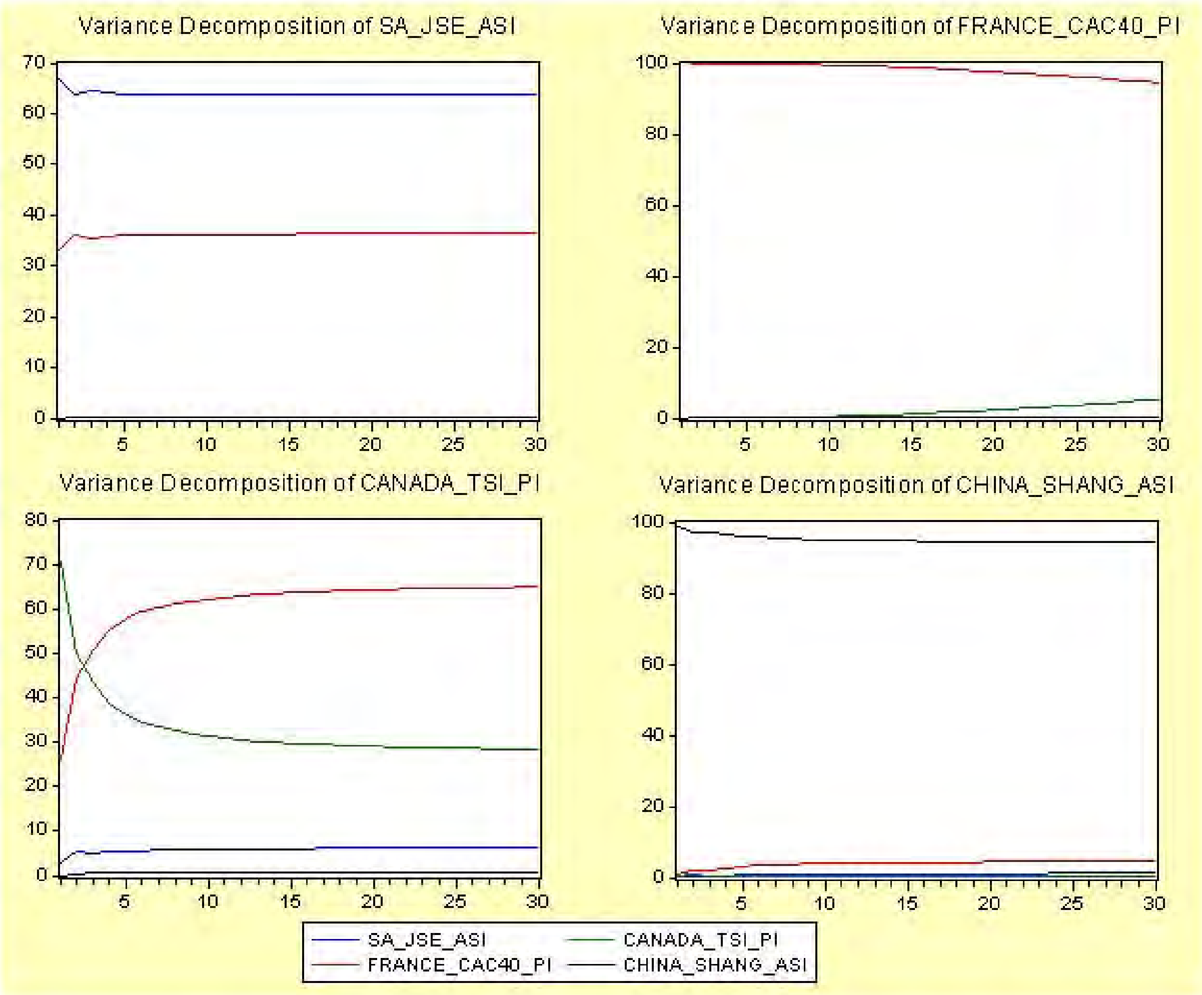
Portfolio B – 1 lag Cholesky (SA – HK – Japan – Australia)



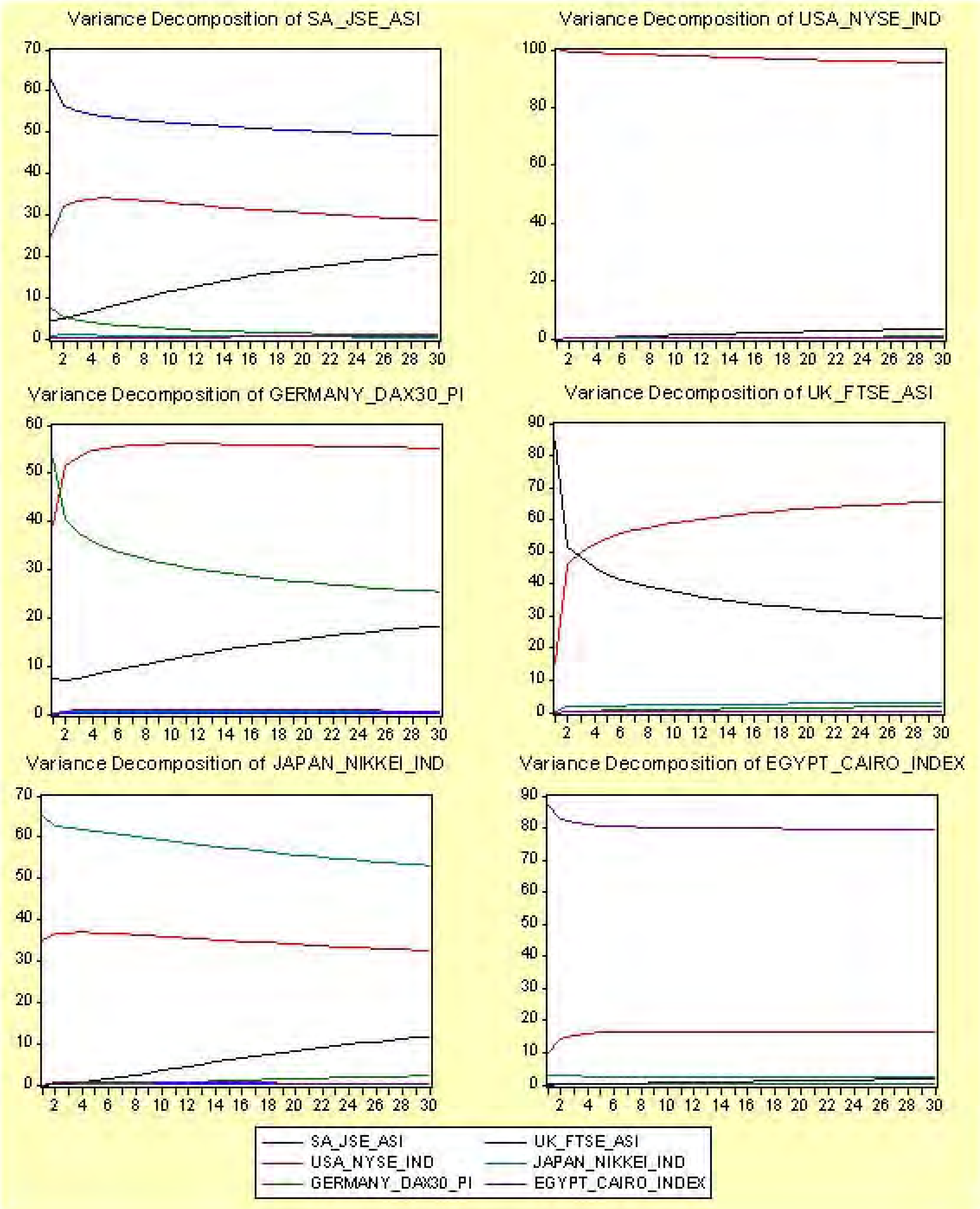
Portfolio C – 2 lags Cholesky (SA – France – Canada – China)



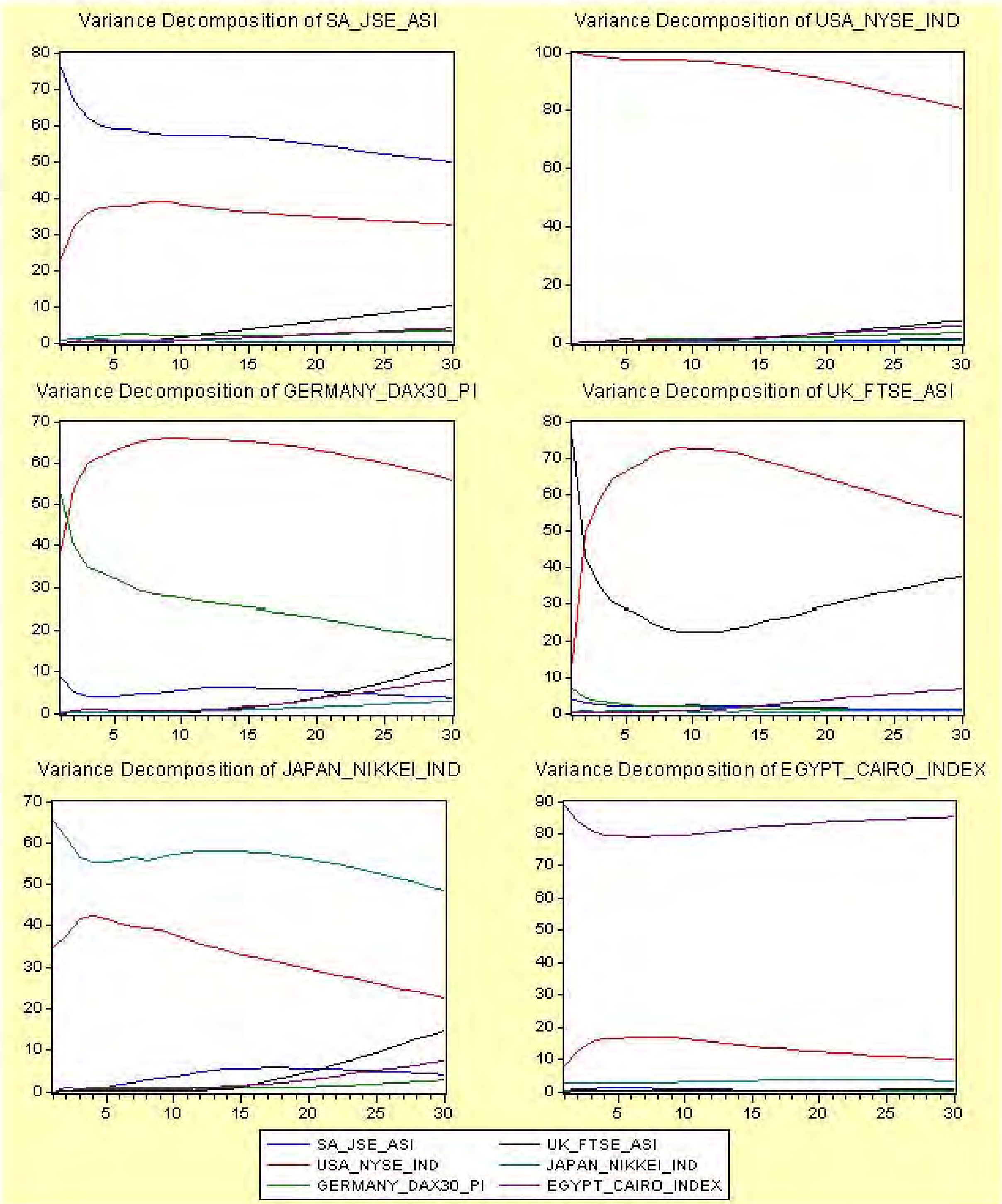
Portfolio C – 4 lags Cholesky (France – SA – Canada – China)



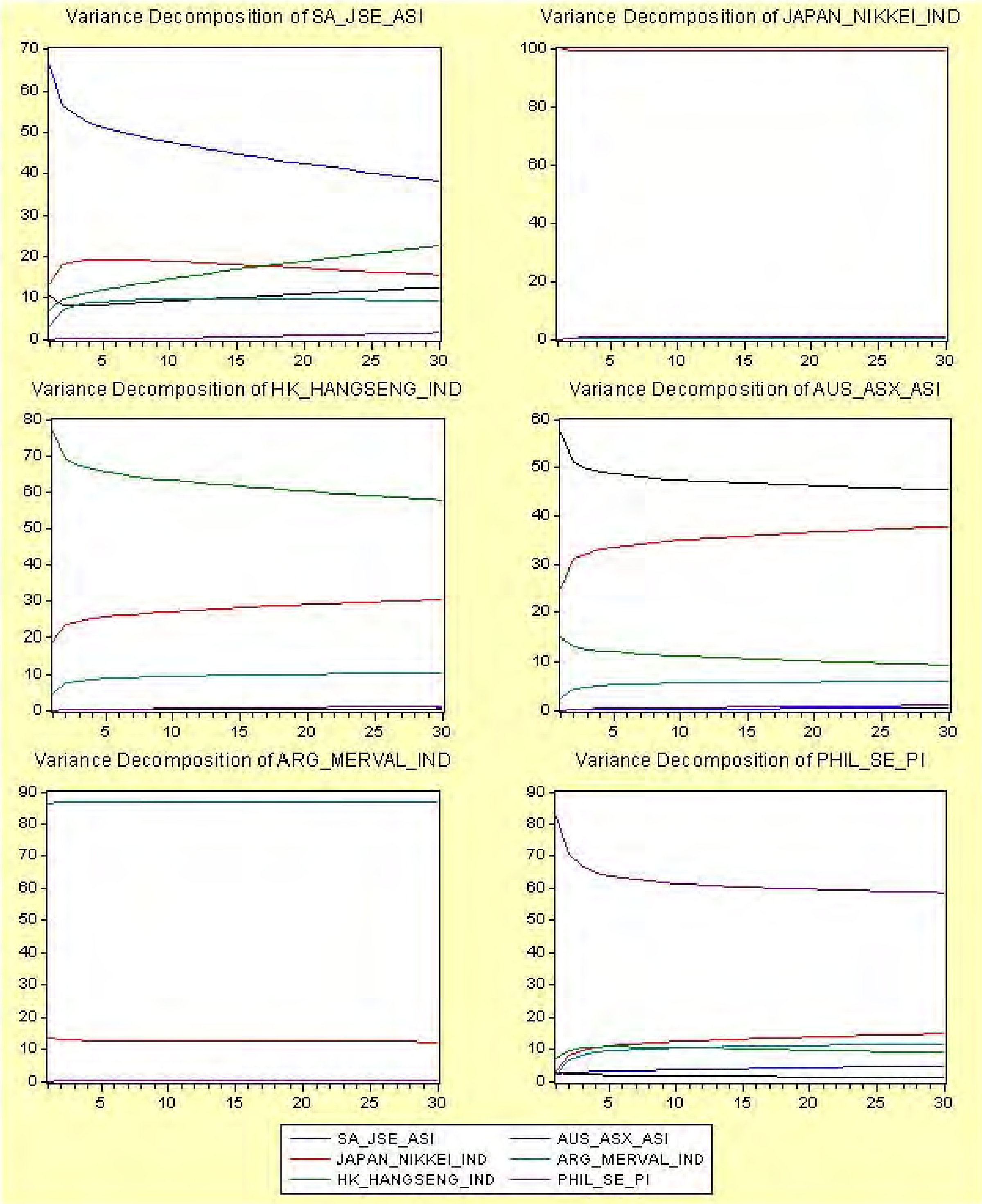
Portfolio D – 2 lags Cholesky (USA – Japan – UK – Germany – Egypt – SA)



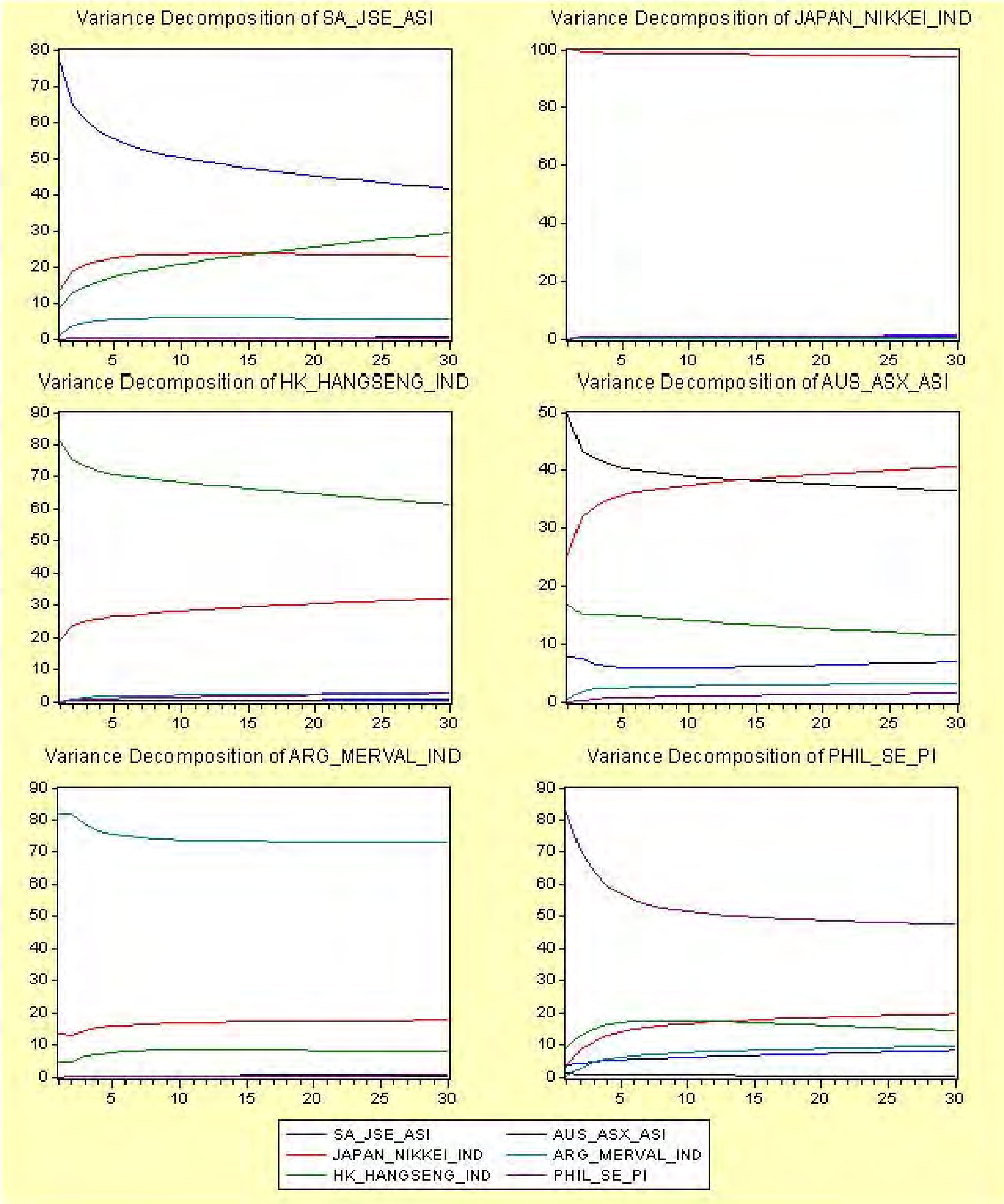
Portfolio D – 11 lags Cholesky (USA – Japan – SA – Germany – Egypt – UK)



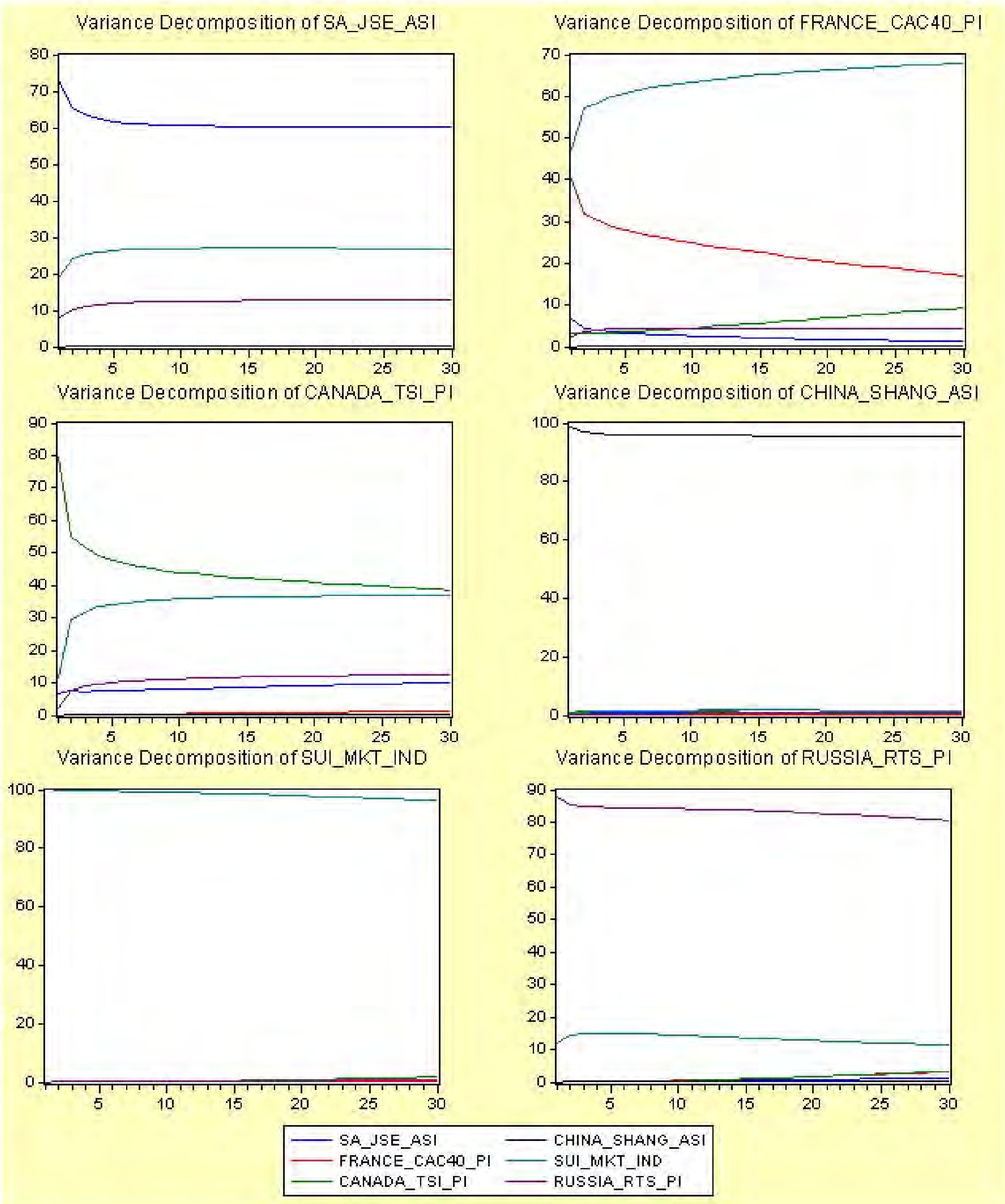
Portfolio E – 2 lags Cholesky (Japan – Argentina – HK – Australia – SA – Philippines)



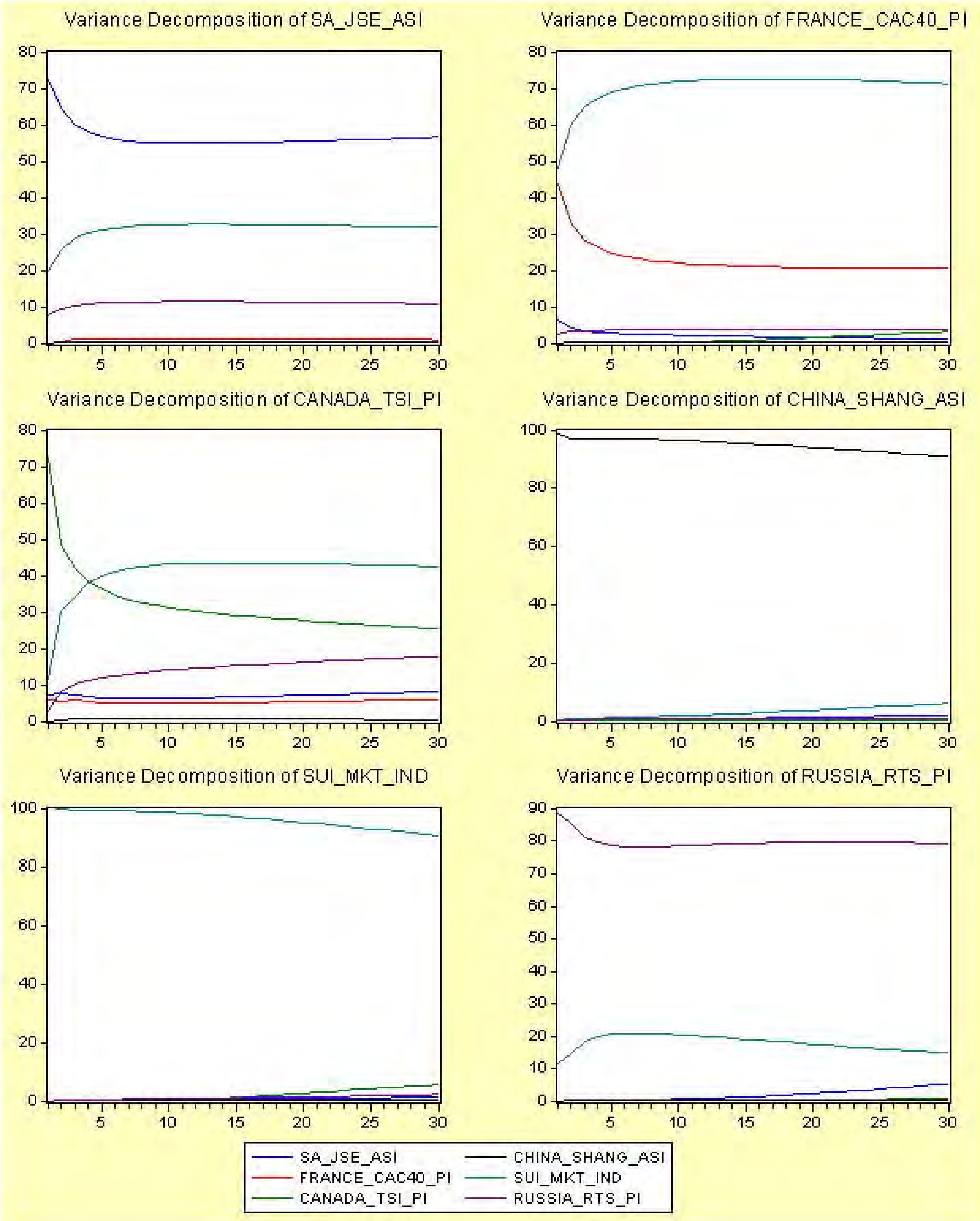
Portfolio E – 3 lags Cholesky (Japan – HK – Argentina – SA – Australia – Philippines)



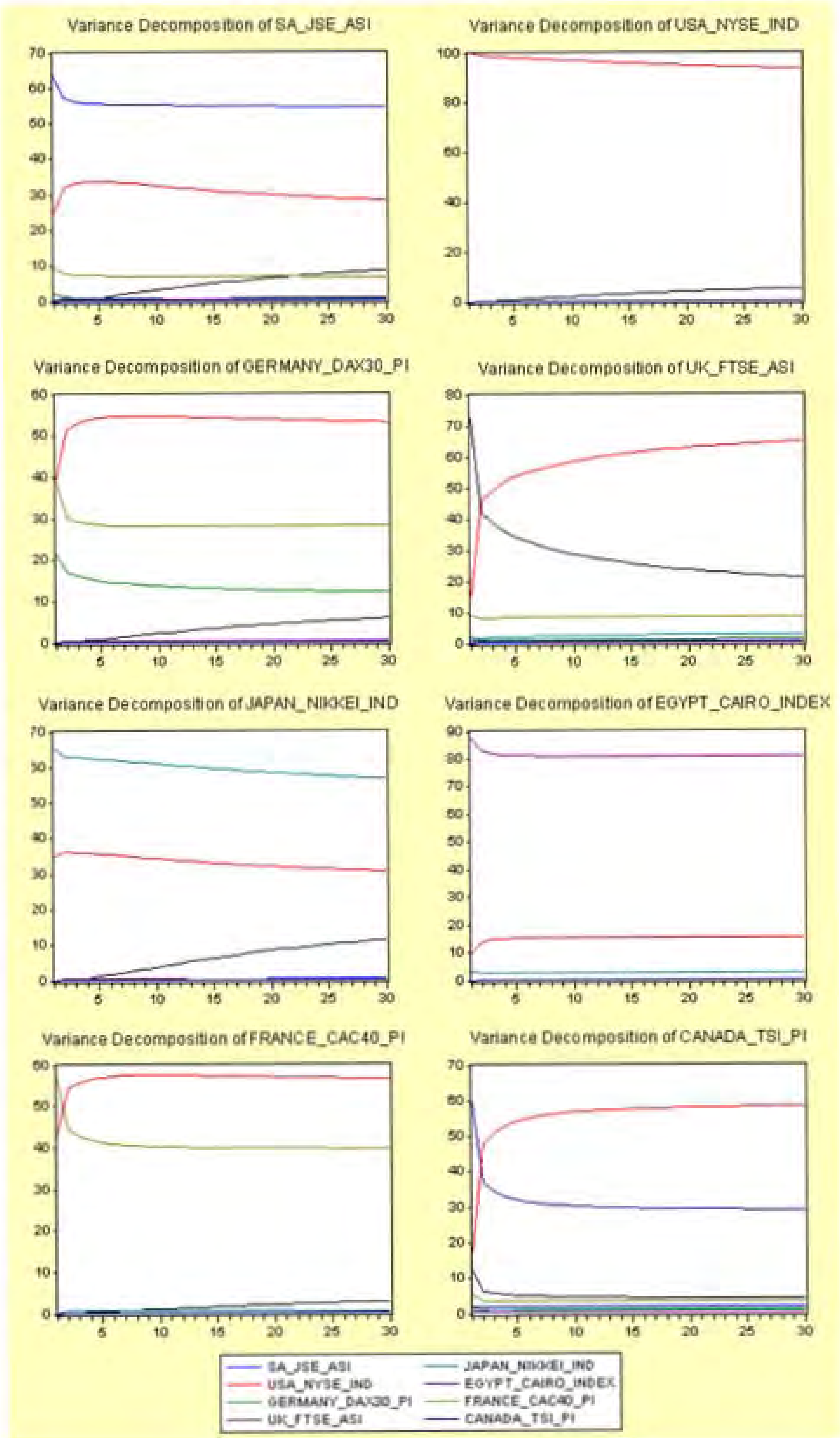
Portfolio F – 2 lags Cholesky (Switzerland – Russia – SA – Canada – France – China)



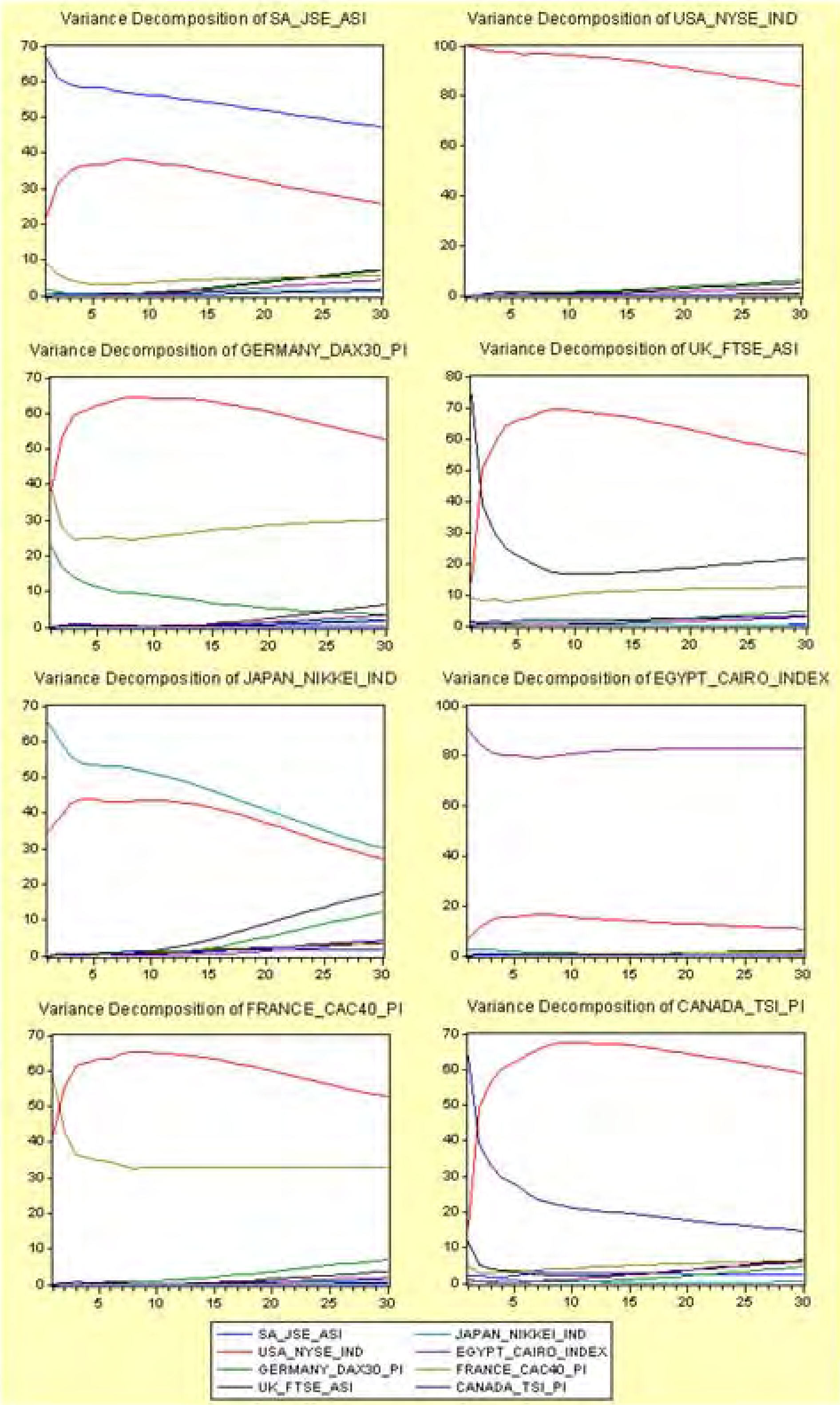
Portfolio F – 4 lags Cholesky (Switzerland – Russia – SA – France – Canada – China)



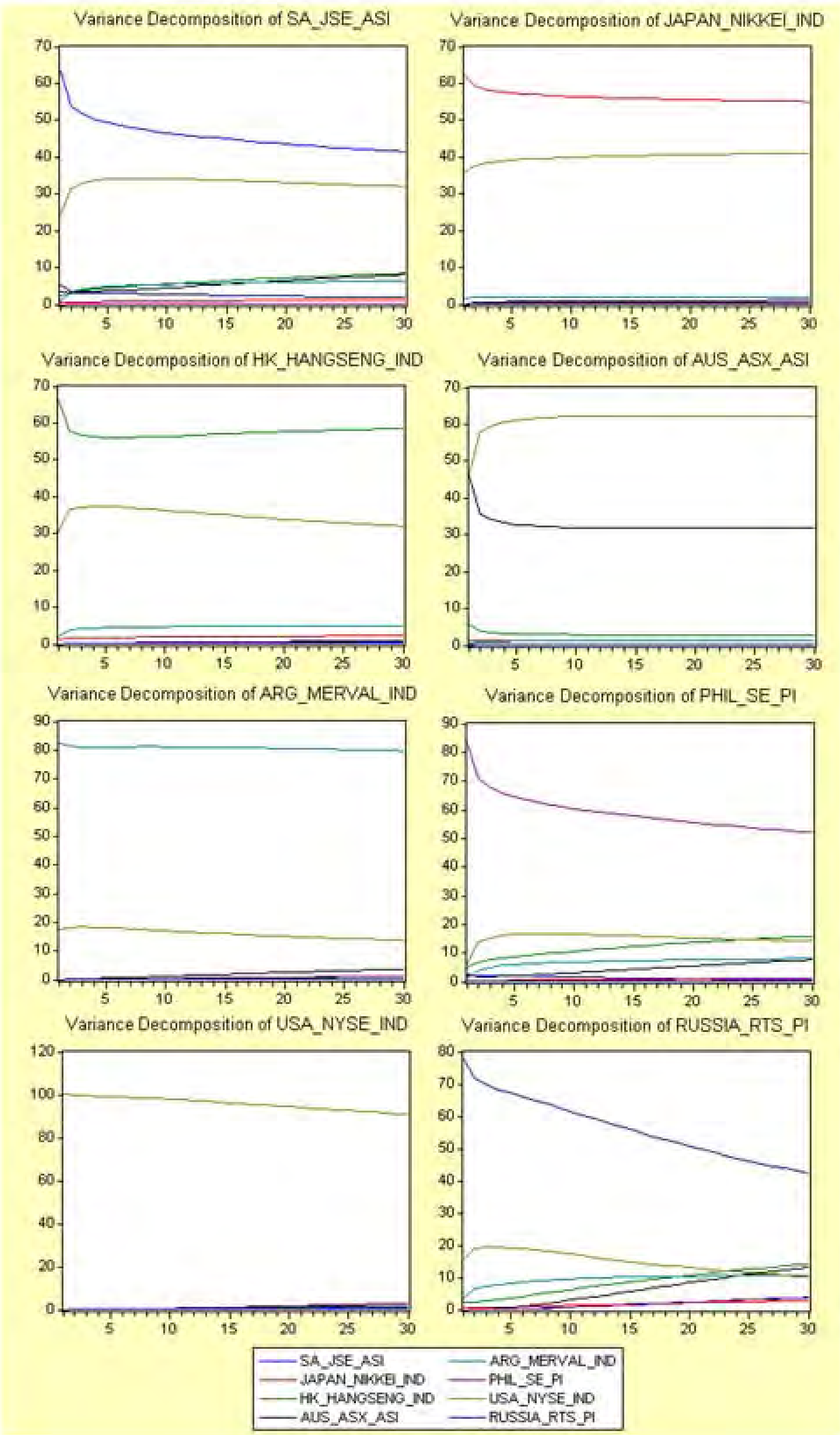
Portfolio G – 2 lags Cholesky (USA – Japan – Egypt – France – Germany – SA – UK – Canada)



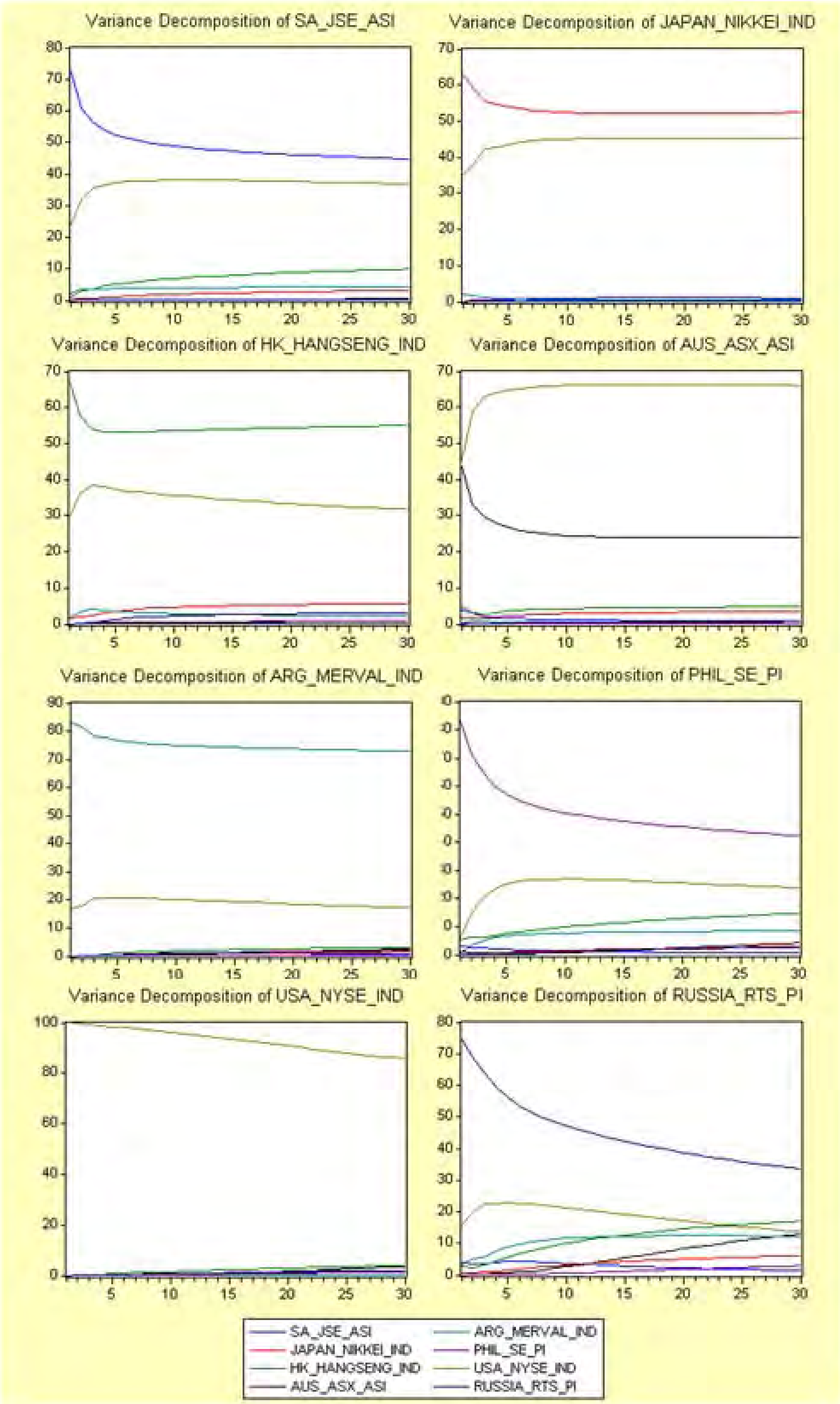
Portfolio G – 8 lags Cholesky (USA – Japan – France – Germany – SA – Egypt – UK – Canada)



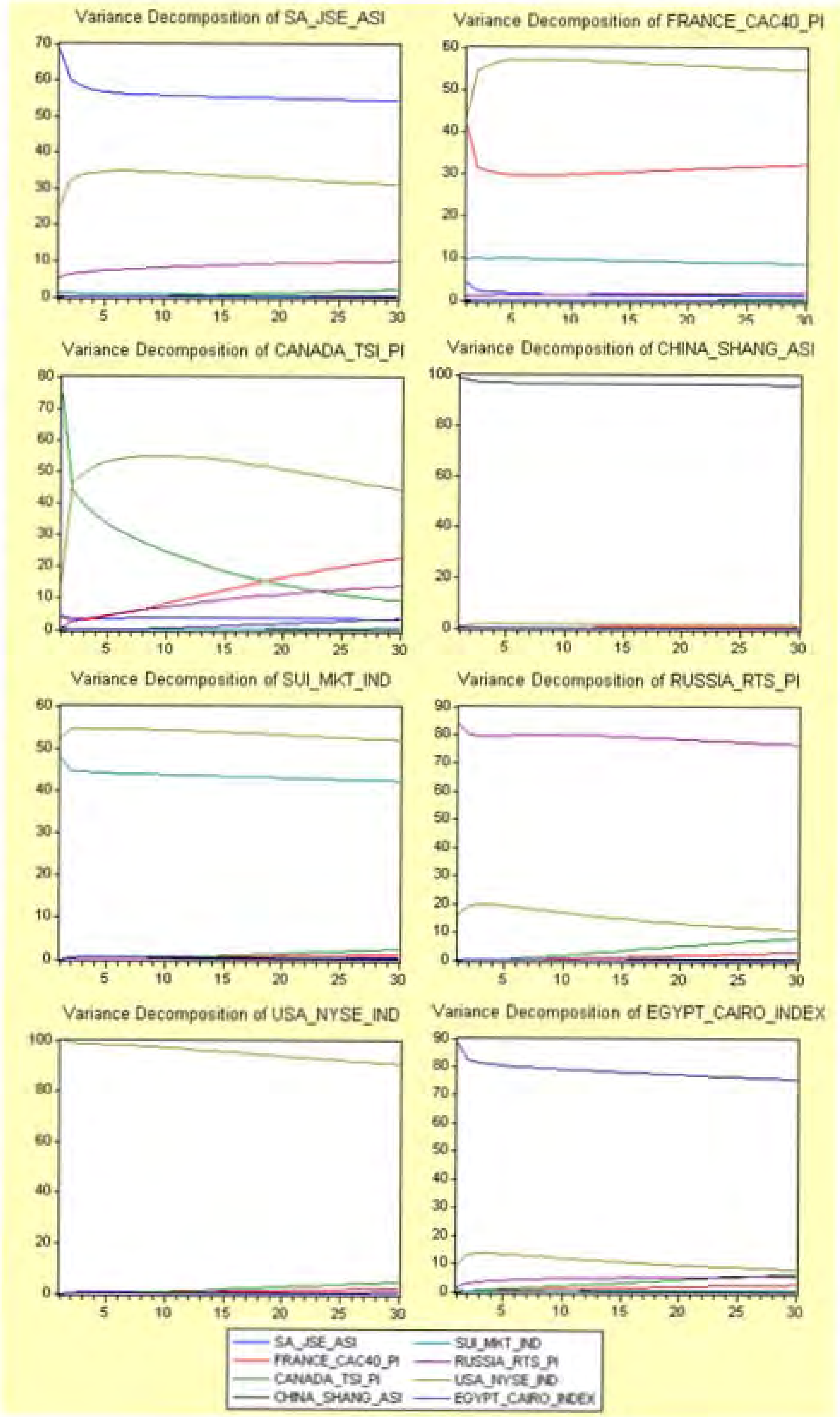
Portfolio H – 2 lags Cholesky (USA – Argentina – Japan – HK – Russia – Australia – SA – Philippines)



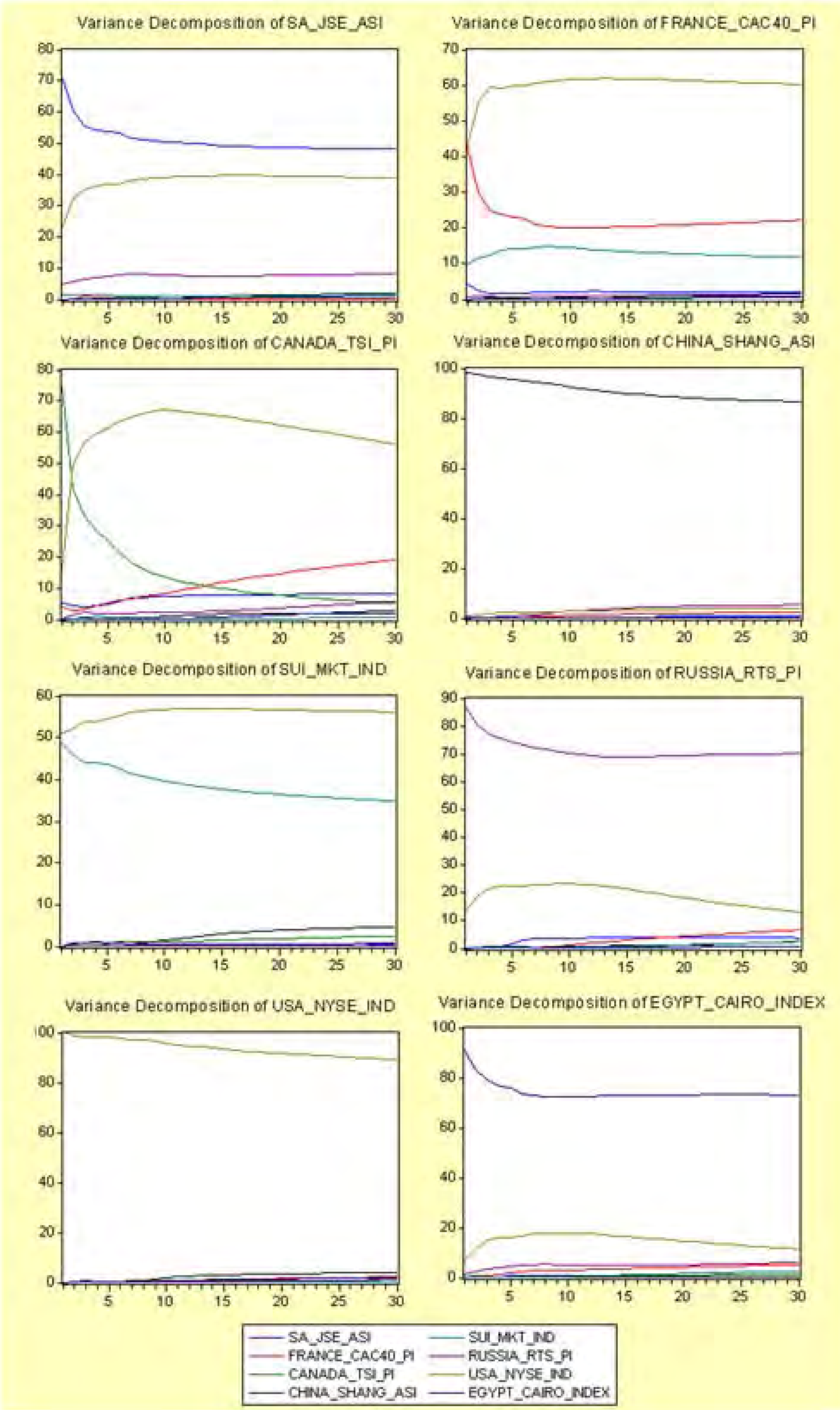
Portfolio H – 4 lags Cholesky (USA – Argentina – Japan – HK– SA – Russia – Australia – Philippines)



Portfolio I – 2 lags Cholesky (USA – Switzerland – Russia – Egypt – SA – France – Canada – China)



Portfolio I – 9 lags Cholesky (USA – Switzerland – Russia – SA – France – China – Egypt – Canada)



Appendix T – Results of Jarque-Bera test on the residuals from the cointegration

	Jarque-Bera	Probability
RESID_ARG_SA	358.3099	0
RESID_AUS_SA	48.67544	0
RESID_BRAZ_SA	117.8762	0
RESID_CAN_SA	65.84887	0
RESID_CHINA_SA	22.99355	0.00001
RESID_COL_SA	40.30996	0
RESID_EGYPT_SA	125.3765	0
RESID_FR_SA	4.022749	0.133805
RESID_GER_SA	19.38113	0.000062
RESID_HK_SA	17.83168	0.000134
RESID_INDIA_SA	33.57831	0
RESID_INDON_SA	52.01609	0
RESID_JAPAN_SA	40.74305	0
RESID_KOREA_SA	94.41587	0
RESID_MEX_SA	61.97282	0
RESID_MOR_SA	25.28411	0.000003
RESID_NED_SA	36.2584	0
RESID_NIG_SA	9.513359	0.008594
RESID_PAK_SA	55.89196	0
RESID_PHIL_SA	11.30403	0.00351
RESID_PI_ARG_SA	234.514	0
RESID_PI_AUS_SA	83.07478	0
RESID_PI_BAN_SA	317.2789	0
RESID_PI_BRA_SA	80.56249	0
RESID_PI_CAN_SA	27.30002	0.000001
RESID_PI_CHI_SHANG_SA	25.49813	0.000003
RESID_PI_CHI_SHEN_SA	11.39624	0.003352
RESID_PI_EGYPT_SA	103.4271	0
RESID_PI_FR_SA	4.81985	0.089822
RESID_PI_GER_SA	9.92772	0.006986
RESID_PI_HK_SA	12.81649	0.001648
RESID_PI_INDIA_SA	90.63724	0
RESID_PI_JAP_NIK_SA	39.54883	0
RESID_PI_JAP_TOP_SA	38.78126	0
RESID_PI_KOR_SA	32.39753	0
RESID_PI_MEX_SA	19.31975	0.000064
RESID_PI_NED_SA	32.98578	0
RESID_PI_PHIL_SA	13.47474	0.001186
RESID_PI_POL_SA	55.98187	0
RESID_PI_RUS_SA	7.843398	0.019807
RESID_PI_SA_ARG	19.50862	0.000058

RESID_PI_SA_AUS	166.8765	0
RESID_PI_SA_BAN	206.091	0
RESID_PI_SA_BRA	23.23192	0.000009
RESID_PI_SA_CAN	41.81258	0
RESID_PI_SA_CHI_SHANG	37.21077	0
RESID_PI_SA_CHI_SHEN	27.64173	0.000001
RESID_PI_SA_EGYPT	4.70081	0.095331
RESID_PI_SA_FR	43.65066	0
RESID_PI_SA_GER	54.88425	0
RESID_PI_SA_HK	49.50965	0
RESID_PI_SA_IND	22.28204	0.000015
RESID_PI_SA_JAP_NIK	78.60144	0
RESID_PI_SA_JAP_TOP	68.58641	0
RESID_PI_SA_KOR	71.92927	0
RESID_PI_SA_MEX	7.880121	0.019447
RESID_PI_SA_NED	69.2854	0
RESID_PI_SA_PHIL	61.76902	0
RESID_PI_SA_POL	48.33025	0
RESID_PI_SA_RUS	65.37633	0
RESID_PI_SA_SP_IBEX	50.43657	0
RESID_PI_SA_SP_MAD	32.62798	0
RESID_PI_SA_SUI	30.94963	0
RESID_PI_SA_THAI	25.55121	0.000003
RESID_PI_SA_TUR	43.06789	0
RESID_PI_SA_UK	41.39012	0
RESID_PI_SA_USA	9.287348	0.009622
RESID_PI_SPA_IBEX_SA	15.34993	0.000464
RESID_PI_SPA_MAD_SA	63.63496	0
RESID_PI_SUI_SA	33.39051	0
RESID_PI_THAI_SA	125.3289	0
RESID_PI_TUR_SA	197.0303	0
RESID_PI_UK_SA	35.89768	0
RESID_PI_USA_SA	87.22256	0
RESID_POL_SA	33.34176	0
RESID_RUS_SA	6.123671	0.046802
RESID_SA_ARG	101.359	0
RESID_SA_AUS	58.00361	0
RESID_SA_BRAZ	41.68914	0
RESID_SA_CAN	56.95638	0
RESID_SA_CHINA	60.3441	0
RESID_SA_COL	12.01222	0.002464
RESID_SA_EGYPT	9.295422	0.009584
RESID_SA_FR	36.10196	0
RESID_SA_GER	47.8952	0
RESID_SA_HK	45.15329	0
RESID_SA_INDIA	15.09252	0.000528

RESID_SA_INDON	12.2826	0.002152
RESID_SA_JAPAN	69.44086	0
RESID_SA_KOREA	10.095	0.006425
RESID_SA_MEX	10.67381	0.004811
RESID_SA_MOR	110.59	0
RESID_SA_NED	68.94739	0
RESID_SA_NIG	6.142519	0.046363
RESID_SA_PAK	23.61152	0.000007
RESID_SA_PHIL	53.62722	0
RESID_SA_POL	17.00615	0.000203
RESID_SA_RUS	2.351616	0.30857
RESID_SA_SPA	40.3753	0
RESID_SA_SUI	20.61072	0.000033
RESID_SA_TUR	58.84697	0
RESID_SA_UK	48.39571	0
RESID_SA_USA	37.85298	0
RESID_SPA_SA	104.6976	0
RESID_SUI_SA	39.34248	0
RESID_TUR_SA	230.7757	0
RESID_UK_SA	44.54977	0
RESID_USA_SA	31.05313	0