

Inflation and economic growth: a case study of Sri Lanka

W I C S Chandika Gunasinghe[†]

Department of Economics, Faculty of Humanities & Social Sciences, University of Ruhuna

Abstract

This paper examines two policy views in economic literature on the relationship between inflation and economic growth. Monetary policy practitioners are of the view that inflation is detrimental to economic growth while structuralists believe that moderate inflation can contribute to economic growth. Therefore, the main objective of this paper is to examine empirically this controversial issue for Sri Lanka. This is tested using a cointegration analysis, Granger Causality Test (GCT), and Generalized Impulse Response Analysis (GIRA). The GCT is carried out to determine the direction as well as the degree of causality between the two macroeconomic variables concerned in the study. GIRA is used to confirm the pattern of volatility transmissions across inflation and economic growth, as empirical studies are still ambiguous about the fact that price stability brings output losses in the short run. The paper employs annual data from 1960 to 2005 for the current research.

Key words: inflation, economic growth, price stability, econometric tools, Sri Lanka

1. Introduction.

Economic growth and price stability have been two leading goals in monetary policy of the Central Bank (CB) in Sri Lanka. To achieve these goals, monetary authority has employed (or currently uses) various policy channels (i.e. interest rate, credit and monetary aggregate etc) in different political regimes from 1950 up to date. Therefore, the monetary authority of Sri Lanka has been of the view that inflation is harmful to economic growth and hence price stability has been an essential goal in its monetary policy. However, empirical studies are still indecisive about whether price stability brings economic growth or output losses particularly in the short run. This is mainly due to the fact that monetary policy practitioners expect that inflation is detrimental to economic growth while structuralists believe that moderate inflation can contribute to economic growth.

Theoretical justifications for the first view are explained below.

First, the most damaging costs of inflation on economic growth are perhaps related to unanticipated inflation, which may cause uncertainty between relative and aggregate price changes. This leads to the misallocation of scarce resources (Nell, 2000). This type of process worsens the long term macroeconomic performance of market economies by reducing total factor productivity, which in turn leads to lower economic growth (Nell, 2000; Andres and Hernando, 1997). For example, higher inflation may frequently induce changes in prices which may be costly for firms in various ways (i.e. costs incurred to arrange new agreements, increased complexity of contracts, raised frequency of meetings, avoidance of certain contracts, re-preparation of accounts etc).

Second, uncertainty about future price levels could force investors to hold up investment decisions which in turn has negative effects on boosting economic growth. This delay occurs due to the fact that investors consider investment as a sunk cost and largely irreversible (Nell, 2000). But even fully anticipated inflation may reduce rate of return of capital and investment, and underestimate the confidence of domestic and foreign investors about the future course of monetary policy. Nevertheless, inflation also affects

[†] Lecturer in the Department of Economics, University of Ruhuna, Sri Lanka. The author is very grateful to anonymous referees and Professor D. Atapattu for their comments on this paper. The author is responsible for any errors in the paper. Email: gunasinghe@econ.ruh.ac.lk Tel: +940412227014

the accumulation of other determinants of growth such as human capital or investment in R&D (Andres and Hernando, 1997).

Third, uncertainty about the real interest rate is mainly due to high and unpredictable prices. If savers and investors form their expectations about the real interest rate differently, funds will be allocated inefficiently. Then the ultimate result of this process is poor economic growth. Some researchers who advocate this monetarist view (that is, inflation negatively affects economic growth) are Andres and Hernando, 1997; Judson and Orphanides, 1999; Bruno and Easterly, 1998; Ghosh and Phillips, 1998)

On the other hand, structuralists put forward the following points to justify their view that moderate inflation could have potential benefits for the economy. Inflationary finance can mobilize resources for capital accumulation. The redistribution of wealth from money into physical assets may carry on through two main channels. **First**, according to the Keynesian approach, if money wages are slow to adjust to inflation, the Keynesian view asserts that inflation will redistribute income from workers with low saving propensities to entrepreneurs (capitalists) with higher saving propensities (Nell, 2000). As a result of this process, assuming imperfect capital mobility, capitalists may have the capacity to further invest and hence it may cause increases in the capital accumulation of the economy, which in turn could boost economic growth. **Second**, according to the Quantity Theory of Money approach, inflation acts as a tax on real money holdings, which redistributes wealth from the holders of money balances towards holdings of physical capital (i.e. investing in housing, lands etc, Gunasinghe, 2006) and/or to the government (i.e. through Treasury Bill market). If the government, for example, may invest these resources to build infrastructure/human capacity of the economy or reduce other distortionary taxes, there may be a positive relation between economic growth and inflation.

Although structuralists believe that upward movements in wages and prices are necessary to reallocate scarce resources in the most efficient way, after some points, inflation began to negatively relate to economic growth. The inevitable trade-off between growth and inflation suggests that higher growth and lower unemployment can only be achieved at the cost of some inflation. They also believe that the causative relation between inflation and growth is bi-directional (Nell, 2000). Few researchers advocate this view (that is, inflation positively affects economic growth), (Temple, 2000).

However, it should also be noted that a few publications related to the current study provides evidence for both negative and positive effects from inflation to growth and two way causations (Temple, 2000; Hussain, 2005; Bruno and Easterly, 1996), while some of them provide no evidence for any type of direction (Temple, 2000; Christoffersen and Doyle, 2000).

Following this line of reasoning, the main objective of this study is to examine this controversial issue for Sri Lanka. This is tested using a co-integration analysis, Granger Causality Test (GCT), and Generalized Impulse Response Analysis (GIRA). The application of co-integration completely depends on whether both inflation and economic growth are non-stationary in the same order $I(1)$ or $I(0)$ (2). If inflation and economic growth are individually integrated (non-stationary) of order " d ", they are differenced " d " times until they become stationary values $I(0)$. Then, all the techniques except cointegration are carried out using these $I(0)$ values. GCT test helps to determine the direction of causality between the two macroeconomic variables concerned in the study. Having modeled both $I(0)$ series in a bi-variate VAR framework, GIRA is then estimated to confirm the pattern of volatility transmissions across inflation and economic growth as empirical studies are still ambiguous about the fact that price stability brings output losses in the short run. The sample period of the study is from 1960 to 2005 for 45 annual observations.

The remaining structure of the paper is organized as follows: section 2 presents a brief discussion on the overview of the behavior of inflation and economic growth in Sri

Lanka; section 3 investigates data and their properties; section 4 is devoted to build an econometric model; section 5 examines empirical results and section 6 presents the final concluding remarks.

2. An overview of the behaviour of inflation and economic growth in Sri Lanka (1960- 2005)

Figure 2.1 helps to get some impression of the pattern of time path of both inflation and economic growth over the period concerned. It seems to represent that a higher reduction of inflation is associated with a somewhat higher increase in growth of GDP.

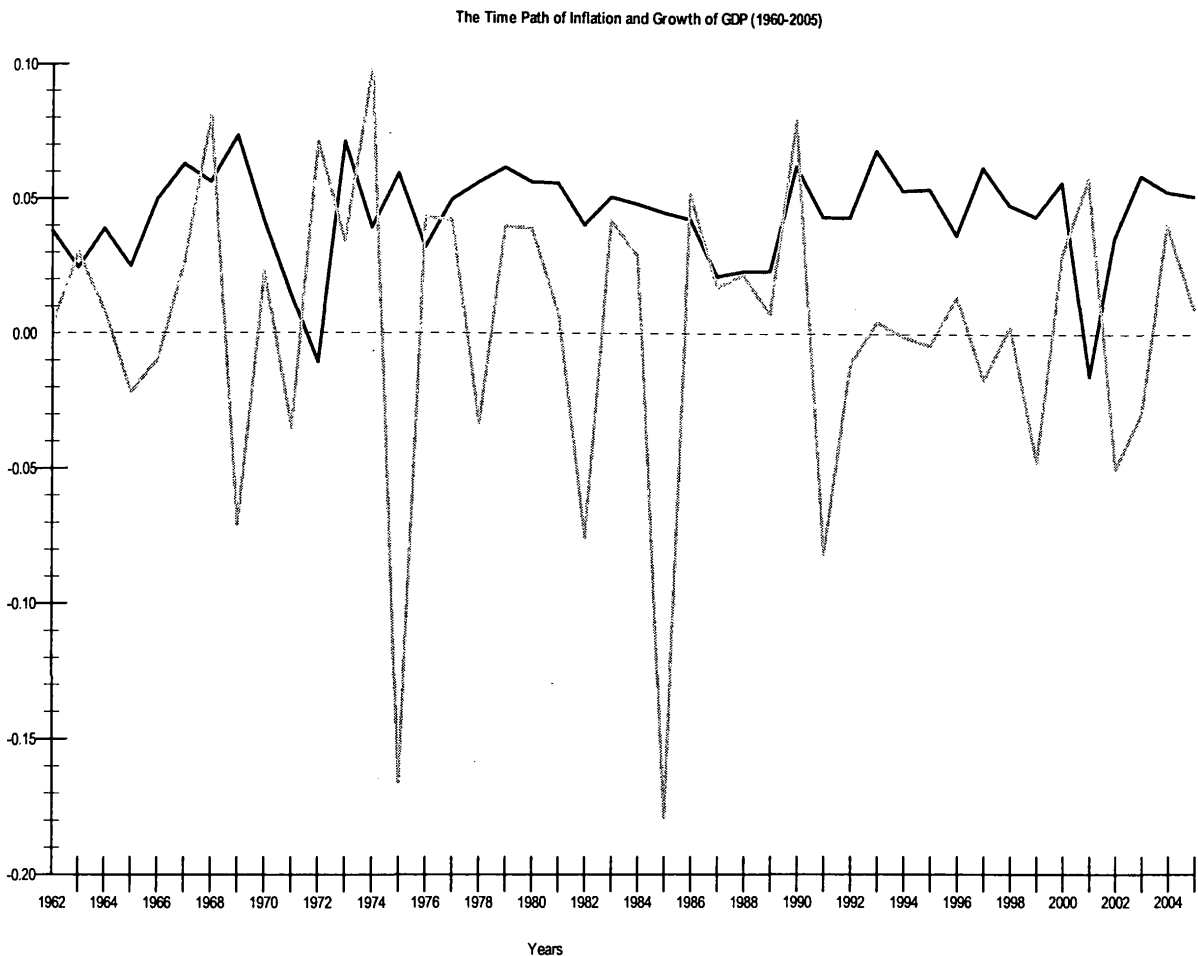


Figure 2.1. The time path of inflation (INF) and GDP growth (GGDP) in Sri Lanka (1960-2005)

It should be noted that as inflation followed an I (2) process (see section 3 for more details), its second difference is used with the first difference of GDP. It clearly indicates that most of the observations of inflation lie within -0.1 and +0.1 while those for GDP lie between +0.02 and +0.07 (Fig. 2.2). As these values are in log form, most of the GDP growth observations lie between two and seven percent. Overall, it is possible to look at a marginal negative effect between the two variables concerned. But on the other hand, when inflation rate is considered as an I (1) process, instead of an I (2) process, it yields a positive relationship between them. It means that very careful attention must be given to the time series properties of the variables concerned. Nevertheless, spurious results can

definitely be yielded. Therefore, our special attention is given to examine time series properties of data using various techniques. This is discussed in the following section.

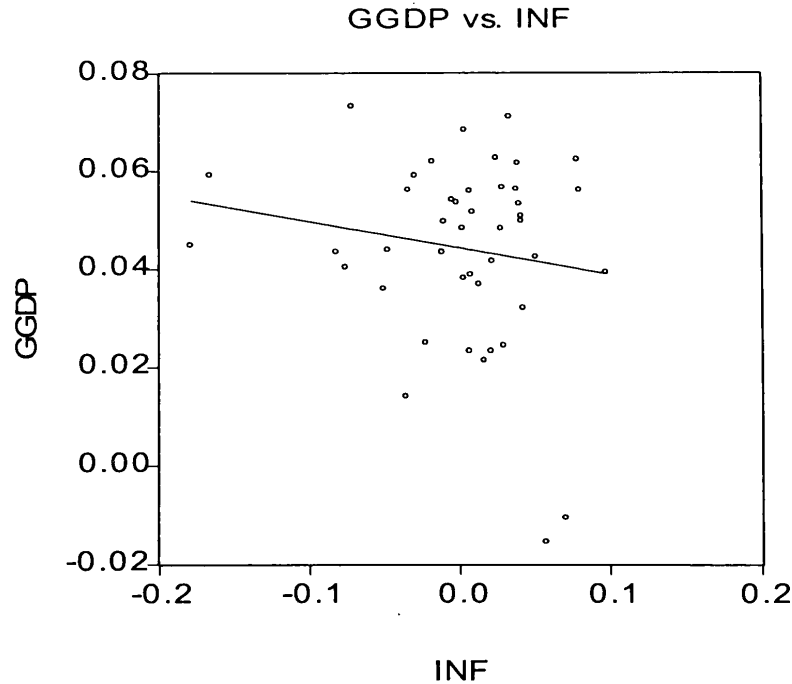


Figure 2.2. The pattern of relationship between inflation and economic growth (1960-2000)

3. Data and their properties

Before moving for co-integration, it is essential to test the non-stationarity of variables. The reason is that co-integration can exist among the variables which are integrated in the same order ($I(1)$ or $\sim I(2)$). The frequency of data is annual and hence it is free from the effects of seasonal adjustment and may well fit to a co-integrated VAR framework (Gulasekaran and Abeysinghe, 2003). The sample period of the study is from 1960 to 2005. INF is the log second difference of GDP deflator. GDP is the log first difference (rate) of real gross domestic product. The base year for GDP deflator is 1996. All the data related to the study were obtained from <http://devdata.worldbank.org/dataonline/>.

Non-stationarity seems a natural feature of economic variables. Legislative changes, technological progress (changes), evolution of the economy and political turmoil are examples of sources of non-stationarity (Gunasinghe, 2005). Hence, a unit root process, which is a type of stochastic non-stationarity process induced by persistent accumulation of past effects, can be interpreted as allowing a different trend at every point in time, which is also called a stochastic trend. Therefore, other variables related to the level of any variable with a stochastic trend will inherit that non-stationarity and hence may follow a unit root process (Hendry and Juselius, 2000, 2001). In order to confirm the non-stationarity of variables, this paper estimates autocorrelation functions and runs an Augmented Dickey Fuller Test (ADF) to test whether the series follows an $I(1)$, $I(2)$ or $I(0)$ process.

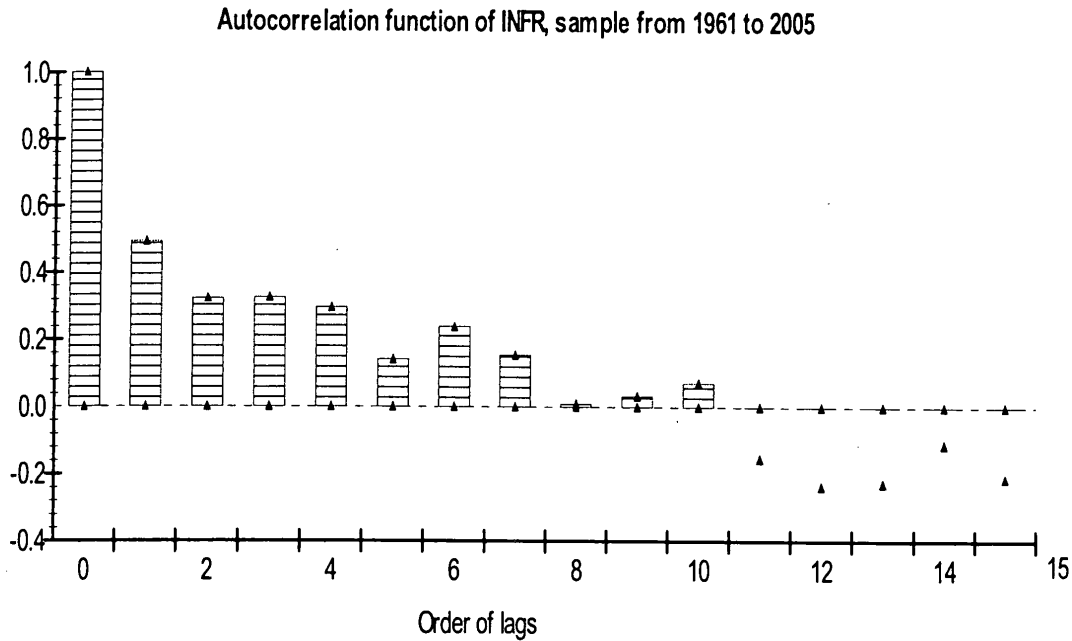


Figure 3.1 Tests for unit roots: autocorrelation functions - INFR (log of inflation rate)

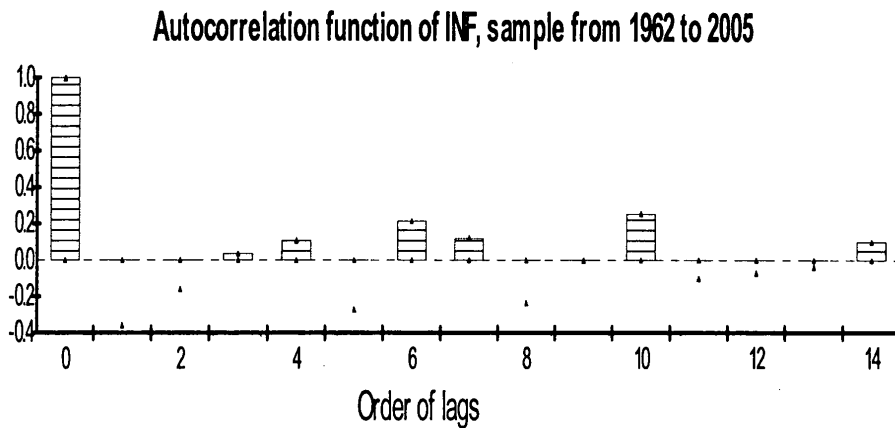


Figure 3.2 Tests for unit roots: autocorrelation functions - INF (first difference of INFR)

Figure 3.1 and Figure 3.3 reveal that autocorrelation tails away (dies off) less geometrically with increasing lags. It emphasizes the fact that log of inflation rate and GDP in log levels obey a lower order autoregressive process (AR). One striking feature of this sample autocorrelation is that it starts at a very high value and tapers off very gradually. This type of pattern is evidence that the series under consideration is following a non-stationary process. However, this feature cannot be seen in Figures 3.2 and 3.4 and hence it is an indicator for the first differenced series following a stationary process. Variables with the former characteristic reveal the presence of a higher interdependence between its current and past values (in levels).

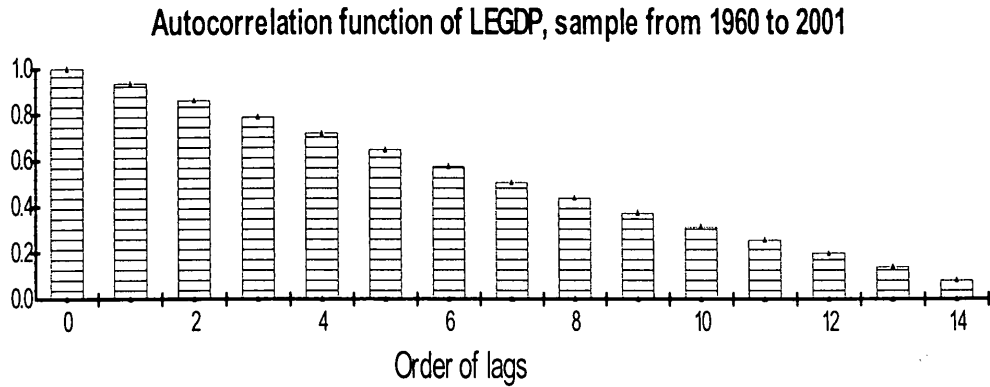


Figure 3.3 Tests for unit roots: autocorrelation functions- GDP (log levels of GDP)

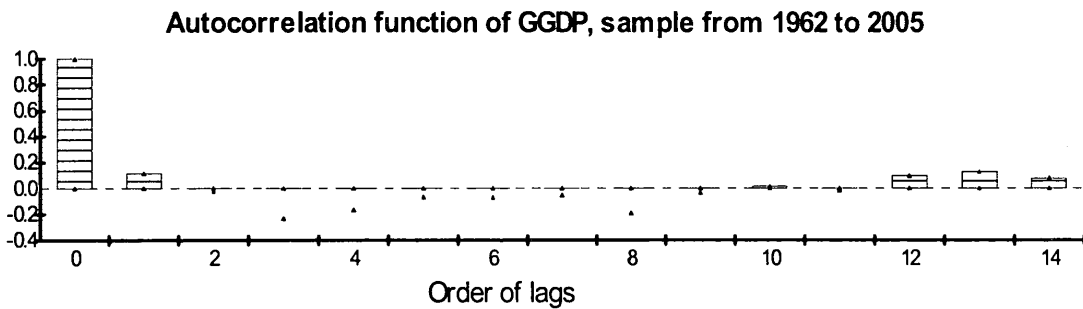


Figure 3.4 Tests for unit roots: autocorrelation functions- GGDP (first difference of GDP)

Tests for unit roots: Augmented Dickey Fuller Test

Before measuring the ADF test to test unit roots (Gunasinghe 2006), it is essential to have kept some basic idea in mind with regard to the data generating process of individual variables. Here, three data generating processes (DGP) are considered.

(i) $X_{jt} = \beta_1 X_{jt-1} + \varepsilon_t$, (ii) $X_{jt} = \beta_1 X_{jt-1} + \beta_0 + \varepsilon_t$, (iii) $X_{jt} = \beta_1 X_{jt-1} + \alpha T + \beta_0 + \varepsilon_t$

ADF equation: $\Delta X_{jt} = \phi X_{jt-1} + \sum_{i=1}^{p-1} \psi_i \Delta X_{jt-i} + a_1 t + a_0 + \varepsilon_t$ (iv) $j=1, 2$

$H_0: \phi = 0$ or $(\beta_1 + \beta_2 + \beta_3 + \dots + \beta_p - 1) = 0$

$H_a: \phi < 1$ or $(\beta_1 + \beta_2 + \beta_3 + \dots + \beta_p - 1) < 0$

Table 3.1 Results of Augmented Dickey Fuller Test for unit roots

1 Variables in	2 Equation under consideration for DGP	3 ADF statistic based on (2)	4 5% Critical Value	5 Nature of integration
<i>GDP (in levels)</i>	(iii)	-2.9320	-3.5189	<i>I(1)</i>
<i>INFR (inflation rate in levels)</i>	(ii)	-2.549578	-2.9320	<i>I(1)</i>
<i>GGDP (first dif. of GDP)</i>	(ii)	-4.461395	-2.9320	<i>I(0)</i>
<i>INF (first dif. of INFR)</i>	(i)	-5.738068	-1.9490	<i>I(0)</i>

According to the results of the ADF test of Table 3.1 given above, it is clear that the null hypothesis, which stands for the presence of unit root, is not rejected at 5% significant level for each variable. Therefore, all variables in the study are non-stationary or all are integrated of order one $\sim I(1)$. These results are further verified by inspecting the acceptance of the null hypothesis that each first difference series does not have a unit root. Even though the inflation rate (INFR) is non-stationary or integrated of order $\sim I(1)$, the first difference of inflation (INF) is stationary of order zero $\sim I(0)$ (Gunasinghe, 2005, 2006). But economic growth (GGDP) is stationary of order zero $\sim I(0)$.

Therefore, it is possible to conclude that one cannot use the co-integration technique to estimate any long term relation between inflation and economic growth. This is due to two reasons. First, inflation (INFR) follows an $I(1)$ process while economic growth (GGDP) follows an $I(0)$ time path and hence they are not in the same order. Second, co-integration deals only with non-stationary variables, which may be either $I(1)$ or $I(2)$. Co-integration means the stationarity of linear combination(s) of non-stationary variables (Gunasinghe, 2006).

4. Econometric model

According to the results of the unit root test in section 3, it is clear that we cannot employ cointegration to model the long term relationship between inflation and economic growth.

Following is the simple econometric model of the relationship between inflation and economic growth.

$$GGDP_t = \beta_0 + \beta_1 INF_t + \varepsilon_t \dots\dots\dots (v)$$

GGDP_t = Growth of Real Gross Domestic Product (1996 = 100)

INF_t = First difference of inflation (1996 = 100)

β_0, β_1 are parameters to be estimated and the sign of the β_1 depends on the practicability of the arguments raised in section 1. The term ε_t represents the unpredicted or unexplained variation in the dependent variable (GGDP_t). The error term is conventionally assumed to have expected value ($E(\varepsilon_t) = 0$) equal to zero, as a nonzero expected value could be absorbed into β_0 . In addition to the variable INF, a variable called VOLINF (volatility of inflation) is added to the above simple model to measure how strongly volatility of inflation can affect economic growth. To take into account the effect of the economic change in 1977, a policy dummy (Dpo) is also introduced.

That is: Dpo = 1 for values ≥ 1978
 0 for values ≤ 1977

Furthermore, to examine whether there is a turning point (a threshold level) of influence from inflation to economic growth, a dummy variable with 1 for the values over 5% and zero for the values below 5% of inflation rate is introduced (D_{TP}). Therefore, we use the following estimation methods to model the hypothetical relationship given above (v).

- 4.1. Correlation Analysis
- 4.2. Simple Ordinary Least Square (OLS) Estimation
- 4.3. Granger Causality Test
- 4.4. Generalized Impulse Response Functions

4.1 Correlation Analysis

Correlation(r) measures how strongly a pair of variables (i.e. $X = INF$, $Y = GGDP$) is related. The formula is as follows.

$$r_{x,y} = \frac{\text{cov}(X, Y)}{\sigma_x \sigma_y} = \frac{E((X - \mu_x)(Y - \mu_y))}{\sigma_x \sigma_y} \dots\dots\dots (vi)$$

4.3 Granger Causality Test

Correlation does not necessarily imply causation in any meaningful sense. Granger Causality Test is used to measure whether INF causes GGDP or whether there is a reverse causation running from GGDP to INF. By doing so, we can examine how much of the current GGDP can be explained by past values of GGDP and then to see whether adding lagged values of INF can improve the explanation. GGDP is said to be Granger-caused by INF if INF helps in the prediction of GGDP, or equivalently if the coefficients on the lagged INF's are statistically significant. Our attention is focused to test a two-way causation as well; that is as frequently the case; INF can Granger cause GGDP and GGDP can Granger cause INF.

4.4 Generalized Impulse Response Functions

First, we estimate a vector autoregressive model (VAR). This model is used for estimating a system of interrelated stationary time series (here GGDP and INF) and for analyzing the dynamic impact of random disturbances ($\epsilon_{1t}, \epsilon_{2t}$) on the system of variables. A VAR (2) model for GDP growth and inflation is given below.

$$Z_t = A_0 + A_1 Z_{t-1} + A_2 Z_{t-2} + u_t \dots\dots\dots (vii)$$

Here $Z = (GGDP, INF)'$ and u_t is a 2x1 residual vector. $A_i = 1,2,3$ are of 2x1, 2x2, and 2x2 coefficient matrices to be estimated respectively. Following equations are obtained by expanding the system.

$$\left. \begin{aligned} GGDP_t &= a_{10} + a_{12} GGDP_{t-1} + a_{13} GGDP_{t-2} + a_{14} INF_{t-1} + a_{15} INF_{t-2} + \epsilon_{1t} \\ INF_t &= a_{20} + a_{22} GGDP_{t-1} + a_{23} GGDP_{t-2} + a_{24} INF_{t-1} + a_{25} INF_{t-2} + \epsilon_{2t} \end{aligned} \right\} \dots\dots\dots (viii)$$

Then, based on this VAR (2) model, generalized impulse response functions are estimated.

GIRFs ($\psi_{\Delta z}^g(n)$), measure the time profile of the effect of a shock at a given point in time on the future values of variables in a dynamic system (Pesaran and Shin, 1998). Here it is intended to estimate the effects on economic growth as a result of one standard error (SE) shock in inflation (Gunasinghe 2005). It further means that if inflation is suddenly changed by some extent that equals to one S.E change, it may lead to generate some affects on GDP growth.

$$\psi_z^s(n) = 6^{-\frac{1}{2}} B_n \Sigma e_j \dots\dots\dots (ix) n = 0, 1, 2, \dots, 10 \text{ (years)}$$

Σ is a 2x2 variance covariance matrix of residual disturbances ($\epsilon_{1t}, \epsilon_{2t}$). B_n is a moving average matrix of “n” time horizons and it will be calculated recursively using VAR coefficients. $6^{-\frac{1}{2}}$ is a weighting index used to overcome an orthogonalized problem. And e_j is a 2x1 matrix in which number “1” is used for the second equation in VAR(2) model to give an one standard error shock and zero for the other (Pesaran, Shin-1998). The objective of the use of GIRFs is to confirm the pattern of volatility transmissions across inflation and economic growth as empirical studies are still ambiguous about the fact that price stability brings output losses in the short-run.

5. Empirical results

Table 5.1 Results of the correlation analysis

	GGDP	INF	VOLINF
GGDP	1		
INF	-.16247	1	
VOLINF	.056835	-.62592	1

According to the results shown in Table 5.1 above, it is clear that the relationship between inflation and economic growth is negative. But low correlation value suggests a poor relationship. However, the relationship between inflation uncertainty (VOLINF) and economic growth is positive with a very poor strength. Negative correlation values, even though they were considerably low, provide information in fewer of the arguments raised by monetarists. That is inflation is harmful to economic growth; when inflation grows up, growth of GDP declines. However, correlation results do not provide any information about the direction of causality; whether causality runs from INF to GGDP or GGDP to INF.

Table 5.2 Results of the Simple Ordinary Least Square (OLS) estimation

Dependent Variable	Explanatory Variable(s)					
	Constant	INF	VOLINF	Dpol	R ²	DW
1. DDGP	.044263 Pro[.000]	-.054291 Pro[.292]	-	-	.027	1.73
2. DDGP	.044957 Pro [.000]	-.069716 Pro [.296]	-.9340E-3 Pro [.710]	-	.029	1.71
3. DDGP	.041900 Pro [.000]	-.051231 Pro [.326]	-	.0037 Pro [.537]	.035	1.75
4. DDGP	.042582 Pro [.000]	-.062307 Pro [.364]	-.6553E-3 Pro [.800]	.0033955 Pro [.582]	.037	1.73

According to the results of Table 5.2, it is very clear that inflation negatively relates to the growth of GDP. That is, on the average, when the rate of inflation (first difference of inflation) goes up by one percent, growth of GDP seems to decline by .06 percent. But,

interestingly, each estimate related to rate of inflation in all equations is not significant at any significant levels (probability values are greater than any of the significant values; .01, .05, and .10). It means that inflation is not a meaningful variable in explaining the movements of Sri Lankan economic growth although it bears a theoretically expected sign. This is further confirmed by inspecting the very poor R^2 (coefficient of determination) values for all equations. On the whole, a less than 4% percent variation in economic growth is explained by inflation in each equation.

Volatility of inflation is negatively related to the GDP growth. But, it is also not an important variable to explain the movements of GDP growth in Sri Lanka. Policy dummy (Dpol) used to capture the effects of economic change in 1977 shows that the said economic change has not affected the relationship between inflation and economic growth. Also, D_{TPs} used in each equation (not shown here) to examine whether there is a turning point of influence from inflation to economic growth are statistically insignificant at any of the significant levels.

A very interesting feature of this model is that constant terms in all equations are very highly significant. It means that nonzero expected values of the error term are absorbed by constant term, β_0 . In all equations, value of the constant term is very similar to the average growth of GDP. It means that the variables we are concerned about are not adequate to explain the growth of GDP in Sri Lanka and other factors are to be taken into account. Even though we observed evidence supporting the monetarists' argument that inflation is negatively related to economic growth, our final decision, as it has been usually found, is inconclusive as results show a statistically insignificant relationship between them.

Table 5.3 Results of Granger Causality Test

Pairwise Granger Causality Tests			
Null Hypothesis:	Obs	F-Statistic	Probability
GGDP does not Granger cause INF	42	3.17363	0.05345
INF does not Granger cause GGDP		0.38046	0.68619

Results shown in Table 5.3 reveal that the causation runs from economic growth to inflation rather than from inflation to economic growth as expected from the economic theory. However, the null hypothesis that economic growth does not Granger cause inflation is significant only at the 10% level. When further lags are added, no evidence is reported of any form of causation. However, this reverse causation gives emphasis to the monetary authority to achieve a higher economic growth, which in turn can influence the rate of inflation. As the Granger Causality Test does not provide us information on whether the direction of causality is positive or negative, this issue is further discussed in the next section.

Results of Generalized Impulse Response Functions

Figure 5.1 shows a unit shock to the inflation equation where the size of the shock is scaled so as to ensure that inflation increases by one standard deviation on impact. It clearly indicates that there is a marginal negative influence from inflation to economic growth. When future inflation goes down (up) as a result of the given shock (i.e. oil price shock), economic growth seems to increase (decline). But the process of volatility transmission (from inflation to economic growth) occurs very slowly. Therefore, the pattern of volatility transmissions across inflation and economic growth does marginally provide evidence supporting the hypothesis that increases in inflation brings output losses in the short run.

On the contrary, a one standard error shock given on the GDP equation (Figure 5.2) generates significant influences on inflation within first 5-6 years. When future economic growth goes up (down) as a result of the given shock on economic growth (i.e. a monetary policy change in favor of production process), inflation seems to decline considerably (increase). Overall, it is possible to say that the monetary policy should be adjusted so as to ensure the economic growth and then it will be more helpful for the monetary authority to control inflation in the economy.

6. Concluding remarks

This paper examined two policy views in economic literature on the relationship between inflation and economic growth. Monetary policy practitioners are of the view that inflation is detrimental to economic growth while structuralists believe that moderate inflation can contribute to economic growth. To examine this controversial issue for Sri Lanka, the current study used the following variety of econometric techniques for a sample consisting of 45 observations from 1960 to 2005; namely, a correlation analysis, OLS estimation, Granger Causality Test (GCT), and Generalized Impulse Response Functions (GIRFs). Also, much of the paper was devoted to analysing time series properties of data as they are, according to the author's understanding, crucial for the relationship between inflation and economic growth. This was carried out using autocorrelation functions and ADF test. A Granger Causality Test was used to confirm whether the direction of causality runs from inflation to economic growth. GIRA was used to assess the pattern of volatility transmissions across inflation and economic growth as empirical studies are still ambiguous about the fact that price stability brings output losses in the short run.

All the tests focused on analysing properties of time series data confirmed that inflation follows a unit root process $I(1)$ while real economic growth follows a stationary time path $I(0)$. Therefore, we used the rate of inflation and economic growth for all our analysis. The result of correlation analysis shows that there is a poor negative relationship between inflation and economic growth. Results of OLS estimation support the hypothesis that inflation negatively affects economic growth. But, as none of these relationships is statistically significant at 01%, 05% or 10% levels, it is possible to say that inflation is not a meaningful variable in explaining the movements of economic growth in Sri Lanka. The result of the Granger Causality Test reveals that the causation runs from economic growth to inflation rather than from inflation to economic growth as expected from the economic theory. However, this reverse causation gives emphasis to the monetary authority to achieve a higher continuous economic growth, which in turn can influence to reduce the rate of inflation in the economy. Interestingly, this issue is further confirmed by the results of GIRFs. Overall, it is possible to say that the monetary policy should be adjusted so as to ensure a considerable continuous economic growth and then it will be more helpful for the monetary authority to control inflation in the economy.

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Figure 5.1 Generalized Impulse Responses to one SE shock in the equation for INF (Rate of inflation)

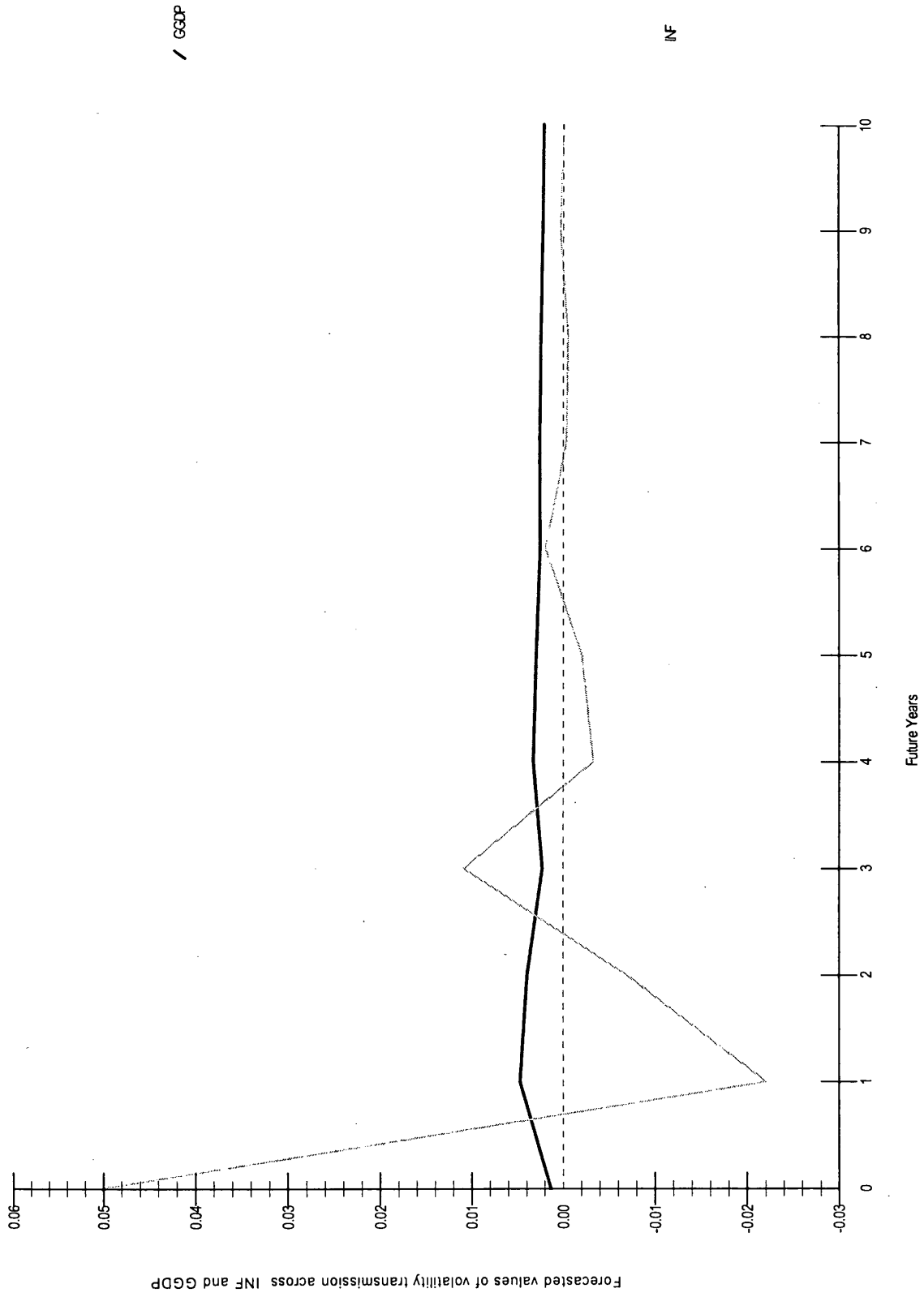


Figure 5.2 Generalized Impulse Responses to one SE shock in the equation for GGDG (Growth of GDP)

