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Publication Details

This working paper was originally published as Wickremasinghe, GB, Macroeconomic forces and stock prices: Some empirical evidence from an emerging stock market , Accounting & Finance Working Paper 06/14, School of Accounting & Finance, University of Wollongong, 2006.

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06/14

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University of Wollongong
School of Accounting & Finance

Working Papers Series

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Macroeconomic Forces and Stock Prices: Some Empirical Evidence from an Emerging Stock Market

Guneratne B Wickremasinghe*

Abstract

This paper examines the causal relationships among stock prices and macroeconomic variables in an emerging stock market, the Colombo Stock Exchange (CSE). We use data on six macroeconomic variables and All share Price Index (ASPI) of the CSE for the period January 1985 to December, 2004. In the empirical analysis, we employed recently developed unit root tests that possess better power and size properties than widely-used Dickey-Fuller type unit root tests. Johansen's test, Error-correction models, variance decomposition and impulse response analyses indicate that there are both short and long-run causal relationships among stock prices and macroeconomic variables in Sri Lanka. These results indicate that stock prices can be predicted from certain macroeconomic variables and hence violate the validity of the semi-strong version of the efficient market hypothesis. The above results have implications for investors, both domestic and international.

JEL Classification: G15
Keywords: Colombo Stock Exchange, Ng-Perron tests, cointegration, Variance decomposition, Granger causality

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1. Introduction

According to stock valuation models, the current price of an equity share is equal to the present value of all future cash flows to that share. Changes in macroeconomic environment affect the expected cash flows and/or the required rate of return to the share, which in turn affect the current price of a share. Further, the Arbitrage Pricing Theory (APT) of Ross (1976) posits relations between stock prices and certain macroeconomic variables. Friedman (1988) and Mishkin (1998) also argue for the roles of equity markets in the specification of money demand and in monetary transmission mechanisms, respectively. The above provide the justification for empirical studies examining the relationship between stock prices and macroeconomic factors.

The causal nexus between stock prices and macroeconomic variables has received a lot of attention from academics. These studies have used different macroeconomic variables and data from both developed and developing countries. A few notable studies for developed countries include those by Fama (1981, 1990); Chen *et al*. (1986); Hamao (1988); Asprem (1989); Chen (1991); Thornton (1993); Naka (1995); Kaneko and Lee (1995): Cheung and Ng (1998) and Darrat and Dickens (1999). These studies find that factors such as slope of the yield curve, risk premia, industrial production, money supply and interest rate as important determinants of stock returns. In relation to developing countries, a few important studies include those by Tsuyoshi (1997) for Zimbabwe, Kwon and Shin (1999) for South Korea, Wongbangpo and Sharma (2002) for Indonesia, Malaysia, the Philippines, Singapore and Thailand, Ibrahim and Aziz (2003) for

Malaysia. These studies found significant interactions between exchange rate, money supply, interest rate, oil price and dividend yield.

In a Sri Lankan context there has been only one study in this area (Gunasekarage *et al*., 2004). This study examined the causal nexus between five macroeconomic variables (money supply, treasury bill rate, consumer price index, US dollar exchange rate and the US share price index) and stock prices. The results of the error-correction models estimated in this study found that lagged values of consumer price index, money supply and treasury bill rate have a significant influence on the stock market. The results further indicated that the stock price has a significant influence only on the treasury bill rate. Both variance decomposition and impulse response analyses revealed that shocks to macroeconomic variables explained only a minority of forecast variance of the market index. Although this is a pioneering study in a Sri Lankan context, it suffers from certain weakness in relation to employing the methodologies adopted. To test for time series properties, this study employed Augmented Dickey-Fuller and Phillip-Perron tests which have low power and size properties. Further, the selection of lags in these tests has not been done using an accepted method. This raises questions regarding the validity of the results of unit root tests. Further, this study has not used a suitable method for the selection of the deterministic components in the Johansen cointegration tests. The results of the Johansen cointegration tests are sensitive to the selection of the deterministic components.

The objectives of this paper are to investigate the causal relationships among stock market prices and macroeconomic variables in Sri Lanka. This study differs from previous studies using Sri Lankan data in the following respects: (i) it employs recently developed unit root tests that have better size and power properties than the widely used Dickey-Fuller (DF) type unit root tests, (ii) it uses more variables than those used in previous studies. These additional variables have been found to have causal relationships with stock prices, (iii) it carefully chooses the appropriate assumption for the deterministic components in the cointegration tests which have been ignored in most previous studies, and (iv) it examines both short and long-run causal relationships among stock prices and macroeconomic variables.

This paper is organised as follows. Section two provides an overview of history and performance of the Colombo Stock Exchange. Methodology and data are discussed in Section three. Section four is devoted to the discussion of empirical results. The last section concludes the paper.

2. An overview of history and performance of the Colombo Stock Exchange

Share trading in Sri Lanka started more than a century ago in 1896 under the Colombo Share Brokers Association. The share trading at that time was carried out by companies that were engaged in opening plantations in the country. However, share trading on a formal basis started in Sri Lanka in 1985 with the establishment of the Colombo Securities Exchange (GTE) Limited by amalgamating Colombo Brokers Association with the Stock Brokers Association. Since then there have been several changes in relation to share trading and related regulations.

In 1987, the Government of Sri Lanka enacted the Securities Council Act No. 36 enabling the establishment of a regulator for the capital market. In the year 1988 the Stock Exchange replaced the by-laws of the Colombo Brokers Association with new rules for listed companies. Further, in 1989 the Stock Exchange introduced new Trading Floor rules and new Conditions of Sale. In 1990, the Colombo Securities Exchange (GTE) Limited became the Colombo Stock Exchange. In addition, in this year the Government of Sri Lanka liberalised investment in the Stock Market by abolishing 100% Transfer of Property Tax on share purchases by foreigners and relaxing exchange control on inward remittances for share purchases and outward remittances of surpluses in relation to listed shares. The year 1991 marks a major milestone in share trading in Sri Lanka with the automation of the Clearing House of the Stock Exchange with the establishment of the Central Depository System (CDS). Another important event in this year was the abolition of the Wealth Tax on listed shares. Further in 1992, the Government of Sri Lanka abolished the Capital Gains Tax on listed shares. All of the above provided motivation for non-nationals to invest in the Sri Lankan share market.

In 1993, the CSE introduced new Trading Floor rules. The year 1995 brought about several changes. The CDS was further upgraded and an over-the-counter market was established for unlisted company shares. Another important event in 1995 was the introduction of a two-tiered board, the Main board and the Second Board. Further, the CSE signed a Memorandum of Understanding with the Stock Exchange of Mauritius to sell the CDS software developed by the CSE. The year 1997 witnessed the automation of

trading with the installation of a screen based trading system. Further, in this year the CSE adopted rules for establishing branch offices and sales outlets of member firms and for dispute resolution between clients/brokers and member firms. A settlement guarantee fund and a compensation fund were also established in 1997.

In 1998, the CSE was admitted as the 52nd member of the World Federation of Exchanges and the CDS was granted membership in the Asia-Pacific Central Securities Group (ACG). Four major changes occurred in 1999. They were the introduction of the Milanka Price Index and the new settlement date of T+1 for debt securities, approval of new rules for listing of debt securities and the establishment of an investor services centre of the CSE in Matara. In 2000, the CSE signed a Memorandum of cooperation with the Mumbai Stock Exchange and introduced new listing rules. The 2001 saw another important change to the share trading activities with the introduction of stock borrowing and lending. Further, the CSE re-opened the Public Gallery and relaunched its web site. In 2003, the CSE opened its second regional branch office in Kandy and re-launched its website with live trading information. Another important event is this year constitutes the signing of a Memorandum of Understanding with Karachi, Lahore and Islamabad stock exchanges.

Insert Table 1 about here

The CSE has been growing rapidly since its establishment in 1985. As at the end of 2004, it had 241 listed companies in 20 business sectors with a market capitalisation of over Rs.382 billion (over US$3.8 billion) which accounts for about 18% of the gross domestic product. Table 1 presents some statistics as to the historical performance of the CSE.

Insert Figure 1 about here

According to Figure 1, the All Share Price Index has gone through several upward and downward movements. After starting formal trading activities in 1985, the CSE has been more or less a bullish market for most of the time till February, 1994 when the ASPI hit an all time high. The sudden rise in the ASPI from May 1993 to February 1994 can be attributed to the influx of foreign capital due to the liberalisation of investment in the Sri Lankan stock market. From March 1994, the ASPI kept decreasing till September 2001. Such behaviour could be related to the political turbulence that prevailed in the country that kept away foreign investors. From October 2001, the CSE underwent a bullish market again mainly due to the signing of a Ceasefire Agreement by the new president Ranil Wickremasinghe with the Tamil insurgents bringing hopes that lasting peace will be restored in Sri Lanka. The bullish market prevailed till the end of the sample period in the study, December 2004.

3. Methodology and Data

Ng-Perron unit root tests

Ng and Perron (2001) introduced four unit root test statistics that are calculated using generalized least squares (GLS) de-trended data for a variable. Compared to the widely-used Dickey-Fuller (DF) and Phillips-Perron (PP) unit root tests, these have better power and size properties. The first unit root test statistic developed by Ng and Perron calculates the Elliot, Rothenberg, and Stock (ERS) point optimal statistic for GLS de-trended data as follows:

$$MP_T^d = \begin{cases} (\bar{c}_k^2 - \bar{c}T^{-1}(y_T^d)^2)/f_0 & \text{if } x_t = \{1\} \\ (\bar{c}_k^2 + (1-\bar{c})T^{-1}(y_T^d)^2)/f_0 & \text{if } x_t = \{1,t\} \end{cases} \tag{1}$$

where $k = \sum_{t=2}^{T}(y_{t-1}^d)^2/T^2$, $\bar{c} = \begin{cases} -7 & \text{if } x_t = \{1\} \\ -13.5 & \text{if } x_t = \{1,t\} \end{cases}$, f_0 is the zero frequency spectrum term, and y_T^d is the generalized least squares (GLS) de-trended value of the variable.

The other three statistics, MZ_α^d , MZ_t^d and MSB^d , are the enhancements of the Phillips-Peron (PP) test statistics which correct for size distortions when residuals are negatively correlated. These test statistics are calculated using the following equations:

$$MZ_\alpha^d = (T^{-1}(y_T^d)^2 - f_0)/2k \tag{2}$$

$$MZ_t^d = MZ_\alpha \times MSB^d \tag{3}$$

$$MSB^d = (k/f_0)^{1/2} \tag{4}$$

All four test statistics above are based on a specification for x_t and a method for estimating f_0, the zero frequency spectrum term. The specification for x_t can take one of two forms. That is, a constant or a constant and a linear trend. The consistent estimate of the residual spectrum at frequency zero is obtained on the basis of autoregressive (AR) spectral regression (GLS-detrended).

Johansen's multivariate cointegration test

This paper adopts Johansen (1991, 1995) cointegration tests. These procedures are carried out in two steps. One condition when applying cointegration tests is that the variables entering the cointegrating relationship should be integrated of the same order. If the variables are integrated of the same order, the second step is to test for cointegration among the variables of interest. Johansen's multivarite cointegration test is based on the following vector autoregression equation:

$$y_t = A_1 y_{t-1} + \ldots + A_p y_{t-p} + Bx_t + \varepsilon_t \tag{3}$$

where y_t and x_t are, respectively, a k-vector of non-stationary $I(1)$ variables and a vector of deterministic variables and ε_t is a vector of innovations.

In making inferences about the number of cointegrating relations, two statistics known as the trace statistic and the maximal eigenvalue statistic are used. The trace statistic is determined using the following formula:

$$\lambda_{trace} = -T \sum_{i=r+1}^{n} \log(1 - \hat{\lambda}_i) \qquad r = 0, 1, 2, \ldots, n\text{-}1$$

where T is the number of observations and $\hat{\lambda}_i$ is the ith eigenvalue.

The maximum eigenvalue statistic is determined using the following formula:

$$\lambda_{\max} = -T \log(1 - \hat{\lambda}_{r+1}) \qquad r = 0, 1, 2, \ldots, n\text{-}2, n\text{-}1$$

To make inferences regarding the number of cointegrating relationships, the trace and maximum eigenvalue statistics are compared with the critical values tabulated in Osterwald-Lenum (1992).

Error-correction model, short and long-run causality and variance decomposition analysis

According to Engle and Granger (1987), if two variables are cointegrated, there exists an error-correction model of the following form:

$$\Delta x_t = a_1 + b_1 ect_{t-1} + \sum_{i=1}^{m} c_1 \Delta x_{t-i} + \sum_{i=1}^{n} d_1 \Delta y_{t-i} + e_{1t} \tag{4}$$

$$\Delta y_t = a_2 + b_2 ect_{t-1} + \sum_{i=1}^{m} c_2 \Delta y_{t-i} + \sum_{i=1}^{n} d_2 \Delta x_{t-i} + e_{2t} \tag{5}$$

where x_t and y_t are the variables which are cointegrated, Δ is the difference operator, m and n are the lag lengths of the variables, ect_t denotes the residuals from the cointegrating equation and e_{1t} and e_{2t} are the white-noise residuals.

The error-correction model opens up another channel of causality through the error-correction term which is ignored in standard Granger causality tests. Therefore, causality can also be tested by examining (i) the statistical significance of the error-correction term by a separate t-test, (ii) the joint significance of the lags of each explanatory variable by an F- or Wald χ^2 test; or by testing (iii) the error-correction

terms and lagged term of each explanatory variable simultaneously by a joint F- or Wald χ^2 test.

Granger causality test results can be interpreted as within-sample causality tests and can be used to make inferences about causal relationships within the sample period only. Therefore, to make inferences on causal relationships beyond the sample period, variance decomposition analysis is used. In variance decomposition analysis, variance of the forecast error of a particular variable is partitioned into proportions attributable to innovations (or shocks) in each variable in the system, including its own. If a variable can be optimally forecast from its own lags, then it will have all its forecast variance accounted for by its own disturbances (Sims, 1982).

Data

Data used in this study consist of All share Price Index (ASPI) of the Colombo Stock Exchange, US dollar exchange rate expressed as the amount of Sri Lankan rupees per unit of US dollar (USD), three-month fixed deposit rate (FDR), Colombo Consumers' Price Index (CPI), US stock market index (USSP), money supply (M1), gross domestic product (GDP) of Sri Lanka on a monthly basis from January 1985 to December 2004. Data on the ASPI were obtained from the data bases of the CSE. Data on the CPI, USD, FDR and the GDP were obtained from the International Financial Statistics CD-ROM. As GDP figures are available for Sri Lanka only on an annual basis, monthly GDP figures were constructed using the local quadratic with sum method. Data on the US stock market index were obtained from Website of Morgan Stanley Investment Corporation.

4. Analysis of empirical results

Descriptive statistics for the logs of the seven variables employed in the empirical analysis are shown in Table 2. A comparison of means and medians for the variables indicate that except for the money supply they are very close to each other during the sample period. However, the results reported in the last row of the table indicate that all variables do not follow normal distributions. The highest range is reported for the ASPI during the sample period followed by GDP, M1 and the US share price index. The lowest range is reported for the US dollar exchange rate followed by the three-month fixed deposit rate and the consumer price index. However, a perusal of coefficient of variations reveals that the consumer price index is the most volatile variable and the GDP is the least volatile variable during the sample period.

Insert Table 2 about here

An examination of skewness figures indicates that all variables except for the US dollar exchange rate are negatively skewed. This indicates that most variables have a large number of large values. That means that the negatively skewed variables have been on the increase during the sample period. As far the ASPI is concerned, this is an indication that investors have been earning large positive returns. However, from the standpoint of the CPI, negative skewness indicates that there have been periods with high inflation. When it comes to three-month fixed deposit rate, negative skewness has provided a favourable picture for the investors. The positive skewness of the GDP indicates that there have been more months with positive growth in GDP than the number of months with negative growth, which is a favourable indication for the foreign investors. A perusal of GDP growth figures also indicates that there was only one month with a

negative growth, January 1989. The money supply also has a negative skewness figure. This indicates that there have been months with high money supply figures which may have led to high inflation in the economy. The positive skewness figure for the US dollar exchange rate indicates that the Sri Lanka rupee has been depreciating against the US dollar by large amounts. This provides incentives to foreign investors as their investment incomes go up. A perusal of kurtosis figures for all variables except for the three month fixed deposit rate indicates that they are platykurtic. This may have combined with the negative skewness figures to provide non-normal distributions for all variables as indicated by the statistical significance of the Jarque-Bera statistics reported in the last row of the table.

Insert Table 3 about here

Table 3 presents the results of the Ng-Perron unit root tests. According to the results, all seven variables are not stationary in their levels. These results are consistent when an intercept and a linear time trend are included as deterministic components in the test equation. The unit root tests performed on the first differences of the variables indicate that the ASPI, three-month fixed deposit rate, gross domestic product, money supply, US dollar exchange rate and the US share price index are stationary. The consumer price index does not become stationary even when its first differences are considered. According to Hansen and Juselius (2002), it is possible to find cointegration among the variables, if at least two variables out of all variables considered in cointegration tests are integrated of order one. As the unit root test results reported in Table 3 satisfy this condition, it is possible to proceed to the second step of the analysis, testing for cointegration among stock market prices and macroeconomic variables.

Insert Table 4 about here

The Johansen and Juselius cointegration test results are shown in Table 4. Most previous studies that used this methodology ignored the assumptions for the deterministic components when testing for cointegration between stock market prices and macroeconomic variables. This leads to unreliable results in cointegration tests leading to erroneous conclusions. This study has overcome this problem by using the Pantula Principle proposed by Johansen (1992) in choosing the deterministic components in cointegration tests. According to the results reported in Table 4, only the trace test finds one cointegrating relationship among the stock prices and the six macroeconomic variables. The maximum eigenvalue test does not provide any support for cointegration among the above variables. Since the trace statistic takes into account all of the smallest eigenvalues, it possesses more power than the maximum eigenvalue statistic (Kasa, 1992; Serletis and King, 1997). Further, Johansen and Juselius (1990) recommend the use of the trace statistic when there is a conflict between these two statistics. Therefore, we conclude that there is a cointegrating relationship among the stock market price and macroeconomic variables in Sri Lanka.

Insert Table 5 about here

As we found one cointegrating relationship between the stock market price and macroeconomic variables, we proceeded to estimate the error-correction models. Previous Sri Lankan studies have not examined both short and long-run causal relationships between stock market prices and macroeconomic variables. The results of short and long-run causality are shown in Table 5. According to the results, we can divide the causal relationships into four groups. That is, (a) long-run causal relationships only,

(b) both short and long-run causal relationships, (c) short-run causal relationships only and (d) no causal relationships. There are five long-run causal relationships among the stock market prices and macroeconomic variables. These causalities run from the ASPI to the CPI, from three-month fixed deposit rate to the ASPI, from the ASPI to the M1, from the ASPI to the US dollar exchange rate and from the GDP to the ASPI. We do not expect the ASPI to cause changes in the US share prices. Therefore, we do not perform Granger causality tests for this relationship.

There are two short and long-run causal relationships between stock prices and macroeconomic variables. These are from the ASPI to three-month fixed deposit rate and from the ASPI to gross domestic product. There is only one short-run causal relationship. That is from the US share price index to the ASPI. No causal relationships exist from consumer price index to the ASPI, and from the US dollar exchange rate to the ASPI. If the causal relationships run in both directions, such causal relationships are known as feedback relationships. According to the results in Table 5 feedback relationships exist between the ASPI and three-month fixed deposit rate and the ASPI and the GDP of Sri Lanka. All other relationships are unidirectional relationships. The above results indicate that the Sri Lankan stock market is not efficient in the semi-strong version of the efficient market hypothesis.

Insert Table 6 about here

Table 6 reports the results of the variance decomposition analysis. This analysis was used to supplement the Granger causality test results to examine the out-of-sample causality. Results reported in columns two to eight show how much of ASPI's own shock is

explained by movements in its own variance and those of the macroeconomic variables over the forecast horizon (i.e. 48 months). According to the results shown in column two of the table, the amount of variance of the ASPI explained by itself goes down when the time horizon increases. At horizon one all variance in ASPI is explained by itself. At horizon forty eight, however, only fifty two percent of its variance is explained by itself. This indicates that at longer horizons, variance in the ASPI is caused by the variance in other variables. In other words there are causal relationships among the ASPI and the other variables at longer horizons.

A perusal of column five of the table reveals that out of the six macroeconomic variables, the gross domestic product is the variable that explains most of the variance of the ASPI. At horizon twelve the GDP explains 11.25 per cent of the variance of the ASPI. When the time horizon goes up, the amount of variance of the ASPI explained by the GDP also goes up. Again these results indicate that the longer the horizon, the larger the amount of variance in the ASPI explained by the GDP. The other variable that causes the variance in the ASPI is the money supply (M1). Its influence on the ASPI increases with the increase in the time horizon. At horizon forty-eight 12.08 per cent of the variance in the ASPI is explained by the money supply. The US share price index also plays some role in determining the share prices in Sri Lanka. However, its impact on the ASPI is not as prominant as those of the GDP and M1. At horizon twelve, the US share price index explains only 7.07 of the variance of the ASPI whereas at horizon forty eight, it explains 8.43 percent of the variance of the ASPI. The consumer price index, three-month fixed deposit rate and the US dollar exchange rate play little role in explaining the variance of

the ASPI. The foregoing discussion indicates that the most influential macroeconomic determinants of the stock prices in Sri Lanka are gross domestic product and the money supply.

Insert Table 7 about here

Table 7 reports the proportions of forecast variance of the macroeconomic variables explained by the ASPI. A perusal of columns two to five and seven indicates that the ASPI explains very little forecast variance of the consumer price index, three-month fixed deposit rate, gross domestic product, money supply and the US share price index. The only macroeconomic variable whose variance is explained by a significant amount by the ASPI is the US dollar exchange rate. For example, the ASPI explains 8.41 per cent and 10.56 per cent of the variance in the US dollar exchange rate at forecast horizon twelve and forty eight, respectively. The results shown in tables 6 and 7 indicate that there is a unidirectional causality from the GDP, M1 and the US share price index to ASPI and from the ASPI to US dollar exchange rate. The above results lead us to conclude that the share prices in Sri Lanka can be predicted from certain macroeconomic variables. Therefore, the Sri Lankan share market does behave according to the predictions of the efficient market hypothesis.

Inset Figure 2 about here

Figure 2 shows the impulse response functions for the ASPI with respect to a standard deviation shock in each of the seven variables. A standard deviation shock in the equation for ASPI increases the ASPI till horizon five. Then the ASPI starts decreasing till horizon ten after which a standard deviation shock to the equation for the ASPI does not introduce any variable impact on the ASPI. A standard deviation shock to the equation for

consumer price index has a variable impact on the ASPI till horizon three. After horizon three a shock to the equation for consumer price index increases the ASPI till horizon thirty. At all horizons after thirty, a shock to the equation for consumer price index does not produce any volatility in the ASPI. When a standard deviation shock is given to the equation for the three-month fixed deposit rate, the ASPI drops till horizon three and suddenly increases till horizon six. Then the ASPI decreases till horizon fourteen. Then there is a little volatility in the ASPI till horizon sixteen. From horizon seventeen a standard deviation shock to the equation for three-month fixed deposit rate does not cause any variability in the ASPI.

A standard deviation shock to the equation for the GDP increases the ASPI till horizon nine. Then the ASPI drops till horizon eleven and keeps increasing till horizon twenty seven after which the ASPI remains more or less stable. A standard deviation shock to the equation for the money supply has a negative impact on the stock price. The money supply suddenly goes down till horizon eleven. Then it keeps decreasing at a slow rate at all horizons till horizon sixty. A standard deviation shock given to the equation for the US dollar exchange rate results in a drop in the stock price till the fifth horizon and then sharply increases the stock price till horizon twelve. Again there is a drop in the stock price till horizon fifteen and thereafter keeps increasing at a very slow rate. A shock given to the equation for the US share price index introduces a sharp increase in the stock price in Sri Lanka till the ninth horizon. Then the stock price drops till horizon thirteen. Thereafter the stock price increases at a very slow phase at the other horizons.

Insert Figure 3 about here

Figure 3 depicts impulse response functions for the six macroeconomic variables when a standard deviation shock is given to the equation for the stock price, the ASPI. A standard deviation shock to the ASPI leads to a negative impact on the consumer price index till the fourth horizon. Then the consumer price index increases at a rapid rate till the sixth horizon. Thereafter there is a certain degree of volatility in the consumer price index till the seventeenth horizon after which stock price keeps increasing at a low rate. One standard deviation shock to the ASPI results in a great degree of variability in the three-month fixed deposit rate. This persists till the seventeenth horizon. After the seventeenth horizon, the three-month fixed deposit rate keeps falling at a slow rate at all horizons. The gross national product responds favourably to a standard deviation shock to the stock price although there is a drop in it till the second horizon. From the third horizon gross domestic product increases at all horizons in response to a standard deviation shock to the equation for the stock price. As far as the money supply is concerned, one standard deviation shock to the stock price leads to a negative impact on the money supply till the fifth horizon. Then the impact is positive till the eighth horizon. From the ninth quarter one standard deviation shock to the equation for the stock price results in a negative impact on the gross national product. The US dollar exchange rate responds negatively at all horizons to a standard deviation shock given to the equation for the stock price. There is a volatility in the US dollar exchange rate till about the fifteenth horizon. Then a shock to the equation for the stock price produces a stable impact on the US dollar exchange rate. We do not report the results for the response of the US share price to a standard deviation shock to the stock price in Sri Lanka. The reason for this is that we do not

expect the stock price of Sri Lanka to influence the stock price of a well-developed stock market such as that of the US.

5. Conclusion

This paper examined the causal relationships among stock prices and six macroeconomic variables in Sri Lanka. We also considered gross domestic product which is expected to have a significant impact on the stock prices. This variable has not been considered in previous studies using Sri Lankan data. As data on gross domestic product were not available on a monthly basis for Sri Lanka, we constructed them using local quadratic with sum method. Taking a departure from previous studies using Sri Lankan data we analysed both short and long-run causal relationships among stock prices and macroeconomic variables. We employed recently developed unit root tests of Ng and Perron to test for time series properties of the variables. These tests are more powerful than the widely used Dickey-Fuller and Philips-Perron tests. Further, we carefully selected the deterministic components in the Johansen cointegration test. This aspect has been overlooked in most of the previous studies including those using Sri Lankan data.

The results of the Johansen cointegration test indicate that there is one cointegration relationship among the stock price and macroeconomic variables. Therefore, we proceeded to estimate the error-correction models to examine both short and long-run causal relationships. We found five long-run relationships, two short-run relationships, two short and long-run relationships among stock prices and macroeconomic variables. As far as the direction of causal relationships are concerned, we found three feedback or

bi-directional causal relationships between the ASPI and the three-month fixed deposit rate, the ASPI and the US share price and the ASPI and the gross domestic product. Bi-directional causal relationships were found from the ASPI to consumer price index, the ASPI to the money supply and the ASPI to the US dollar exchange rate. These results indicate that stock prices in Sri Lanka can be predicted using macroeconomic variables.

As the Granger causality test results indicate only in-sample causal relationships, we also performed variance decomposition analyses to find out-of-sample causal relationships among the stock prices and macroeconomic variables. We found that at shorter horizons most of the forecast variance of the stock prices is explained by the stock prices themselves. However, at longer horizons we found that the gross domestic product and the money supply play important roles in explaining the forecast variance in stock prices. As far as macroeconomic variables are concerned, the stock prices are able to explain the forecast variance of the US dollar exchange rate only.

In the last stage of analysis, we investigated whether a standard deviation shock given to an equation for a variable in the system could generate a response from itself and other variables at different horizons. Firstly we examined the impulse response of the ASPI to a standard deviation shock given to equations for the six macroeconomic variables. We found that a shock to equations for macroeconomic variables generate responses from the ASPI only at short horizons. At longer horizons, the ASPI does not show any variability for shocks to macroeconomic variables. We also found that a shock given to the equation for the money supply generates negative responses from the ASPI at all horizons

considered. Secondly we investigated whether a shock given to the equation for the ASPI generated any response from the macroeconomic variables. We found that all macroeconomic variables except for the money supply generated an initial negative response. We further found that except for the gross domestic product, all macroeconomic variables underwent a certain degree of volatility at shorter horizons as a result of a shock to the equation for the ASPI. These results again indicate that stock prices and macroeconomic variables in Sri Lanka are causally linked.

The above results violate the validity of the semi-strong form of the efficient market hypothesis and have implications for both local and foreign investors. Investors can devise methods to predict share prices from macroeconomic factors. However, they should consider the costs involved in such activities are less than the gains from share trading generating a profit for them.

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Table 1. Performance indicators for Colombo Stock Exchange

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Annual Turnover (Rs Mn)	11,249	7,403	18,315	18,232	14,842	11,049	14,057	30,523	73,837	59,052
Domestic (Rs Mn)	5,815	3,355	10,455	11,807	9,317	7,922	11,433	24,266	59,998	48,327
Foreign (Rs Mn)	5,434	4,048	7,860	6,425	5,525	3,127	2,624	6,257	13,839	10,724
Market Days (No)	240	242	241	240	241	241	240	238	240	240
Daily Average Turnover (Rs Mn)	47	31	76	76	61	46	58	128	308	246
Shares traded (No Mn)	316	227	515	634	486	449	747	1,220	2,255	2,752
Domestic (No Mn)	185	133	337	425	357	350	607	1,035	1,932	2,479
Foreign (No Mn)	131	94	178	208	129	99	140	185	323	272
Trades (No)	186,275	98,191	206,312	329,068	205,759	160,277	159,723	283,126	482,954	645,083
Domestic (No)	165,255	87,782	189,772	311,708	193,615	149,868	152,839	273,167	460,911	611,654
Foreign (No)	21,020	10,409	16,540	17,360	12,144	10,409	6,884	9,959	22,043	33,429
New Listing (No)	14	9	6	6	4	5	2	9	8	5
Delisting (No)	3	-	2	5	7	3	3	9	2	5
Companies Listed	226.0	235.0	239.00	240	237	239	238	238	244	242
Companies Traded	215.0	214.0	225.00	224	226	228	225	231	236	241
Market Capiterlization (Rs Bn)	106.9	104.2	129.40	116.6	112.8	88.8	124.0	162.6	262.8	382.1
Market PER year end (Times)	11.2	10.7	12.50	9.0	6.6	5.2	7.5	12.1	11.1	10.8
Turnover to Market Capiterlization (%)	10.5	7.1	14.10	15.5	13.1	12.4	11.3	18.7	28.1	15.5
Dividend Yield Year End (%)	4.3	4.1	3.20	4.5	5.2	6.5	6.8	4.3	3.1	3.2
Price to Book Value Year End (Times)	1.4	1.1	1.30	1.1	1.0	0.8	0.8	0.9	1.1	1.3

Source: Data Library of Colombo Stock Exchange - 2005

Table 2. Descriptive statistics for the variables

	ASPI	CPI	FDR	GDP	M1	USD	USSP
Mean	6.13	4.09	2.42	13.28	10.99	3.95	6.27
Median	6.35	4.12	2.48	13.34	11.13	3.91	6.10
Maximum	7.34	5.05	2.98	14.59	12.15	4.65	7.29
Minimum	4.57	3.07	1.58	11.95	9.49	3.27	5.14
Range	2.77	1.98	1.40	2.64	2.66	1.37	2.15
Standard Deviation	0.73	0.59	0.31	0.80	0.67	0.42	0.64
Coefficient of Variation (%)	11.96	14.43	12.81	6.02	6.10	10.63	10.21
Skewness	-0.61	-0.22	-0.97	-0.12	-0.30	0.07	-0.01
Kurtosis	2.24	1.80	3.97	1.72	2.01	1.86	1.64
Jarque-Bera	20.79[a]	16.31[a]	46.78[a]	16.96[a]	13.43[a]	13.13[a]	18.48[a]

Notes:
1. 'a' implies statistical significance at the one per cent level.

Table 3 unit root test results

Variable	Unit root test statistic			
	MZa	MZt	MSB	MPT
ASPI	0.96081	0.97996	1.01993	71.8783
	-3.59696	-1.34077	0.37275	25.3289
ΔASPI	-80.0065[a]	-6.32080[a]	0.07900[a]	0.31469[a]
	-112.874[a]	-7.51220[a]	0.06655[a]	0.80823[a]
CCPI	1.49270	3.14759	2.10865	317.379
	-4.25427	-1.43511	0.33733	21.1978
ΔCPI	0.96679	0.66360	0.68640	36.4069
	-11.8330	-2.38330	0.20141	7.97017
M1	1.53377	3.92589	2.55963	468.101
	-8.73347	-2.08210	0.23840	10.4630
ΔM1	-126.743[a]	-7.95631[a]	0.06278[a]	0.20065[a]
	-159.592[a]	-8.93119[a]	0.05596[a]	0.57616[a]
FDR	1.60445	1.11484	0.69484	41.4280
	-5.89524	-1.62218	0.27517	15.3482
ΔFDR	-204.689[a]	-10.1091[a]	0.04939[a]	0.12977[a]
	-173.030[a]	-9.29305[a]	0.05371[a]	0.55146[a]
USD	1.62704	5.35424	3.29078	783.252
	-9.22044	-2.14706	0.23286	9.88328
ΔUSD	-138.025[a]	-8.30648[a]	0.06018[a]	0.17896[a]
	-125.754[a]	-7.92780[a]	0.06304[a]	0.73051[a]
USSP	0.93996	1.46660	1.56028	158.163
	-4.50421	-1.39632	0.31000	19.4534
ΔUSSP	-121.799[a]	-7.79928[a]	0.06403[a]	0.20903[a]
	-121.062[a]	-7.77620[a]	0.06423[a]	0.76667[a]
GDP	0.58942	0.41025	0.69602	34.6897
	-6.69893	-1.80104	0.26886	13.6293
ΔGDP	-18.3419[a]	-3.00055[a]	0.16359[a]	1.43875[a]
	-26.9431[a]	-3.66712[a]	0.13611[a]	3.40165[a]

Notes:

1. See notes for Table 1 for the definitions of the notations used in column 1.
2. A Δ indicates the first difference of these exchange rates.
3. a, b and c imply statistical significance at the one, five and ten per cent level, respectively.
4. The first figure under each unit root test for a currency or its first difference is the unit root test statistics when a constant is used as the deterministic component. The second figure is the unit root test statistic when a constant and a linear time trend are used as deterministic components.
5. The lag lengths in the Ng-Perron tests were selected using spectral GLS-detrended based on SIC.

Table 4. Johansen Test Results for cointegration among stock prices and macroeconomic variables

Null Hypothesis	Trace Statistics	5% Critical Value	1% Critical Value	Maximal Eigen Value Statistics	5% Critical Value	1% Critical Value
$r = 0$	132.3953[b]	124.24	133.57	44.50809	45.28	51.57
$r \leq 1$	87.88719	94.15	103.18	28.01768	39.37	45.10
$r \leq 2$	59.86951	68.52	76.07	22.53742	33.46	38.77
$r \leq 3$	37.33208	47.21	54.46	21.06096	27.07	32.24
$r \leq 4$	16.27113	29.68	35.65	10.45743	20.97	25.52
$r \leq 5$	5.813694	15.41	20.04	5.605662	14.07	18.63
$r \leq 6$	0.208031	3.76	6.65	0.208031	3.76	6.65

Notes:

1. b implies significance at the 5% level.
2. The deterministic components are selected using the Pantula principale suggested by Johansen (1992). Pantula principle selected the cointegration equation with linear deterministic trend.
3. Five lags were included in the vector autoregression determined by the likelihood ratio.

Table 5. Temporal causality test results based on the Vector Error-correction model

Causality		χ^2 test statistic	ECT (t-statistic)	Nature of causality	Direction of causality
From	To				
ASPI	CPI	7.45	-3.90[a]	Long-run	Unidirectional
CPI	ASPI	3.09	1.51	No causality	
ASPI	FDR	9.86[c]	-3.90[a]	Short and long-run	Feedback
FDR	ASPI	1.96	3.45[a]	Long-run	
ASPI	M1	2.97	-3.90[a]	Long-run	Unidirectional
M1	ASPI	0.93	-1.07	No causality	
ASPI	USD	2.52	-3.90[a]	Long-run	Unidirectional
USD	ASPI	7.02	0.10	No causality	
ASPI	USSP	8.85	-3.90[a]	Long-run	Feedback
USSP	ASPI	10.25[c]	1.19	Short-run	
ASPI	GDP	17.41[a]	-3.90[a]	Short and long-run	Feedback
GDP	ASPI	8.55	1.99[b]	Long-run	

Notes:

1. a, b and c imply significance at the 1%, 5% and 10% level, respectively.
2. Only one error-correction term was included in the error correction model as there was only one cointegrating relationship among the seven variables. ECTs are the estimated t-statistics testing the null hypothesis that ECTs are each statistically significant. Number of lags in the VECM was selected using the likelihood ratio test.

Table 6. Percentage of forecast variance in ASPI explained by innovations in

Months	ASPI	CPI	FDR	GDP	M1	USD	USSP
1	100.00	0.00	0.00	0.00	0.00	0.00	0.00
12	72.84	1.44	1.40	11.25	4.86	1.14	7.07
24	60.07	3.24	1.27	15.31	9.37	2.62	8.12
36	54.83	4.03	1.22	17.01	11.23	3.35	8.34
48	52.28	4.41	1.19	17.88	12.08	3.72	8.43

Notes:

1. Figures in the first column refer to months after a once-only shock. Cholesky ordering for the variance decomposition was log(ASPI), log(CPI), log(FDR), log(GDP), log(M1), log(USD) and USSP.
2. See note 1 for Table 1 for details of notations in column 2.
3. Variance decompositions for the months 1, 12, 24, 36, and 48 only are reported. All figures in columns three through nine have been rounded to two decimal places

Table 7. Percentage of forecast variance in macroeconomic variables explained by innovations in ASPI

Months	CPI	FDR	GDP	M1	USD	USSP
1	0.28	0.57	0.15	1.03	0.60	0.47
12	0.70	3.80	0.65	0.79	8.41	0.75
24	0.79	3.10	0.90	0.74	9.85	0.53
36	0.92	2.81	1.03	0.79	10.33	0.43
48	1.01	2.72	1.09	0.86	10.56	0.38

Note:
1. See notes for Table 6.

Figure 1. Behaviour of All Share Price Index (ASPI) during the sample period

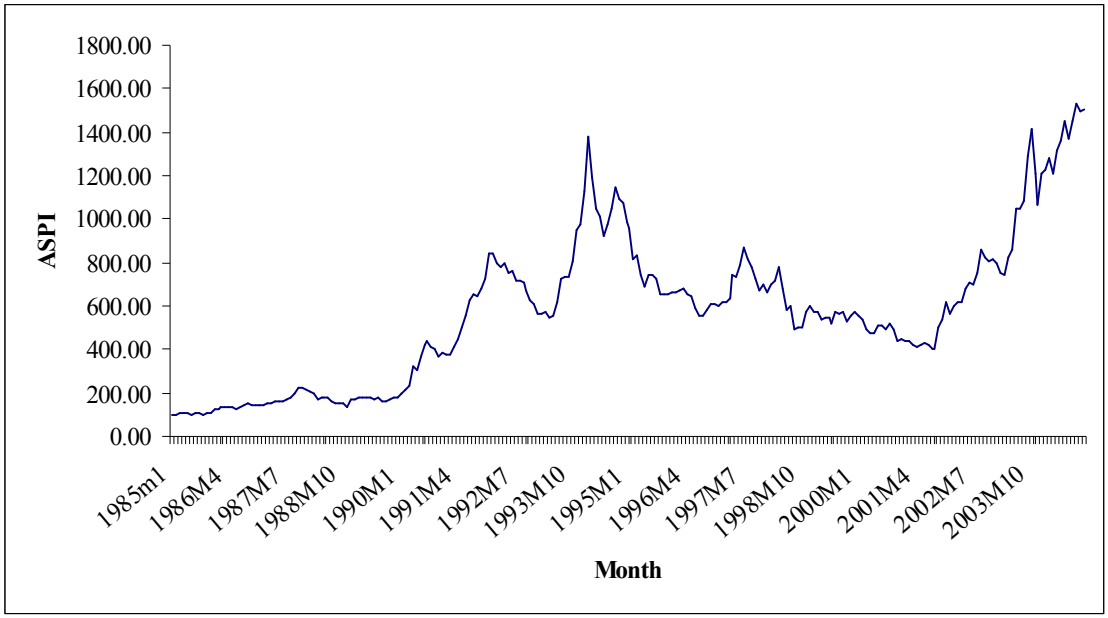
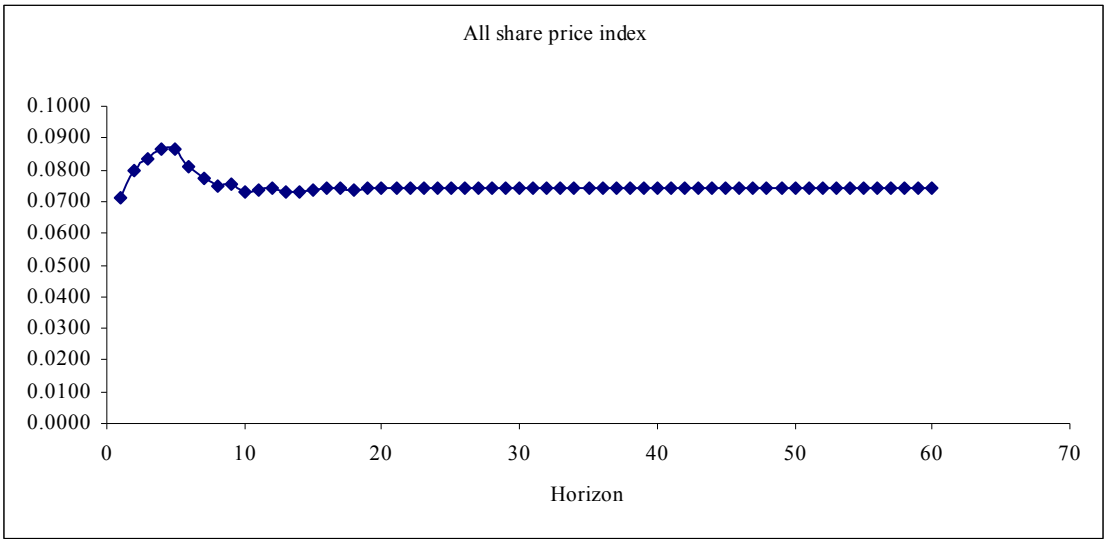
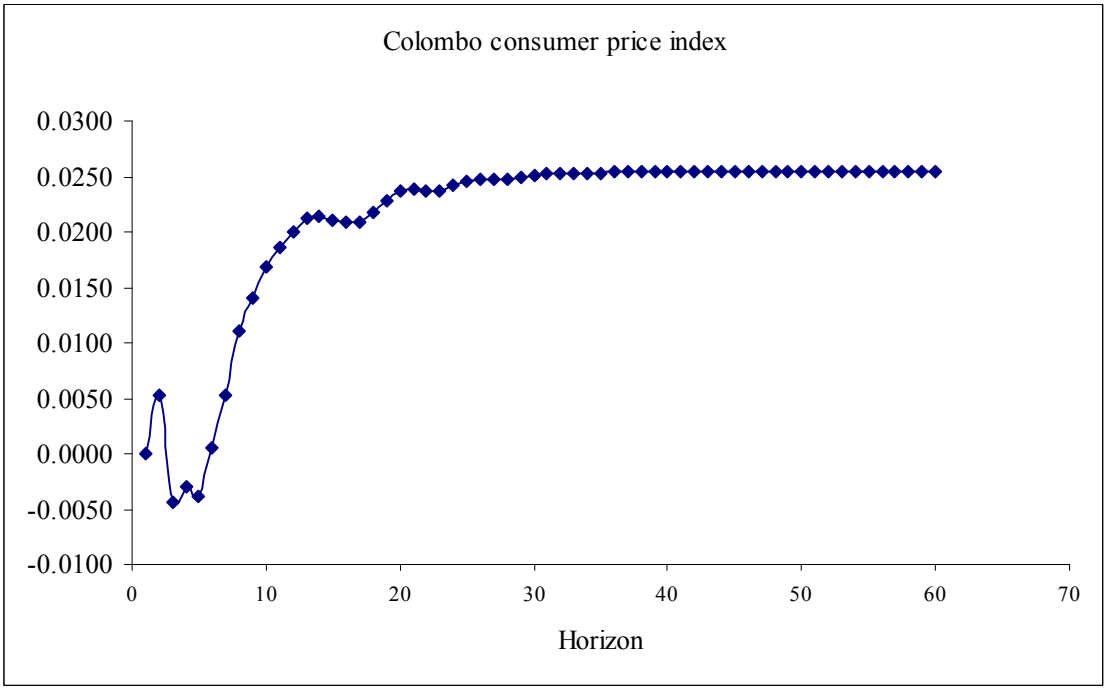
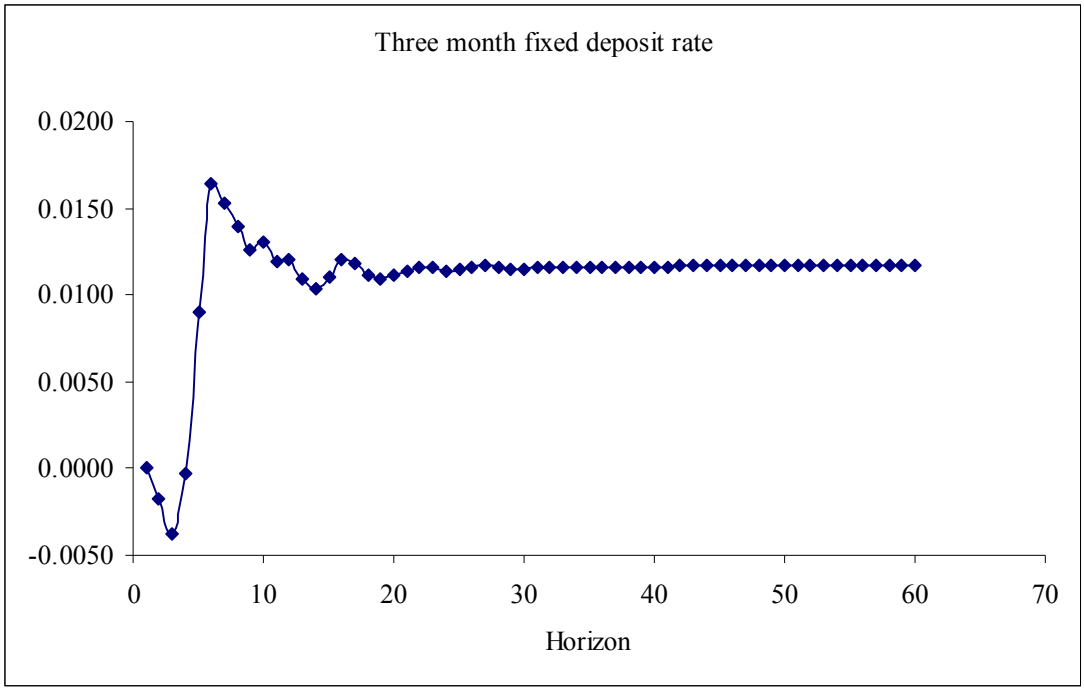


Figure 2. Impulse response of ASPI to one standard deviation shock in the equations for ASPI and macroeconomic variables



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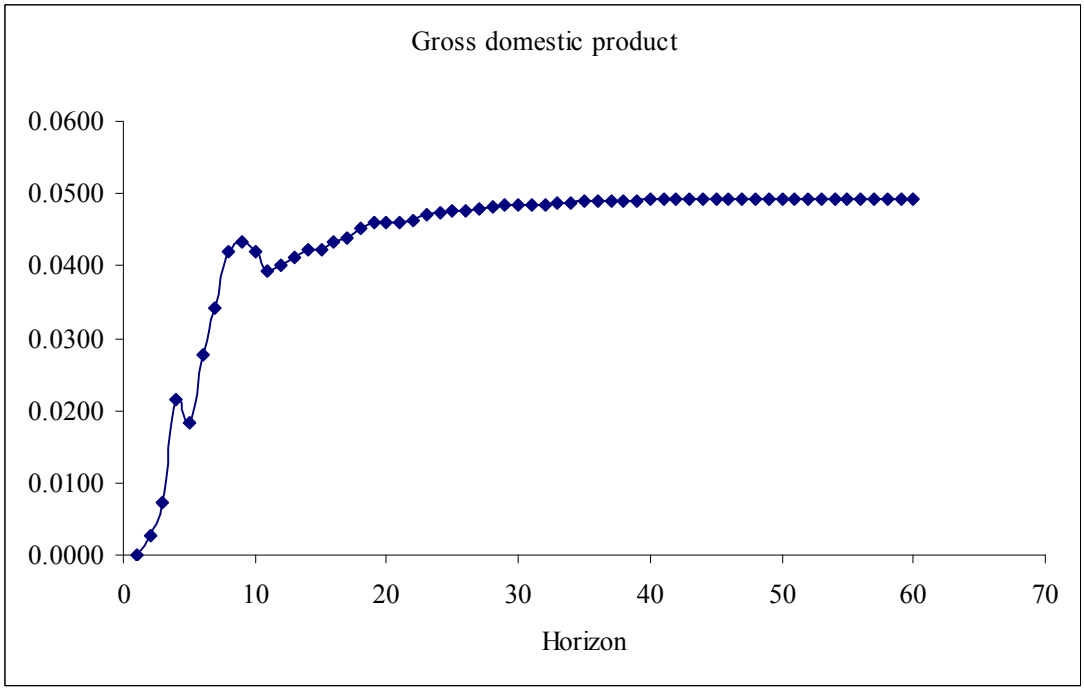
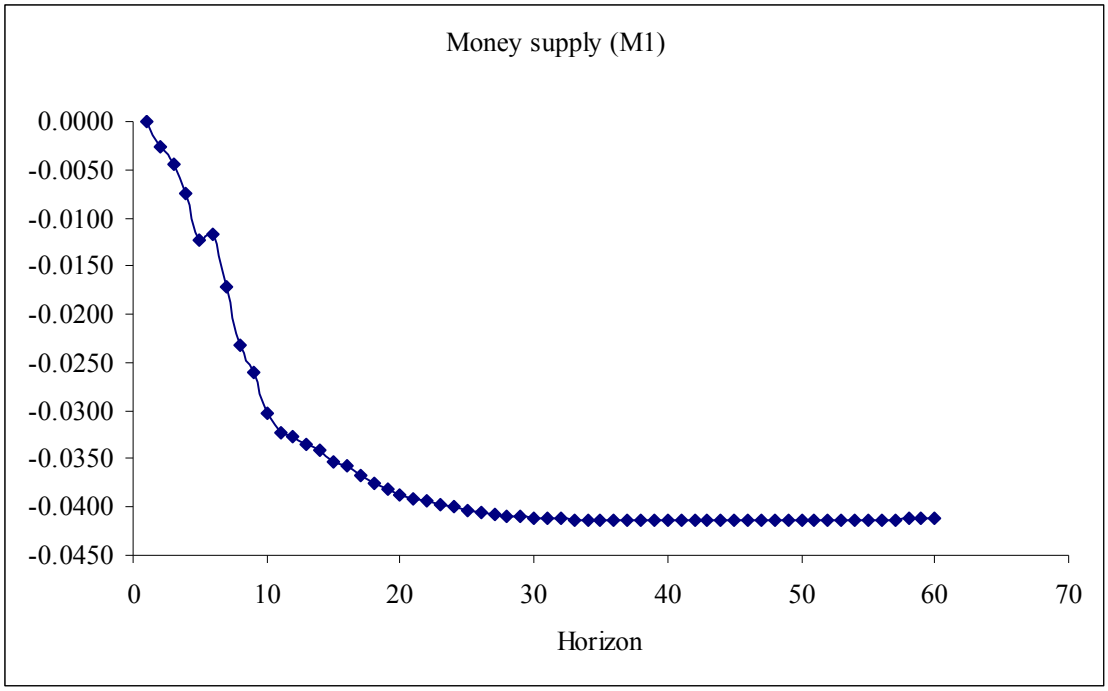
0.0100
0.0050
0.0000
-0.0050
0
10
20
30
40
50
60
70
Horizon


Gross domestic product
0.0600
0.0500
0.0400
0.0300
0.0200
0.0100
0.0000
0
10
20
30
40
50
60
70
Horizon


Money supply (M1)
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-0.0100
-0.0150
-0.0200
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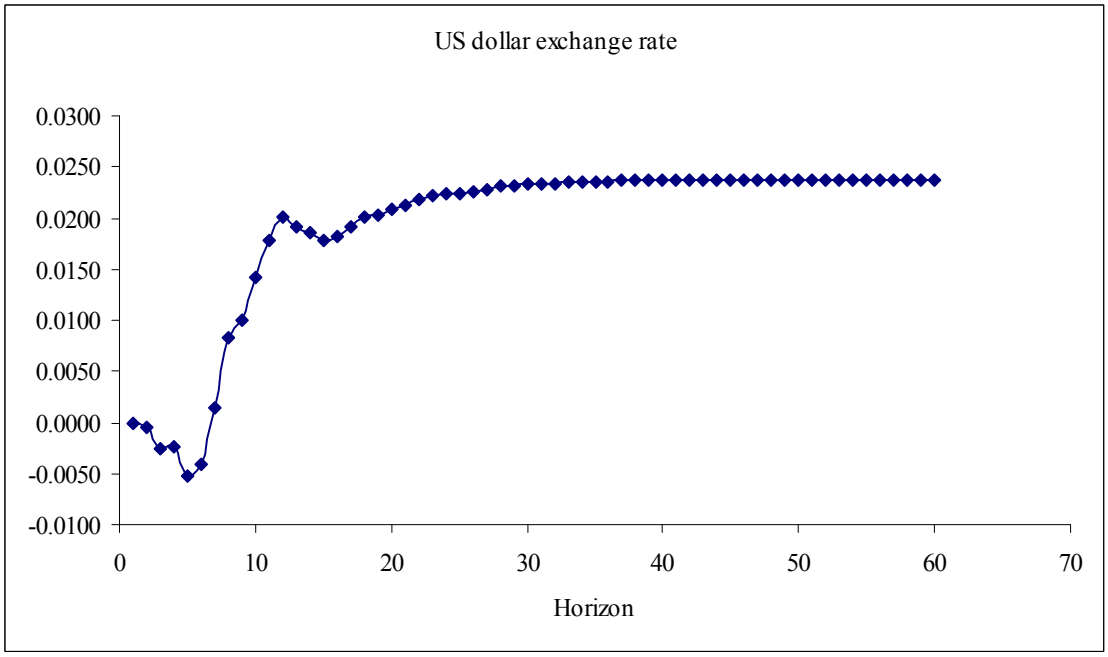
-0.0350
-0.0400
-0.0450
0
10
20
30
40
50
60
70
Horizon


US dollar exchange rate
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0.0250
0.0200
0.0150
0.0100
0.0050
0.0000
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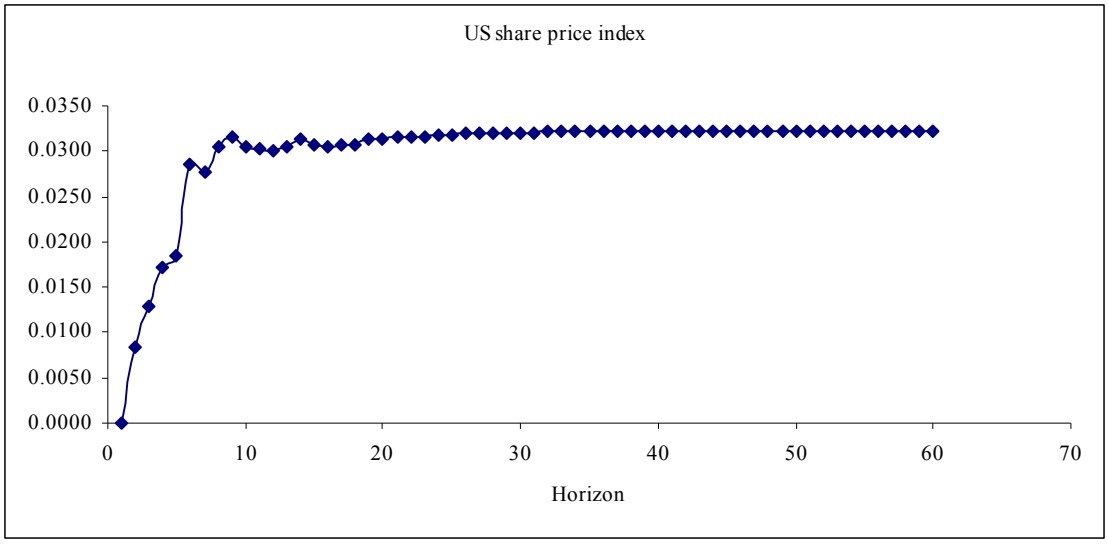
0
10
20
30
40
50
60
70
Horizon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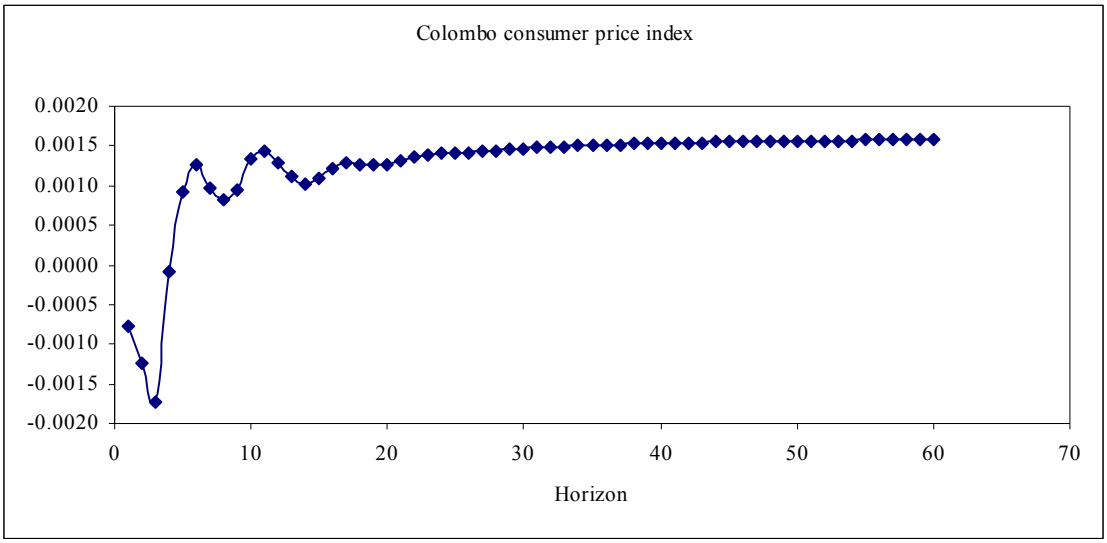
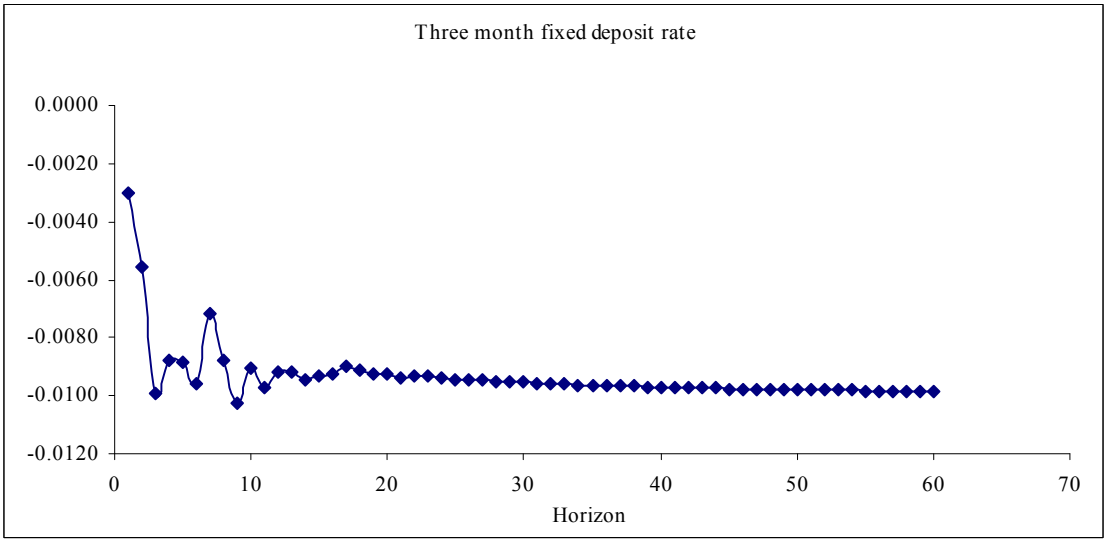
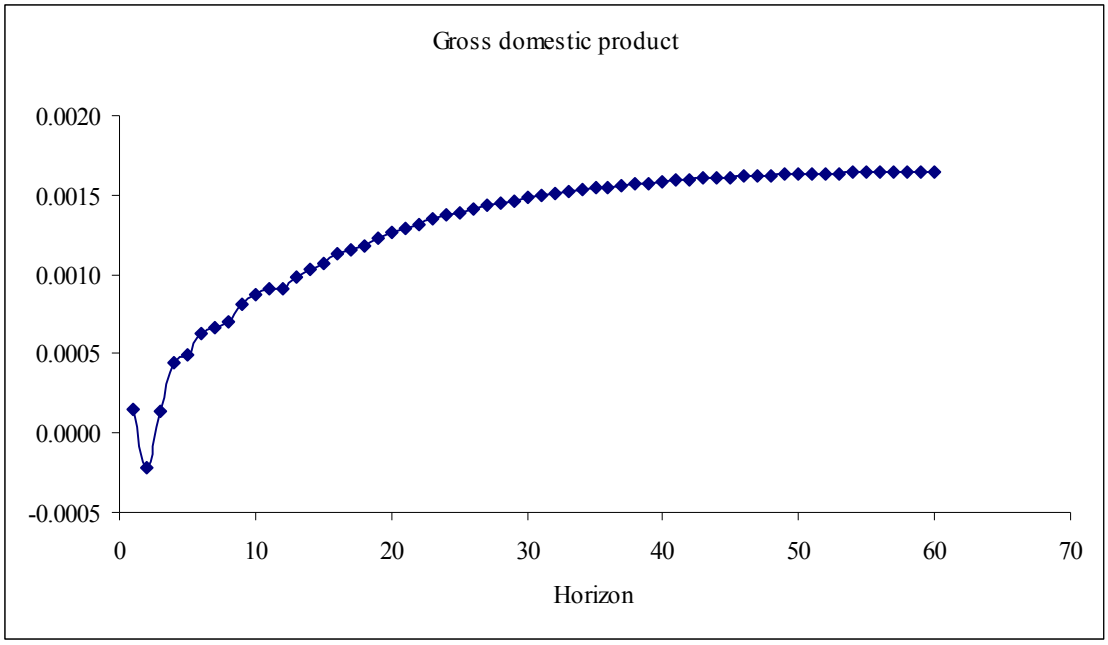
0.0250
0.0200
0.0150
0.0100
0.0050
0.0000
0
10
20
30
40
50
60
70
Horizon

Figure 3. Impulse response of Macroeconomic variables to one standard deviation shock in the equation for ASPI






Gross domestic product
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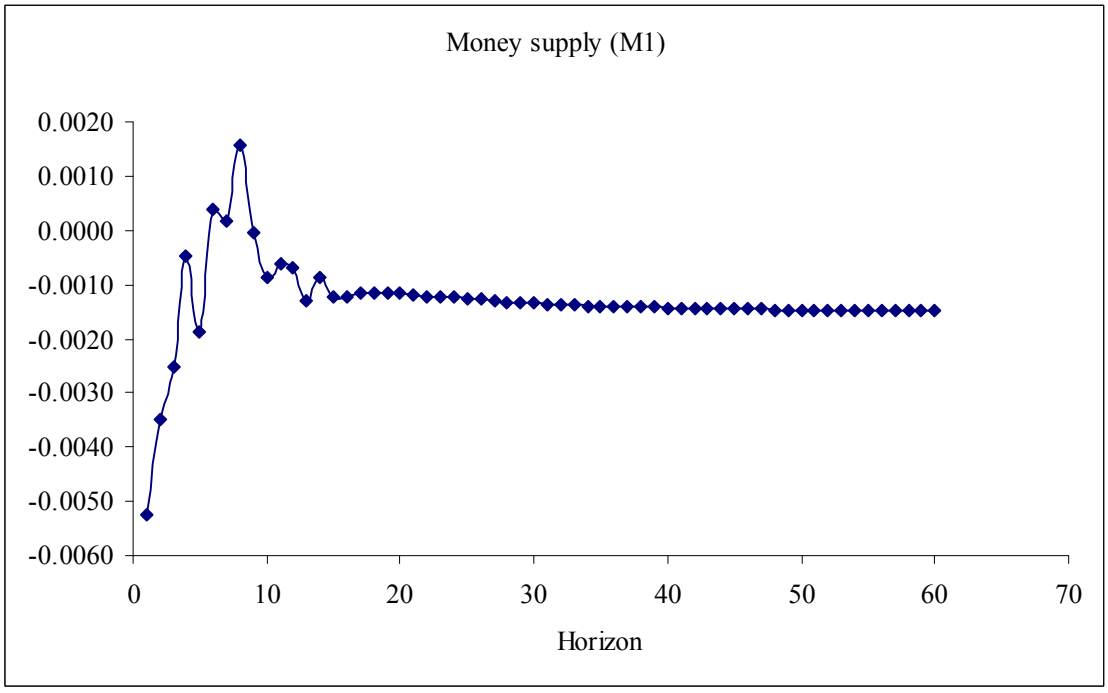
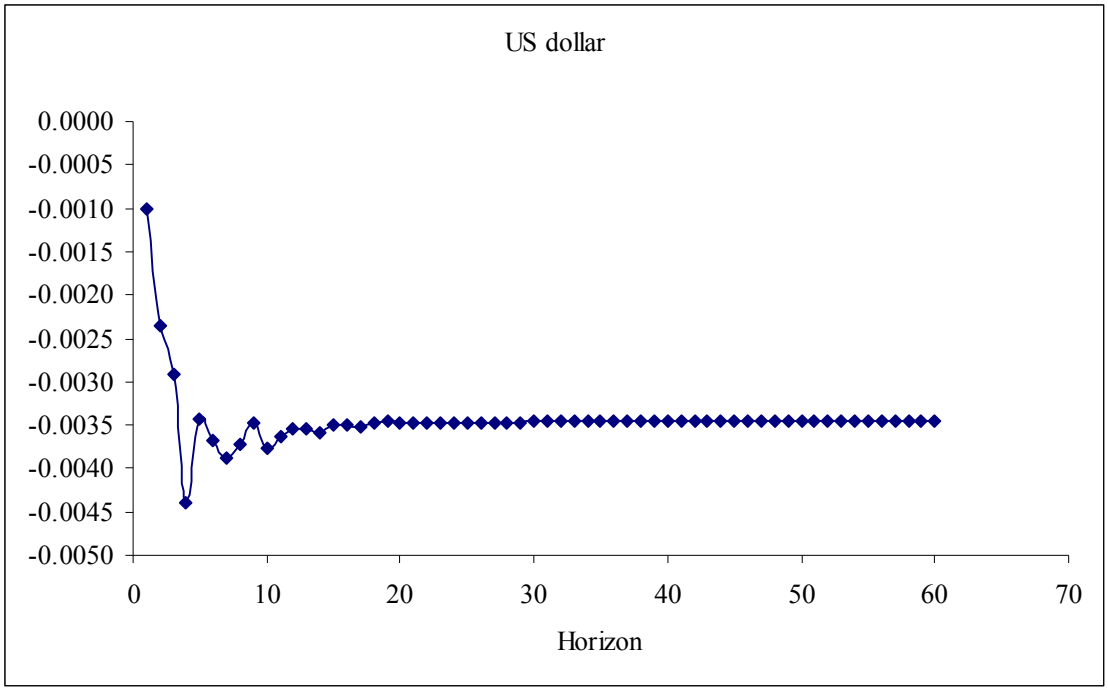
0.0010
0.0005
0.0000
-0.0005
0
10
20
30
40
50
60
70
Horizon


Money supply (M1)
0.0020
0.0010
0.0000
-0.0010
-0.0020
-0.0030
-0.0040
-0.0050
-0.0060
0
10
20
30
40
50
60
70
Horizon


US dollar
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-0.0035
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-0.0050
0
10
20
30
40
50
60
70
Horizon