Causal Ordering Between Inflation and Productivity of Labor and Capital: An Empirical Approach for Pakistan

Hussain, Karrar

Kennedy School of Government-Harvard University

6 August 2009

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Karrar Hussain

Kennedy School of Government - Harvard University

Abstract: This study attempts to analyze the causal relationship between inflation and productivity of labor and capital, in Pakistan's economy by covering the period from 1960-M1 to 2007-M12. For this purpose Vector Autoregression (VAR) approach is used, which is based on error correction model (ECM). Using this approach we have showed the causal ordering between inflation and exchange rate management policy controlling for, monetary variables like broad money (M-2) and discount rate, which are endogenous in case of Pakistan. We considered the relationship of inflation with two measures of productivity (average and marginal productivity) of labor and capital controlling for capital labor ratio. The objective of this paper is to identify the relative importance of each of these inflation channels by generating Impulse Response Functions (IRFs) to confirm the response of a shock on a variable upon itself and other variables over the four years of time span. Our study concludes that there is a unidirectional causality from inflation to labor productivity through capital labor ratio. And also, there is bidirectional causality between inflation and capital productivity through capital labor ratio. And lastly each channel takes almost fifteen months (on average) for input productivities to affect or affected by inflation.

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1. Introduction

This paper attempts to estimate the association or impact of inflation on Pakistan's key economic activities i.e. input productivities. Input productivities are concerned with relationships between real output and inputs. In a broader sense when it comes to the understanding of input productivities like labor and capital it covers the whole range of issues from labor to capital markets and everything in between them. In this regard economists argue that there are only two paths by which an economy may increase its level of economic growth: either through more capital accumulation and labor effort applied in the production process (specifically, more jobs) or through an increase in the productivities of inputs i.e. labor force and capital. Capital productivity usually depends on the financial market conditions, process of information dissemination in the financial market, financial depth of economy, expectation formation mechanism and foreign exchange market along with sound money. While labor force and its productivity depend on labor market conditions and human capital market (health and education markets) due to its forward and back ward linkages and externalities associated in this process. In sum, as said by Krugman "Productivity is not everything, but in the long run it is almost everything."[1]

We start by testing for the causality among key macroeconomic variables like inflation, exchange rate and monetary policy instruments i.e. broad money (M2) and discount rate by employing the vector Autoregression (VARs) model based on Error Correction Approach. The objective is to identify the channels through which monetary policy (including broad money, discount rate and exchange rate due to fixed exchange rate policy in Pakistan) shocks play an important role in Pakistan economic fluctuations. Although, there are four main channels through which monetary policy simultaneously affects output and input productivities, in case of Pakistan; namely the interest rate channel, asset price channel, credit channel and exchange rate channel[2]. In this paper we unfold the impact of three of these channels i.e. endogenous credit channel (M2) and interest rate channel, along with exchange rate channel which is exogenous in case of Pakistan.

Before proceeding further, it is pertinent to mention how each of above-mentioned channels affects inflation, output and input productivities in a country. Identifying the individual importance of these channels helps us in checking whether predictions of different theories regarding monetary policy are consistent with the empirical evidence.

The exchange rate affects both output and prices through demand and supply side channels. A devaluation of domestic currency increases the price of foreign goods relative to domestic goods. Due to increased import prices and production costs, shifting spending from foreign to domestic goods increases thus causing increase in prices and aggregate demand. On the other hand, a devaluation of currency lowers export prices. This causes the net exports to decrease leading to a fall in real income in the economy. Thus the combined effects that occur through the demand and supply channels determine the net results of exchange rate fluctuations on real output and price[3].

The credit channel works through two separate mechanisms. Firstly, in case of a contractionary monetary policy the volume of bank reserves reduces resulting in a decline in bank loans. This leads to a decrease in aggregate spending since

[1] Mahmud (2006)

[2] Agha, Ahmed, Mubarik & Shah (2005)

[3] Kandil & Mirzaie (2000)

significant number of firms and households rely on bank financing. Secondly, money supply changes can also influence output by inducing changes in interest rate i.e. an increase in interest rate due to a fall in money supply reduces the value of assets i.e. stocks and bond. This leads to shrinkage in the household resources thereby decreasing consumption levels and thus output[4].

In case of the interest rate channel, an increase in nominal interest rate translates into an increase in real rate of interest and user cost of capital in the short run. This leads to changes in savings and investment decisions of household and firms i.e. it is less attractive to take out loans for financing consumption or investment. Thus interest rate increase causes borrowing and spending levels to decline thereby leading to decrease in aggregate demand and thus the output level[5].

After carrying out Granger causality and VECM tests we conclude that incase of Pakistan economy, exchange rate management policy is the most important monetary policy transmission channel through which inflation is propagated not only in the short run but also in the long run and there is long run stable relationship between exchange rate and inflation.

Lastly, after establishing the relationship between inflation and monetary policy we then carry out causality and VECM test for the input productivities and inflation controlling for capital labor ratio and exchange rate. This paper also looks at the different types of productivities like marginal and average productivities along with total factor productivity assuming a Cobb Douglas production function.

The rest of the paper is organized as follows: Section 2 gives detailed literature existent on this research area for United States and other economies. Section 3 outlines the data sources and the methodology used to establish causal links between the variables. Section 4 highlights the main findings in case of each of the inflationary channel on input productivities discussed and Section 5 concludes the paper with policy recommendations for the future.

2. Literature review

To enhance the competitiveness of nations, it is significant to understand the relationship between capital and labor productivity growth and inflation. Many studies done on this matter suggest that, it is imperative to judge whether there is an indirect or a direct causation running from productivity to inflation, or inflation to productivity.

During the period 1953(I)-1982(IV), the United States faced high inflation rates and low productivity which raised concern to understand the linkage between the inflation and productivity. The paper "Causal ordering across inflation and productivity growth in the post-war United States" Ram came to investigate the pattern of Granger-causal ordering between inflation and productivity change in the post-war United States.[6] His study concludes that causal impact of productivity change on inflation is insignificant while the depressive impact of inflation on productivity growth is substantial. The reason for this phenomenon as explained by him is that, impact of inflation on productivity operates through a reduction in output growth, which probably occurs fairly rapidly, and very little through an acceleration of the growth of man-hours. Other than USA, the study focuses on the following evidences and methods provided by other:

[4] Agha, Ahmed, Mubarik & Shah (2005)-SBP working paper series

[5] "Transmission Mechanism", n.d.

[6] Rati Ram (1984)

first, Guilky and Salami (1982) and Geweke, Meese and Dent (1983) on bivariate causality tests. Second, two other measures derived from the consumer price index and GNP deflator. Third, Kendrick and Grossman (1980) publication on total factor productivity indices and BLS index of output per hour. Moreover, the study used similar analysis done recently such as Jarrett and Selody (1982).

When investigating the causal ordering between inflation and productivity, many recent influential points have been considered. According to Boskin, Gertler and Taylor (1980, pp.17-36) who had determined that several factors that have impact on inflation and productivity and these are: incentive to work, saving, accumulation of financial assets, investment and business operations, income tax, competitiveness and trade. Others have also determined influential points, Freund and Manchester (1980, pp. 66-99) stated that increasing in uncertainty could have a negative impact on business investment plans.

Due to many economic changes in the US and Canada, several studies have been conducted to identify the correlation between price inflation and productivity growth. Many argued that price inflation has adverse impact on investment and as a result causes economic inefficiencies. Similar to other papers, the paper by Peter Jarret and Jack G. examined the linkage between inflation and productivity by testing the hypothesis of that increasing in productivity growth is a one-for-one reduction in inflation, against the alternative hypothesis that it is more than one-for-one as a result of feedback relationship which is a reverse causal relationship. To better explore such a relationship, the paper explores different approaches. The bivariate reduced form approach which relies on methodologies done by Granger (1969) and Sims (1972) is useful as noted above because it provides different points of influence[7]. The Trivariate reduced form approach uses the innovation accounting framework of Sims (1978, 1980) which analyses regression of different variables and then through simulation analysis it transforms the model to changing average representation.

According to them there are number of ways through which inflation may affect productivity. First, inflation may affect the desire or ability of labor to do productive work (Leijonhufvud, 1977). Second, inflation may affect labor productivity by causing an inefficient mix of factor inputs. Inefficiencies also result because inflation lowers the information content of price signals, thus decreasing the reliability of absolute price movements to reflect relative price changes accurately.[8] Even in a period of steady inflation the information content of price changes is reduced. With less information on which to base their decisions, business managers will make more errors and hence will more often choose suboptimal factor input mixes and suboptimal types of capital. Moreover, there is an increased expenditure of time and resources on search activities and "protective outlays" (Jaffee and Kleiman, 1977), that is, efforts to get out of nominal and into real assets. In addition, inflation shortens optimal contract length and planning horizons, thereby increasing contracting costs (Hayes and Abernathy, 1980). Third, increasing uncertainty about inflation can decrease productivity by inducing firms to increase their inventories of "unproductive" buffer stocks and

[7] Jerrat and Selody (1982)
[8] Higher levels of inflation tend to be associated with higher variance of inflation and of relative prices. See Okun (1971), Gordon (1971), Klein (1976), Vining and Elwertowski (1976), Jaffee and Kleiman (1977), Parks (1978), Foster (1978) and Gale (1981).

to reduce their expenditures on long-term basic research (Mansfield, 1980, p. 871). Finally, because of non-neutral tax laws, inflation reduces after-tax profits, and this in turn causes a reduction in business capital accumulation, so vital in the determination of labor productivity growth (Pesando, 1980; Belanger and Mcllveen, 1980).

While the above papers focused on US and Canada, Dritsakis attempts to analyze the linkage between inflation and productivity growth for Romania. VAR along with VECM models have been used in this paper to test the causal relationship between the price level and the productivity of Romania[9]. In this study he finds that, the price level and productivity cause the gross domestic product, while there is a bilateral causal relationship between gross domestic product and interest rate. Finally, there is a dynamic causal relationship between the gross domestic product and the productivity, but also between the interest rate and the productivity for the examined period.

George A. Akerlof and Janet Yellen (1986) in their seminal book "*Efficiency Wage Models of the Labor Market*"[10] have also discovered the relationship between labor productivity and real wages. According to them labor productivity depends on the real wage, paid by the firm. Workers while deciding how much effort to put in the work or production, definitely take into the inflationary movements of the economy overall, therefore, resulting in an association of these two important variables.

3. Data Sources and Methodology

The dataset used for the analysis is largely extracted from the IMF dataset (IFS) compiled by the United Nations Statistical Database and World Development Indicators (WDI). It covers a period of 48 years from 1960-2007. The variables used are as follows:

- Total labor employed
- Gross fixed capital formation
- Monetary aggregates (M-2)
- Real GDP
- Exchange Rate (Rupees/ $ US)
- Money market discount rate
- Inflation i.e. change in Consumer Price Index (CPI)

In order to generate the series for Real GDP at 2000 base year, we used the GDP deflator[11]. This is done by using the data series for GDP at current prices, factor cost and GDP at constant prices, factor cost and then dividing the original GDP series with the GDP deflator of the year 2000. The data for CPI has also been converted to the same base year[12].

To increase the number of observations and to fully ascertain the impact of aggregate demand policy shocks on variables during the year, we have converted the yearly data in time series into monthly data. The methodology used is as follows:

3.1. Procedure to convert yearly data into monthly data

We follow the Denton's (1971) method of obtaining monthly data for a given year by using both annual and quarterly values for that year by using the least square approach[13]. Denton computes the proportional Denton method of interpolation of an annual flow time series by use of an associated "indicator series", imposing the constraints that the interpolated series obeys the annual totals. The method is described in IMF Chapter 6, Benchmarking (2001) as "relatively

[9] Dritsakis (2003)
[10] Akerlof and Yellen (1986)

[11] GDP Deflator = [Nominal GDP / Real GDP]*100
[12] Year 2006 figures for money and GDP have been obtained from Economic Survey whereas that for inflation has been taken from the Adjusted values by the Ministry of Economy UAE.
[13] Bloem, dippelsman and Maehle (IMF-2001)

simple, robust, and well-suited for large-scale applications." It may be particularly useful in cases where, due to sizable statistical discrepancy, quarterly series do not integrate to annual totals which we can expect in case of Pakistan. The indicator series only contribute their pattern to the interpolation; thus it is quite feasible to use both quarterly and annual flow series expressed at an annual rate. The interpolated series will be at a quarterly rate. Although the procedure is usually applied to flow series (such as GDP), it may be applied to stock series if they are differenced and then integrated via generate sum (), after adding their initial value[14].

Following the same methodology, all series in the paper have been converted to monthly estimates before we proceed to the regression analysis[15].

3.2. Methodology:

Before applying the time series regression equations we take first differences of the log forms of all series and apply the unit root test on all of them i.e. Dickey Fuller test. T-statistic with a value less than that at 5% level confirms that the series is stationary. For the purpose of simple time series regression equations all the level form series were made stationary using the Phillips-Perron unit root test[16].

3.2.1. Estimation of Marginal Product

In economics, when it comes to the analysis of output, in terms of marginal products of a set of inputs used in the production process, a functional form is the first necessary step. Production functions can be applied to a single firm, an industry, or an entire nation. Note, however, that they are limited to producing a single output, so that joint production is disallowed, although multiple inputs are used. The simplest production function used frequently in economics is a Cobb-Douglas production function.[17] In case of multi- input this production function takes on the form:

$$Y = e^{B'z} = e^{b_1}\prod_{i=2}^{p} x_i^{bi} \qquad (1)$$

where Y is a measure of output

$z' = (1, z_2, z_3, \ldots., z_p)$

is a row vector of the natural logarithms of measures of input, x_i $(i = 1,2,3, \ldots, p)$ with $x_1 = e$ the base of napierian logarithms, and

$B' = (b_1, b_2, \ldots., b_p)$

is a p-dimensional row vector of coefficients, the elements of which are usually known as elasticity parameters. A prime indicates the transposition of a column vector. The first differential coefficient of (1) with respect to x_i,

$$\frac{\partial y}{\partial x_i} = M_i(z) = x_i^{-1} b_i e^{B'z} \qquad (2)$$

is defined as the marginal product of input "***i***" at the values of the inputs determining z. In this section we examine the usual estimator of $M_i(z)$, obtained by replacing population parameters in (2) with the corresponding sample values.

Econometrically, for two inputs case i.e. Labor (L) and Capital (K), equation (1) can be estimated by the following equation:

$$y = A' + B_1 l + B_2 k + u \qquad (3)$$

In the above regression function, y is natural log of output, "***l***" is natural log of labor employed, $\boldsymbol{A'}$ is natural log of total factor productivity and "***k***" is the natural log of amount of capital in the production process whereas "*u*" is the log of all the residual error term in the regression function. The assumption is

[14] Baum (2001)
[15] All variables are taken in log form unless otherwise specified. Also all regressions are carried out in Stata 9.1 using inbuilt commands for all tests of stationarity, cointegration, and VAR and Granger causality.
[16] This is because Phillips-Perron test cannot be applied to log form so we used Dickey Fuller test for the log form series.
[17] El-Moaty and El-Shawadfy

usually made that the *"u"* are independent error variables with equal variances. Consequently, standard multiple regression theory yields the least-squares estimators of $B_1 \; and \; B_2$ in the form of the customary partial regression coefficients $b_1 and \; b_2$ computed from the data.

Finally, the marginal product of labor and capital is estimated by[18]

$\frac{\partial y}{\partial x} = ab_j x_j^{b_{j-1}} \prod_{k \neq j} x_k^{b_k} = b_1 \bar{y} / L$ (4) If x_j is labor $\bar{y}$, is the estimated output of overall economy, which is the function of capital and labor employed. And "$\boldsymbol{L}$" is the total labor employed in the production process.

3.2.2. Estimation of Total Factor Productivity

The part of the output, which is not explained by the amount of inputs used in the production process, is called total factor productivity (TFP). In other words, it determines, by how efficiently and intensely the inputs are used or utilized in the production. TFP is usually measured by the Solow residual. Assuming a two input Cobb Douglas Production function (Neo-Classical production function) along with the assumption of perfect competition Solow residual can accurately measure the TFP in equation (3) of the above section. In this paper, following this methodology, we estimated the TFP for Pakistan economy from 1960-M1 to 2007-M12 by simply taking antilog of estimated parameter $\boldsymbol{A'}$.

3.2.3. Different Specifications for Vector Autoregression Approach (VAR)

Our basic VAR model in a bivariate system can be specified as follows:

$$\begin{bmatrix} x_t \\ y_t \end{bmatrix} = A\ (L) \begin{bmatrix} y_{t-1} \\ x_{t-1} \end{bmatrix} + \begin{bmatrix} u_{yt} \\ u_{xt} \end{bmatrix}$$

Where x_t represents average or marginal productivity of capital or labor estimates and y_t is inflation. *A (L)* is a 2 × 2 matrix polynomial in the lag operator L and u_{it} is a time t serially independent innovation to the ith variable. These innovations can either be independently distributed shocks to x_t, y_t or to policy.[19] Our procedure involves taking one policy instrument at a time and running the VAR with x_t[20].

3.2.4. Determination of Lags

Models estimating causal links between variables are very sensitive to the number of lags involved i.e. how many past values should enter the equation. We use Schwarz's Bayesian Information Criterion (SBIC) in order to estimate our autoregressive model (ARMA)[21]. Mostly, the model with the smallest SBIC value is chosen. This method is preferred over AIC although both give the likelihood value based on goodness of fit and the number of parameters used to obtain that fit (assuming constant is included in the model)[22]. However, SBIC is favored since it has the property of selecting the true model as T → infinity, provided that the true model is in the class of ARMA models for small values of free parameters[23].

3.2.5. Checking Co-integration of Series

Once we determine the optimal number of lags used for each of the variables in a particular regression, we need to ensure that the series are not co-integrated so that the VAR is stable. If two or more series are co-integrated, in intuitive terms this implies that they have a long run equilibrium relationship that they

[18] Carter and Hartely (1958)

[19] Walsh (2003)

[20] Same numbers of lags are used for each set of the two variables x_t and y_t.

[21] The two famous methods used to determining the optimal number of lags are Akaike's Information Criterion (AIC) and SBIC.

[22] Verbeek (1997)

[23] Hannan (1980)

may deviate from in the short run, but which will always be returned to in the long run[24].

We use Johansen's test for co-integration and this method is preferred mainly because it is able to detect more than one co-integrating relationship as opposed to Engle-Granger approach. Also since the Johansen method relies on the relationship between the rank of the matrix and its characteristic roots it is more suited for a multivariate system[25].

3.2.5. Vector Error Correction Models (VECM) and Granger Causality

If co-integration has been detected between series we know that there exists a long-term equilibrium relationship between them so we apply Vector Error Correction Model (VECM) in order to evaluate the short run properties of the co-integrated series. In case of no co-integration VECM is no longer required and we directly proceed to short run Granger causality tests to establish causal links between variables. The regression equation form for VECM is as follows:

$$\Delta Y_t = \alpha_1 + p_1 e_{t-1} + \sum_{i=0}^{n} \beta_i \Delta Y_{t-i} + \sum_{i=0}^{n} \delta_i \Delta X_{t-i}$$

$$\Delta X_t = \alpha_2 + p_2 e_{t-1} + \sum_{i=0}^{n} \beta_i \Delta Y_{t-i} + \sum_{i=0}^{n} \delta_i \Delta X_{t-i}$$

In VECM the co-integration rank shows the number of co-integrating vectors. For instance a rank of two indicates that two linearly independent combinations of the non-stationary variables will be stationary. A negative and significant coefficient of the ECM (i.e. e_{t-1} in the above equations) indicates that any short-term fluctuations between the independent variables and the dependant variable will give rise to a stable long run relationship between the variables.

In case the coefficient does not fulfill the property of being negative and significant; we conclude that no stable long run relationship exists between the variables. Moreover, the magnitude of the error term coefficient indicates the speed of adjustment with which the variables converge overtime.

In order to evaluate the short-term behavior between the two series we look at the coefficients of the lagged terms of ΔY_t and ΔX_t. For instance if the lagged coefficients of ΔX_t turn out to be significant in the regression of ΔY_t then X causes Y[26].Omitting the error correction term from the above two equations gives us the Granger causality equations[27], required to investigate the causal links in case of no co-integration among series.

To avoid spurious statistical inferences, the VAR models are usually estimated in first difference form if the data series are non-stationary in the level form. Shocks to the differenced variables will have a temporary effect on the growth rate but a permanent effect on its level. Estimation of a VAR model with stationary variables is consistent regardless whether the time series are co-integrated or not. If, however, the series are integrated of order one, I(1), and co-integrated, then we need to include additional information gained from the long-run relationship to get efficient estimates. This requires the inclusion of a vector of co-integrating residuals in the VAR with differenced variables. This is known as a vector error correction model (VECM).

3.2.6. Impulse Response Functions (IRFs)

In our analysis we apply a one-percent (since all variables are in natural log form) shock to the policy

[24] Verbeek (1997)
[25] Verbeek (1997).
[26] Hussain and Abbas
[27] A variable *x* is said to Granger cause a variable *y* if, given the past values of *x* and *y* are useful for predicting *y*.

tool of interest all of them are related to aggregate demand management policy channels like broad money and discount rate of the economy and estimate the Impulse Response Functions over a period of 48 months in other words 4 years of time span on the inflation and average productivity of capital and labor. Results are presented in last section of this paper along with other important graphs.

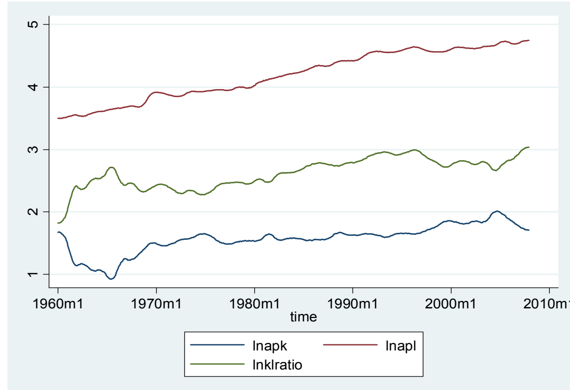
4. Results

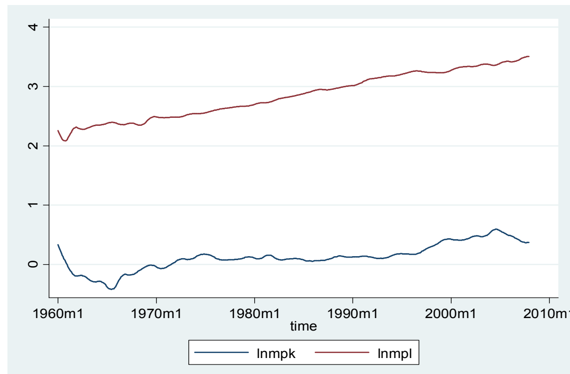
4.1. Summary Statistics

Before starting with Vector Autoregression results it will be helpful to look at the simple statistics of important variables along with average productivity of labor and capital which are as follows:

Variable	Mean	Std. Dev.
Average Product of Labor (lnapl)	4.193508	0.3903771
Average Product of Capital (lnapk)	1.569693	0.224977
Marginal Product of Labor (lnmpl)	2.84611	0.386596
Marginal Product of Capital (lnmpk)	0.120599	0.21835
Total Factor Productivity (lntfp)	34.35273	1.05972
Capital Labor Ratio (lnklratio)	2.623814	0.240423

The table above suggests that monthly average product of labor is almost twice as large as average product of capital, on the average, over the period from 1960-M1 to 2007-M12. Similarly the same is also true for marginal products of these two important inputs on monthly basis. Compared to average product of labor, average product of capital has small standard deviation suggesting that labor productivity is more fluctuating on the average. Average monthly, capital labor ratio is almost the same as average marginal product of capital, but the two series almost behave differently with respect to each other over this time period. For more details about the behavior of these variables over time, the following graphs are presented.





4.2. Bivariate Analysis of inflation and Exchange Rate

Bivariate analysis and causality between inflation and exchange rate (Rupee/$US) are presented in Table 1 in the form of VECM table[28], since the two series are co-integrated of order one.

[Table 1 about here]

The VECM approach not only enables us to determine the direction of causality among the variables, but it also allows us to distinguish between the two types of Granger causality[29]: short run and long run causality. The long run causality from

[28] *indicates significant at 5% level

[29] Granger causality is a technique to determine whether one time series variable is useful in forecasting or predicting the other time series variable or not. In statistical terms if one variable let's call it "*a*" has an explanatory power to predict the other variable "*b*" then if this test supports this notion (probability that the variable or its lagged terms are statistically significant) then we can say that "*a*" Granger causes "*b*". If both "*a*" and "*b*" are driven by a common third process with different lags, their measure of Granger causality could still be statistically significant

independent variables to the dependent variable is evaluated by testing the null hypothesis that the coefficient (**CointEq L1**) of the error correction term (EC_{t-1}) is zero. Short run causality from an independent variable to the dependent variable is evaluated by testing the null hypothesis that each coefficient (β_i) on the independent variable is zero. By rejecting either of the two hypotheses, we conclude that independent variables Granger cause the dependent variable.

Result presented in the table 1, indicates the presence of long-run causality from exchange rate to inflation in bivariate system. This relationship is stable since the (**CointEq L1**) vector is negative and statistically significant. The negative coefficient on this vector indicates that inflation adjusts accordingly in face of any exogenous shock in exchange rate. Lastly, from co-integration relation in table 1 it seems that inflation and exchange rate are related negatively but, the coefficient is statistically insignificant. However, there is only short-run causality from exchange rate to (imported) inflation because the 12^{th}, 13^{th}, 16^{th} and 17^{th} lags are significant statistically. In short, we can say that exchange rate does Granger cause inflation both in the short run and long run.

4.3. Trivariate Analysis of inflation

After establishing the relationship between inflation and exchange rate in bivariate framework, in order to understand the inflationary channels in depth, this paper has also considered other important monetary policy variables in trivariate framework. In this regards, we have considered two other channels i.e. broad money M-2 and discount rate (because currently State Bank of Pakistan operates monetary policy through this variable). After controlling for the broad money M-2 the results are presented in table 2:

[Table 2 about here]

The table suggests that after controlling for broad money (M-2) the relationship between inflation and exchange rate remains statistically significant not only in the short run but also in the long run. The variable (**CointEq L1**) on inflation again indicates that inflation adjusts itself in face of exogenous shocks in other two variables. The short run causal relationship indicates that, exchange rate does Granger causes broad money after controlling for the inflation, but the long run relationship is unstable.

In this framework, after controlling for the broad money M-2, there exists a short run relationship between inflation and exchange rate i.e. inflation also Granger causes exchange rate implying that there is a bidirectional causal relation between this two important variables. The equation of co-integration relation indicates that exchange rate and inflation have a negative relationship but this coefficient is again statistically insignificant.

Results from discount rate, inflation and exchange rate as a nominal anchor are presented in table 3:

[Table 3 about here]

This table also suggests that, after controlling for discount rate and its 15 lag values (computed after following the Schwarz's Bayesian Information Criterion (SBIC) methodology for optimal lag selection), the relationship between inflation and exchange rate remains statistically significant not only in the short run but also in the long run. The variable (**CointEq L1**) on inflation again indicates that inflation adjusts itself in face of exogenous shocks in other two variables. The short run causal relationship indicates that, exchange rate and its lag values do Granger cause discount rate after controlling for the inflation, but the long run relationship is unstable. Cointegration equation bear the normal expected signs for both exchange rate and discount rate, but both are statistically insignificant.

4.4. Inflation and Labor Productivity Analysis

Before we start with formal analysis it is useful to assess the relationship of these productivities with inflation and its different categories the following table is presented:

Correlation	Inflation	Capital Labor Ratio	Average product of Labor	Average Product of Capital	Marginal Product of Labor
Inflation	1				
Capital Labor Ratio	-0.1946	1			
Average product of Labor	-0.0184	0.8504	1		
Average Product of Capital	0.1742	0.4134	0.8306	1	
Marginal Product of Labor	-0.0496	0.8597	0.9903	0.8041	1
Marginal Product of Capital	0.1246	0.4289	0.8231	0.9707	0.8302
Total Factor Productivity	-0.0828	0.8965	0.9896	0.7639	0.9925

The table shows that there is a negative correlation between inflation and labor productivity measures and a positive correlation with capital productivity. And the correlation estimate between labor productivity and inflation is smaller than capital productivity suggesting that, labor market is less affected by or affects inflation (since causality has not been established yet). The negative association may be due to a number of considerations as pointed out by Boskin, Gertler and Taylor (1980, pp. 17-36) i.e. (a) incentive to work (b) saving (c) accumulation of financial assets (d) investment and business operations (e) taxation of capital assets (f) competitiveness and trade and lastly due to inefficient mix of factor inputs as mentioned by Jerrett and Selody, they described that this inefficiency results because inflation lowers the information content of price signals due to which a rational agent in economy make more error and as a result use suboptimal input mix. They also suggested that even in the period of steady inflation the information content of the price level is reduced[30].

Average Product of Labor:

We start with the simple bivariate analysis of inflation and average product of labor. The results are presented in table 4 in the VECM table.

[Table 4 about here]

The table shows that, there exists a long run relationship between inflation and average product of labor, but there is no Granger causal relation between the two variables. In this bivariate setup, inflation acts as stabilizer in the face of exogenous shock in the average product of labor.

Quadvariate vector error correction model is applied in all the cases in order to analyze the inflation and input products (average and marginal) dynamics. The selection of the other two variables besides inflation and input products was made, based on the assumption that exchange rate acts a nominal anchor, and capital labor ratio is an important determinate of input products based on Cobb Douglas production function which we also assumed to compute the marginal products of inputs.

Results for average product of labor are presented in table 5:

[Table 5 about here]

The table statistically signifies a few important results. The four series under consideration are co-integrated with rank 3. This implies that, long run relationships among all these variables can be

[30] Jerrett and Selody (1982)

explained by 3 co-integration equations. First, with regards to inflation, the long run dynamics of the system is stable i.e. inflation plays the role of stabilizer in the presence of capital labor ratio and exchange rate series but without controlling for average product of labor. This is evident from third co-integration equation of this table. In the short run, there is no Granger causality between inflation and average product of labor, i.e. both average product of labor and inflation don't have the power of prediction, to forecast each other in the short run.

Second, the long run relationships among the series are unstable with regards to exchange rate and average product of labor. And there is a unidirectional causality from exchange rate to capital labor ratio, supporting the notion that, exchange rate management policies do affect input mix not only in the long run but also in the short run.

Marginal Product of Labor:

Assuming Cobb Douglas production function for Pakistan's economy, we estimated the marginal product of labor. Bivariate analysis and causality between inflation and marginal product of labor are presented in Table 6 in the form of VECM table[31], since the two series are co-integrated of order one.

[Table 6 about here]

This time the table shows that, there is bidirectional causality between inflation and marginal product of labor in the short run. In the long run inflation as usual, acts a stabilizer in the system (in face exogenous shock in marginal product of labor) since the coefficient of (**CointEq L1**), with regards to inflation is negative and significant.

Now using marginal product of labor and its dynamics with inflation, (controlling for exchange rate and capital labor ratio) the results are presented in table 7:

[Table 7 about here]

The table statistically signifies a few important results. The under consideration four series are co-integrated of rank 1. This time because, (**CointEq L1**) the inflation coefficient is negative and statistically significant therefore, it acts as a stabilizer in the presence of marginal product of labor, exchange rate and capital labor ratio.

The table also shows that there is unidirectional causal relationship from inflation to marginal product of labor directly and also indirectly through capital labor ratio. In other words the second relationship is indirect. Also, there is direct causal relationship from exchange rate to marginal product of labor controlling for capital labor ratio and inflation. The co-integration equation also implies that inflation and marginal product of labor are associated in a negative manner which is significant statistically.

4.6. Inflation and Capital Productivity Analysis

In this paper, we also explored the effect of inflation on capital productivity assuming the fact that nominal rate of interest does not vary a lot over time, because of the fixed exchange rate regime prevailing in Pakistan's economy. So following the same methodology (as for labor productivity) we come up with the following sets of results below:

Average Product of Capital:

We start with the simple bivariate analysis of inflation and average product of capital. The results are presented in table 8 in the VECM table

[Table 8 about here]

[31] *indicates significant at 5% level

The table shows that, there exists a long run relationship between inflation and average product of capital. Importantly, there is bidirectional Granger causal relation between the two variables. In this bivariate setup, inflation acts as stabilizer in the face of exogenous shock in the average product of capital.

Quadvariate vector error correction model is also applied in this case also in order to analyze the inflation and capital productivity (both average and marginal) dynamics. Results for average product of capital are presented in table 9:

[Table 9 about here]

The table statistically signifies a few important results. The four series under consideration are co-integrated with rank 3like in average product of labor case. This implies that long run relationships among all these variables can be explained by 3 co-integration equations. First, with regards to inflation, the long run dynamics of the system is stable i.e. inflation plays the role of stabilizer in the presence of capital labor ratio and exchange rate series but not after controlling for average product of capital. This is evident from third co-integration equation of this table. In the short run, there is a definite Granger causality between inflation and average product of capital both directly and indirectly through capital labor ratio (this time this variable is inversely related to average product of capital) contrary to the results we got in the case of average product of labor. In other words both average product of capital and inflation, have the power of prediction, to forecast each other not only in the short run but also in the long run.

Second, the long run relationships among the series are unstable with regards to average product of capital only. And there is a unidirectional causality from exchange rate to capital labor ratio.

Marginal Product of Capital:

Bivariate analysis and causality between inflation and marginal product of capital are presented in Table 10 in the form of VECM table[32], since the two series are co-integrated of order one.

[Table 10 about here]

The table shows that, there is bidirectional causality between inflation and marginal product of capital in the short run. In the long run inflation as usual, acts a stabilizer in the system since the coefficient of (**CointEq L1**), with regards to inflation is negative and significant.

Now it's dynamics with inflation, controlling for exchange rate and capital labor ratio, the results are presented in table 11:

[Table 11 about here]

The under consideration four series are co-integrated of rank 1. This time again because, (**CointEq L1**) on inflation coefficient is negative and statistically significant therefore, it acts as a stabilizer in the presence of marginal product of capital, exchange rate and capital labor ratio.

The table also shows that there is unidirectional causal relationship from inflation to marginal product of capital directly and also indirectly through capital labor ratio. In other words the second relationship is indirect. Also, there is direct causal relationship from exchange rate to marginal product of capital controlling for capital labor ratio and inflation. The co-integration equation also implies that inflation and marginal product of capital are associated in a negative manner which is significant statistically.

Finally, following the Johansen Methodology, for checking the co-integration rank among the four

[32] *indicates significant at 5% level

series (total factor productivity, inflation, exchange rate and capital labor ratio), we found that, the series are not co-integrated. Co-integration tests are performed under the assumption of a linear trend in the data, and an intercept but no trend in the co-integrating equation. With maximum lags set to thirty, the optimal lag length was selected using different lag selection criteria in the unrestricted VAR model. Sequential modified likelihood ratio test, final prediction error criterion and Akaike's information criterion all selected fifteen lags in the unrestricted VAR model. Finally, the null hypothesis of one co-integrating relation among the variables (r=1) is rejected under the Johansen test. Therefore we proceed with the unrestricted VAR methodology to check the short run causality among the four series. But in this technique VAR stability conditions were given due consideration due to the absence of co-integrating factor. The results are presented in table 12:

[Table 12 about here]

The table shows that, in case of total factor productivity (TFP) there is direct causal relationship from exchange rate and capital labor ratio to TFP. And also there is an indirect causal relationship from inflation to TFP through capital labor ratio only in the short run since the long run relationship cannot be captured in this set up. Lastly, there is a reverse causality running from TFP to exchange rate in case of Pakistan, based on this data set.

5. Conclusion and Policy Recommendations

This paper is an attempt to unravel the various impact of inflation on labor and capital productivities induced by exchange rate policy not only in the short run but also in the long run for the economy of Pakistan. We have attempted to quantify the average time lag associated with inflation channel to investigate the strength of inflationary channels through which these shocks were propagated on input productivities. This paper discovered that, the estimates for both inputs (capital and labor) productivities (based on Johansen full information maximum likelihood technique) and inflation are co-integrated and move together in the long run controlling for exchange rate and capital labor ratio. The results are robust to the lag orders. For the short dynamics, we estimated the error correction models in different specifications. The following conclusions have been derived from the analysis:

First, the descriptive statistics provides the evidence regarding the linkages of output and input growth from 1960-M1 to 2007-M12. Using these series we constructed the respective input productivities. Over this period the *monthly* growth rate was .49 percent for overall output on the average. *Monthly* growth rate of labor employed was .27 percent. Lastly, capital's *monthly* growth rate for was .48 percent on the average. From these estimates it is clear that both labor and capital productivities are increasing over this period in the overall economy. It may be attributed to skill sets, labor and financial market conditions, technological intensity and lastly externalities associated with technological advancement in Pakistan's economy.

Secondly, this paper found that in Pakistan's economy, inflation is not a monetary phenomenon but it is an exchange rate phenomenon due to exchange rate regime. Empirically, this was shown using Johansen co-integration technique which confirmed this notion. Compared to broad money (M2), exchange rate takes almost two to three more months on the average, to effect the inflation while broad money takes almost fifteen months to take the effect in terms of its transmission into inflation.

Thirdly, about the labor productivity this paper found that this variable is associated negatively with inflation not only in the short run but also in the long run. The relationship is unidirectional from inflation to labor marginal product which is directly associated with firms profit maximization behavior. The result doesn't remain valid if we consider the relationship between average labor productivity and inflation. This paper found that there is no causal relation between the two series. In order to investigate the reason for this phenomenon we should considered other types of inflation in this regard like food inflation and medical inflation based on theoretical efficiency wage hypothesis[33] and human capital consideration.

This paper found that there is unidirectional causality from inflation to capital productivity, but this time also the association is negative according to our prior belief that, in case of inflation the capital productivity should or expected to go the other way because of declining real rate of return.[34]For this experiment, we have assumed that, money market interest rate does not vary much overtime. The reason for this assumption is that keeping the nominal rate of return on capital as constant we can assess the effect of inflation on capital productivity of Pakistan.

[33] George A. Akerlof (1986)
[34] Fischer Equation

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Table 1 (*indicates significant at 5% level)

Error Correction Model	D_inf_p	Std. Err.	D_lnexrate	Std. Err.
CointEq L1	-0.029500*	0.005792	0.0001068	0.010214
inf_p				
LD.	0.8793792*	0.042635	0.0339187	0.075189
L2D.	-0.008126	0.056282	-0.0474383	0.099257
L3D.	-0.394164*	0.054411	-0.006109	0.095958
L4D.	0.3670125*	0.056008	0.0214528	0.098773
L5D.	-0.0206835	0.050623	-0.0594806	0.089277
L6D.	-0.0212178	0.039597	-0.0158058	0.069832
L7D.	0.038331	0.036689	0.0029642	0.064703
L8D.	0.008546	0.036491	-0.0098637	0.064355
L9D.	0.020639	0.036013	0.0047482	0.063512
L10D.	0.0040915	0.035823	-0.0100929	0.063175
L11D.	0.0042183	0.035801	-0.0068423	0.063137
L12D.	-0.639373*	0.035796	-0.1885898	0.063129
L13D.	0.5971399*	0.045309	0.2100337	0.079905
L14D.	-0.0255694	0.050466	-0.0484892	0.089
L15D.	-0.249164*	0.047321	-0.0804271	0.083455
L16D.	0.2342367*	0.046056	0.0992569	0.081224
L17D.	-0.0322577	0.033914	-0.0568913	0.059809
lnexrate				
LD.	-0.0089393	0.024313	1.879997*	0.042878
L2D.	0.0024322	0.051315	-0.909103*	0.090498
L3D.	0.0204605	0.055334	-0.394378*	0.097585
L4D.	-0.0356124	0.053847	0.743479*	0.094964
L5D.	0.0183121	0.047876	-0.355168*	0.084433
L6D.	0.0076207	0.044092	-0.0179294	0.077759
L7D.	0.0008564	0.043123	0.0533799	0.076051
L8D.	6.04E-06	0.042928	-0.0253452	0.075707
L9D.	0.0027116	0.042869	0.0121329	0.075602
L10D.	-0.0028174	0.042813	-0.0262712	0.075503
L11D.	0.0021523	0.042789	0.0137786	0.075461
L12D.	0.0984954*	0.042786	-0.571909*	0.075456
L13D.	-0.188229*	0.044577	1.119611*	0.078615
L14D.	0.0904717	0.05032	-0.565870*	0.088743
L15D.	0.0476934	0.051512	-0.2161329	0.090844
L16D.	-0.097793*	0.047451	0.410553*	0.083683
L17D.	0.0574815*	0.022384	-0.185282*	0.039475
Constant	5.88E-07	3.17E-05	0.0001624*	5.58E-05

Co-Integration Relation 1: $Inflation_t = .0041417 - \underset{(.0009461\ )}{.0007432} \ln exrate_t + u_t$

Table 2 (*indicates significant at 5% level)

Error Correction Model	D_inf_p	Std. Err.	D_lnM2	Std. Err.	D_lnexrate	Std. Err.
CointEq L1	-0.026930*	0.006017	0.0642806*	0.029948	0.0020203	0.010362
inf_p						
LD.	0.8657336*	0.042645	0.6028935*	0.212266	0.0575689	0.073444
L2D.	-0.0537253	0.050881	0.0336836	0.25326	-0.0566093	0.087628
L3D.	-0.251281*	0.040599	-0.422715*	0.202084	0.009662	0.069921
L4D.	0.2506529*	0.038551	-0.1166168	0.19189	0.0259205	0.066394
L5D.	0.0102918	0.039844	0.2227366	0.198323	-0.0406247	0.06862
L6D.	0.0029359	0.039206	-0.0924395	0.195148	0.0275628	0.067521
L7D.	0.0331322	0.038981	-0.421463*	0.194029	-0.0081848	0.067134
L8D.	0.01504	0.03918	0.1515896	0.195018	-0.0233779	0.067476
L9D.	0.0295069	0.039187	-0.1935231	0.195051	0.002365	0.067488
L10D.	0.0088904	0.039091	0.2410063	0.194574	-0.0170808	0.067323
L11D.	-0.007841	0.038459	-0.0327696	0.191428	-0.0470636	0.066234
L12D.	-0.556855*	0.037396	-0.45392*	0.186137	-0.171899*	0.064403
L13D.	0.5090091*	0.042559	0.1043037	0.211837	0.1826473*	0.073296
L14D.	-0.072918*	0.035237	-0.1303834	0.175391	-0.0576539	0.060685
lnM2						
LD.	0.0018653	0.008862	0.3128172*	0.044112	-0.015543	0.015263
L2D.	-0.007715	0.009254	0.4375239*	0.046062	-0.0221433	0.015938
L3D.	0.0068066	0.010034	0.2732282*	0.049942	0.0211058	0.01728
L4D.	-0.0110621	0.01029	-0.0347896	0.051219	0.01162	0.017722
L5D.	-0.000089	0.010223	-0.0202434	0.050886	-0.0022571	0.017607
L6D.	-0.0044139	0.010111	-0.0359848	0.050327	-0.0151023	0.017413
L7D.	0.011103	0.010078	0.0974946	0.050162	0.0207908	0.017356
L8D.	-0.0050908	0.01011	0.0186178	0.050324	0.0033066	0.017412
L9D.	0.0046485	0.010093	-0.156954*	0.050236	-0.0179496	0.017382
L10D.	-0.0072747	0.010189	-0.152487*	0.050718	0.0263264	0.017548
L11D.	0.0027439	0.010283	-0.0161923	0.051184	0.0209684	0.01771
L12D.	0.0060413	0.010049	-0.0055414	0.050018	-0.0247308	0.017306
L13D.	0.001599	0.009164	0.0576555	0.045613	-0.0271815	0.015782
L14D.	-0.0003752	0.008636	0.0503725	0.042987	0.0042749	0.014874
lnexrate						
LD.	-0.0066784	0.022297	0.2420566*	0.110986	1.833058*	0.038401
L2D.	-0.0081554	0.044097	-0.271297	0.219496	-0.853673*	0.075946
L3D.	0.0268308	0.04501	0.0476113	0.224037	-0.253854*	0.077517
L4D.	-0.0204025	0.044273	-0.0709429	0.22037	0.4668498*	0.076248
L5D.	0.0086751	0.045576	-0.1254663	0.226856	-0.204969*	0.078492
L6D.	0.0093763	0.045793	0.2795138	0.227935	-0.0510994	0.078866
L7D.	-0.0106165	0.045645	-0.0513133	0.227197	0.0526989	0.07861
L8D.	0.0052629	0.045615	-0.2820279	0.227048	-0.0036115	0.078559
L9D.	0.0001701	0.045598	0.3112758	0.226964	0.0088602	0.07853
L10D.	-0.0033446	0.045319	-0.1449363	0.225576	-0.0609129	0.07805
L11D.	0.0097537	0.043965	0.1287521	0.218837	0.0366601	0.075718
L12D.	0.0802361	0.043534	0.0297185	0.216689	-0.511378*	0.074975
L13D.	-0.163243*	0.040955	0.0453077	0.203853	0.9587215*	0.070533
L14D.	0.080564*	0.020799	-0.1746111	0.103525	-0.453772*	0.03582
Constant	0.0007615*	0.000186	0.0003098	0.000924	0.0002939	0.00032

Co-Integration Relation 1: $Inflation_t = -.0309412 - \underset{(.0057615)}{.001174} \ln exrate_t + \underset{(.0026782)}{.000354} \ln M2_t + u_t$

Table 3 (*indicates significant at 5% level)

Error Correction Model	D_inf_p	Std. Err.	D_i	Std. Err.	D_lnexrate	Std. Err.
CointEq L1	-0.031645*	0.00641	-0.0067416	0.007937	-0.0027993	0.01118
inf_p						
LD.	0.864666*	0.042348	0.0073523	0.052437	0.0464589	0.073863
L2D.	-0.0406758	0.050316	-0.0053355	0.062304	-0.0628358	0.087761
L3D.	-0.248326*	0.039937	-0.0187367	0.049452	-0.0018379	0.069658
L4D.	0.2421291*	0.037607	0.0256297	0.046566	0.0160712	0.065593
L5D.	0.004233	0.03886	0.0010968	0.048118	-0.0163416	0.067779
L6D.	-0.0040589	0.038398	0.0069183	0.047546	0.0111836	0.066974
L7D.	0.0297785	0.038181	0.0016935	0.047277	-0.01118	0.066594
L8D.	0.0121872	0.038176	0.0038202	0.047272	-0.0031448	0.066587
L9D.	0.0295865	0.038169	0.004353	0.047263	0.0088895	0.066575
L10D.	-0.0030369	0.038056	0.0043271	0.047123	-0.0043041	0.066377
L11D.	-0.0048247	0.03735	0.0029993	0.046249	-0.0129665	0.065146
L12D.	-0.565765*	0.036295	0.0457934	0.044942	-0.162752*	0.063305
L13D.	0.5167065*	0.042039	-0.0322593	0.052055	0.1929486*	0.073325
L14D.	-0.0639637	0.034489	-0.0103317	0.042706	-0.0659088	0.060156
i						
LD.	0.0005567	0.025425	1.845967*	0.031483	-0.0157759	0.044347
L2D.	0.0023546	0.043917	-0.852024*	0.05438	0.0162912	0.0766
L3D.	-0.0097809	0.043791	-0.108677*	0.054225	-0.0272837	0.076381
L4D.	0.0203467	0.043826	0.206787*	0.054267	0.0525168	0.076441
L5D.	-0.0097217	0.044392	-0.0984178	0.054968	-0.0257591	0.077429
L6D.	0.0016832	0.044514	-0.0110632	0.055119	-0.0001936	0.077641
L7D.	-0.0016975	0.044503	0.0206802	0.055106	0.0016352	0.077622
L8D.	0.0006031	0.044501	-0.0094835	0.055103	-0.0012528	0.077618
L9D.	0.000403	0.0445	0.0042163	0.055103	0.0014221	0.077618
L10D.	-0.000844	0.04437	-0.0141997	0.054941	-0.0023927	0.07739
L11D.	-0.0010216	0.043788	0.0097495	0.054221	-0.0012354	0.076376
L12D.	0.0289405	0.043629	-0.842415*	0.054024	0.0527792	0.076098
L13D.	-0.0496781	0.043677	1.538965*	0.054083	-0.1072878	0.076182
L14D.	0.0265551	0.025442	-0.702229*	0.031504	0.0579296	0.044376
lnexrate						
LD.	-0.01103	0.021971	0.0041573	0.027205	1.838409*	0.038321
L2D.	-0.0010848	0.0435	-0.0055679	0.053864	-0.871781*	0.075873
L3D.	0.0241421	0.044644	-0.0256718	0.055281	-0.230663*	0.077869
L4D.	-0.0197033	0.043879	0.0466619	0.054333	0.4600737*	0.076534
L5D.	0.0072762	0.045127	-0.0213567	0.055878	-0.223764*	0.07871
L6D.	0.0074174	0.04542	-0.0016779	0.056241	-0.0260216	0.079221
L7D.	-0.0077103	0.045363	0.002451	0.056171	0.0506778	0.079123
L8D.	0.0044765	0.045348	-0.0014847	0.056152	-0.021281	0.079096
L9D.	0.0005788	0.045345	0.0034633	0.056149	0.0175439	0.079091
L10D.	-0.0028479	0.045036	-0.0069294	0.055766	-0.0537176	0.078552
L11D.	0.0048833	0.043658	0.0025513	0.054059	0.0363787	0.076148
L12D.	0.0859171*	0.043241	0.0724722	0.053543	-0.517306*	0.075421
L13D.	-0.168657*	0.040572	-0.120414*	0.050238	0.960269*	0.070765
L14D.	0.0859648*	0.020228	0.0506072*	0.025047	-0.454989*	0.035281
Constant	-0.0000192	3.12E-05	0.0000216	3.87E-05	0.0001647*	5.44E-05

Co-Integration Relation 1: $Inflation_t = .0063819 + \underset{(.0013291)}{.0006268} \ln exrate_t - \underset{(.0040664)}{.0018777} i_t + u_t$

Table 4 (*indicates significant at 5% level)

Error Correction Model	D_lnapl	Std. Err.	D_inf_p	Std. Err.
CointEq L1	-0.0000452	2.58E-05	-0.000028*	6.40E-06
lnapl				
LD.	0.2790206*	0.043289	0.0065337	0.010745
L2D.	0.3652844*	0.044842	0.00981	0.01113
L3D.	0.2098246*	0.046665	-0.0021699	0.011583
L4D.	0.1305528*	0.047504	0.0010433	0.011791
L5D.	-0.0409581	0.047824	-0.001151	0.01187
L6D.	-0.0644567	0.047854	-0.0041215	0.011878
L7D.	0.0251302	0.047936	-0.0061678	0.011898
L8D.	-0.0172818	0.047837	0.0099078	0.011874
L9D.	0.0123146	0.04777	0.0132367	0.011857
L10D.	-0.0363547	0.047452	0.0077895	0.011778
L11D.	-0.216592*	0.046508	-0.0055955	0.011544
L12D.	0.0614834	0.044681	-0.0135229	0.01109
L13D.	-0.0036992	0.04326	-0.0054113	0.010738
inf_p				
LD.	0.0827011	0.145902	0.8202395*	0.036214
L2D.	-0.2077871	0.156197	0.0125716	0.03877
L3D.	-0.0039744	0.134032	-0.251771*	0.033268
L4D.	0.2161258	0.140339	0.2413817*	0.034834
L5D.	-0.0836163	0.144568	0.0083724	0.035883
L6D.	0.0276905	0.143237	-0.0083508	0.035553
L7D.	-0.0321188	0.143156	0.020142	0.035533
L8D.	0.131963	0.14316	0.0090155	0.035534
L9D.	-0.0452813	0.143222	0.0280713	0.035549
L10D.	0.0110289	0.141029	-0.0191007	0.035005
L11D.	0.0391635	0.135783	0.008374	0.033703
L12D.	0.1664792	0.132366	-0.510106*	0.032855
L13D.	0.0089678	0.114114	0.4141358*	0.028324
Constant	0.0001938	0.000304	-0.000310*	7.54E-05

Co-Integration Relation 1:

$$\ln apl_t = 19.8073 - \underset{(185.8841)}{873.0935} Inflation_t + u_t$$

Table 5 (*indicates significant at 5% level)

Error Correction Model	D_lnapl	Std. Err.	D_lnklratio	Std. Err.	D_inf_p	Std. Err.	D_lnexrate	Std. Err.
CointEq L1	0.0015214	0.001547	0.0007775	0.001876	0.000179	0.000367	0.0028641*	0.000643
CointEq L2	-0.0003249	0.001042	-0.003784*	0.001264	-0.0000734	0.000248	-0.0008337	0.000433
CointEq L3	-0.0337723	0.026814	-0.0362899	0.032506	-0.024218*	0.006367	-0.0126289	0.01115
lnapl								
LD.	0.2323929*	0.045173	0.088646	0.054764	0.0111273	0.010726	-0.0252776	0.018785
L2D.	0.3239275*	0.046342	0.022416	0.05618	0.01002	0.011004	-0.0230505	0.019271
L3D.	0.2186434*	0.04851	-0.0061276	0.058809	-0.0023674	0.011519	-0.0077186	0.020173
L4D.	0.1436654*	0.048374	-0.006397	0.058644	-0.0016235	0.011486	0.0080572	0.020116
L5D.	-0.0223241	0.04864	0.0019449	0.058966	-0.0060284	0.011549	0.0119386	0.020227
L6D.	-0.0517742	0.048547	-0.0541769	0.058854	-0.0082474	0.011527	0.028269	0.020188
L7D.	0.0299348	0.048696	0.0503149	0.059034	-0.0141905	0.011563	0.0015006	0.02025
L8D.	-0.0036529	0.048784	-0.0320628	0.05914	0.008933	0.011583	0.0075904	0.020286
L9D.	0.0125967	0.04856	0.024087	0.058869	0.0124074	0.01153	-0.0145806	0.020193
L10D.	-0.0232416	0.048421	0.0131912	0.058701	0.0121885	0.011497	-0.0135969	0.020135
L11D.	-0.221598*	0.047896	0.0212276	0.058064	-0.0021613	0.011373	-0.0006099	0.019917
L12D.	0.0660707	0.047903	0.1059006	0.058073	-0.0088324	0.011375	-0.0123864	0.01992
L13D.	-0.0365102	0.045953	-0.0014104	0.055709	-0.0080389	0.010911	-0.0009002	0.019109
L14D.	-0.0000687	0.044733	-0.0824298	0.05423	-0.0022363	0.010622	-0.0226193	0.018602
lnklratio								
LD.	0.0649565	0.036823	0.5953877*	0.044641	0.0008577	0.008744	-0.0180692	0.015313
L2D.	0.0230661	0.042012	0.3449894*	0.05093	-0.0050754	0.009976	0.018022	0.01747
L3D.	-0.0211919	0.043153	0.0437698	0.052314	0.00904	0.010246	0.0071823	0.017945
L4D.	0.0029582	0.043199	-0.0972972	0.05237	0.0088645	0.010258	-0.0066119	0.017964
L5D.	-0.0084772	0.042962	0.0900731	0.052083	-0.016881	0.010201	-0.0019082	0.017865
L6D.	-0.0573184	0.043008	0.0833082	0.052138	0.0100086	0.010212	0.010151	0.017884
L7D.	0.0047909	0.043087	-0.0914781	0.052234	0.0117019	0.010231	-0.0160903	0.017917
L8D.	-0.0243746	0.04289	0.021065	0.051996	-0.021623*	0.010184	-0.0039911	0.017836
L9D.	-0.0054548	0.042803	-0.0196455	0.05189	-0.0136792	0.010164	0.007604	0.017799
L10D.	0.0106717	0.042507	-0.164214*	0.051531	0.0537893*	0.010093	-0.0206294	0.017676
L11D.	0.0103678	0.043531	-0.039236	0.052773	-0.001468	0.010336	-0.0209541	0.018102
L12D.	-0.0744327	0.043398	-0.148367*	0.052612	-0.021229*	0.010305	-0.0156935	0.018047
L13D.	0.0434122	0.041216	0.1621022*	0.049966	-0.022970*	0.009787	0.055824*	0.017139
L14D.	0.0434152	0.036255	0.1384196*	0.043951	0.0119245	0.008609	0.0023857	0.015076
inf_p								
LD.	0.1798568	0.182727	-0.838987*	0.22152	0.8362107*	0.043388	0.1204004	0.075985
L2D.	-0.0782179	0.214166	0.3109959	0.259633	-0.0247796	0.050853	-0.0721641	0.089059
L3D.	-0.1464925	0.170396	-0.0744694	0.206571	-0.267367*	0.04046	-0.0018328	0.070858
L4D.	0.2719521	0.159292	0.0585842	0.19311	0.2479806*	0.037823	0.0547947	0.06624
L5D.	-0.0133269	0.165514	-0.279306	0.200652	0.0153941	0.039301	0.0038168	0.068828
L6D.	0.0776805	0.163113	0.4337731*	0.197741	-0.019712	0.038731	-0.0031743	0.067829
L7D.	-0.0866241	0.162386	-0.0630848	0.19686	0.0375917	0.038558	0.0206288	0.067527
L8D.	0.1677061	0.162015	-0.1091277	0.19641	0.0178978	0.03847	-0.0003748	0.067372
L9D.	-0.003799	0.161869	0.2903743	0.196234	0.0135882	0.038435	-0.0101948	0.067312
L10D.	-0.0804618	0.161504	-0.1858563	0.195791	0.0011345	0.038349	-0.0006301	0.06716
L11D.	0.066083	0.158348	-0.0727542	0.191965	0.047189	0.037599	-0.0432042	0.065848
L12D.	0.0501286	0.15386	0.0432225	0.186524	-0.557631*	0.036533	-0.202909*	0.063981
L13D.	-0.0332858	0.177801	-0.0997461	0.215548	0.4872708*	0.042218	0.2049619*	0.073937
L14D.	-0.0693394	0.147321	0.0173999	0.178597	-0.071146*	0.034981	-0.0468338	0.061262
lnexrate								

LD.	-0.1267132	0.09462	0.0566489	0.114708	-0.0009567	0.022467	1.76873*	0.039347
L2D.	0.0808605	0.180586	-0.0452742	0.218924	-0.0216465	0.04288	-0.805199*	0.075095
L3D.	0.1735719	0.183412	0.1944831	0.222349	0.0322385	0.04355	-0.230377*	0.07627
L4D.	-0.199172	0.180699	-0.4415518	0.21906	-0.0098684	0.042906	0.451882*	0.075142
L5D.	0.1101599	0.187119	0.1943772	0.226843	-0.003084	0.044431	-0.235273*	0.077812
L6D.	-0.1696307	0.188672	0.2260591	0.228726	0.0091003	0.044799	0.0028955	0.078457
L7D.	0.1600567	0.18867	-0.1808623	0.228724	-0.0127709	0.044799	0.0413099	0.078457
L8D.	-0.0926021	0.188763	-0.2093752	0.228837	0.0197867	0.044821	-0.0262361	0.078495
L9D.	-0.0489846	0.188817	0.3188578	0.228902	-0.0138381	0.044834	0.0115668	0.078518
L10D.	0.2325783	0.187908	0.1178983	0.2278	0.0063898	0.044618	-0.043979	0.07814
L11D.	-0.2962722	0.182645	-0.605902*	0.221421	0.0049748	0.043368	0.040017	0.075951
L12D.	0.3320344	0.182538	0.7268502*	0.221291	0.0903947	0.043343	-0.547755*	0.075907
L13D.	-0.202598	0.172964	-0.298457	0.209684	-0.190092*	0.04107	0.9631483*	0.071925
L14D.	0.0257976	0.087464	-0.0306007	0.106033	0.0973175*	0.020768	-0.43528*	0.036371
Constant	0.0002556	0.000354	0.0000103	0.000429	-0.000309*	0.000084	-0.0001192	0.000147

Co-Integration Relation 1:

$$\ln apl_t = 3.908453 + \underset{(.022234)}{.4386172} \ln exrate_t - 2.28\text{e-}15\, Inflation_t - 5.55\text{e-}17 \ln klratio_t + u_t$$

Co-Integration Relation 2:

$$\ln klratio_t = 2.338124 + \underset{(.0448577)}{.2670926} \ln exrate_t + 4.44\text{e-}16\, Inflation_t + u_t$$

Co-Integration Relation 3:

$$Inflation_t = .0169862 - \underset{(.0013291)}{.0012867} \ln exrate_t - 1.73\text{e-}18 \ln klratio_t + u_t$$

Table 6 (*indicates significant at 5% level)

Error Correction Model	D_lnmpl	Std. Err.	D_inf_p	Std. Err.
CointEq L1	-2.50E-06	2.04E-06	-0.000006*	1.43E-06
lnmpl				
LD.	0.8371455*	0.042684	0.0259748	0.02989
L2D.	0.2760961*	0.056178	-0.0033215	0.03934
L3D.	-0.0826387	0.05726	0.0132967	0.040097
L4D.	-0.147138*	0.056694	0.0346613	0.039701
L5D.	0.1083756	0.056918	-0.0686903	0.039857
L6D.	0.060642	0.056905	0.0391441	0.039849
L7D.	-0.141421*	0.056477	0.0331676	0.039549
L8D.	0.0531006	0.056658	-0.0905174	0.039675
L9D.	0.0835641	0.05673	-0.0294659	0.039726
L10D.	-0.230690*	0.056436	0.1557561*	0.03952
L11D.	-0.0281413	0.057358	-0.0192119	0.040166
L12D.	-0.155691*	0.055901	-0.0687324	0.039146
L13D.	0.2614393*	0.042198	0.0088609	0.029549
inf_p				
LD.	-0.328638*	0.052882	0.8294752*	0.037031
L2D.	0.1113362	0.058323	0.0111939	0.040841
L3D.	0.2153302*	0.051975	-0.257762*	0.036397
L4D.	-0.0857372	0.054369	0.2765767*	0.038073
L5D.	-0.0852813	0.055907	0.0047577	0.03915
L6D.	0.213294*	0.055269	-0.0122494	0.038703
L7D.	-0.0482859	0.05598	0.0579268	0.039201
L8D.	-0.0570125	0.056012	-0.0007496	0.039223
L9D.	0.143901*	0.056028	-0.0134807	0.039235
L10D.	-0.0451968	0.055316	0.0167339	0.038736
L11D.	-0.0998536	0.053075	0.0610777	0.037166
L12D.	0.1190804*	0.052286	-0.506994*	0.036614
L13D.	-0.085899*	0.040832	0.4067952*	0.028593
Constant	0.0002365*	0.000062	-0.000085*	4.34E-05

Co-Integration Relation 1:

$$\ln mpl_t = 29.20335 - \underset{(735.6628)}{3944.537}\, Inflation_t + u_t$$

Table 7 (*indicates significant at 5% level)

Error Correction Model	D_lnmpl	Std. Err.	D_lnklratio	Std. Err.	D_inf_p	Std. Err.	D_lnexrate	Std. Err.
CointEq L1	-0.0000433	5.76E-05	-0.000208	0.000223	-0.000182*	0.0000434	0.0000347	7.75E-05
lnmpl								
LD.	2.120057*	0.142927	1.583926*	0.553412	0.1535984	0.1076044	0.1317415	0.192324
L2D.	-1.446037*	0.275471	-2.859491*	1.066623	-0.1492891	0.2073923	0.0675263	0.370678
L3D.	0.1240369	0.288784	1.7893	1.118171	0.0129609	0.2174152	-0.3184033	0.388592
L4D.	0.5267697	0.284459	0.1235698	1.101424	0.1138703	0.2141589	0.2268991	0.382772
L5D.	-0.5479276	0.294073	-1.375357	1.13865	-0.1151172	0.2213971	0.0081699	0.395709
L6D.	0.1606823	0.296254	0.8524139	1.147093	0.0652061	0.2230387	-0.2106142	0.398643
L7D.	0.1939991	0.295297	0.4708367	1.143388	-0.0469798	0.2223184	0.2067693	0.397356
L8D.	-0.2597273	0.295038	-0.9122439	1.142384	-0.0293024	0.2221231	-0.0326415	0.397007
L9D.	0.0498249	0.294903	0.2210499	1.141863	0.0756935	0.2220217	-0.036564	0.396826
L10D.	0.0121752	0.292238	0.1078956	1.131544	-0.0169889	0.2200153	-0.0646414	0.393239
L11D.	0.1102116	0.281694	0.3518697	1.090719	-0.0589655	0.2120774	0.0640812	0.379052
L12D.	-0.5212967	0.280625	0.2939498	1.086578	0.1812704	0.2112722	0.3104969	0.377613
L13D.	1.014989*	0.266101	0.0618292	1.030341	-0.2129785	0.2003376	-0.4050441	0.358069
L14D.	-0.588874*	0.136045	-0.5738028	0.526765	0.1031434	0.1024232	0.1405033	0.183064
lnklratio								
LD.	-0.354107*	0.036046	0.2358216	0.139569	-0.0351078	0.0271376	-0.0586672	0.048504
L2D.	0.4253721*	0.065833	1.023582*	0.254905	0.0302826	0.0495633	-0.0012295	0.088586
L3D.	-0.0236036	0.069614	-0.3816566	0.269545	0.0045389	0.0524098	0.0822784	0.093673
L4D.	-0.150464*	0.068503	-0.1208143	0.265242	-0.0182333	0.0515731	-0.0604737	0.092178
L5D.	0.1603355*	0.070738	0.4215868	0.273897	0.0104117	0.0532559	-0.0033065	0.095186
L6D.	-0.034116	0.071433	-0.1354195	0.276588	-0.0055251	0.0537792	0.0638057	0.096121
L7D.	-0.0617966	0.071091	-0.1901075	0.275263	0.0231679	0.0535216	-0.0626126	0.095661
L8D.	0.0768358	0.070958	0.2353935	0.274749	-0.014015	0.0534218	0.0092791	0.095482
L9D.	-0.0138336	0.070858	-0.0780683	0.274361	-0.0313616	0.0533462	0.014614	0.095347
L10D.	-0.0671303	0.070259	-0.2019745	0.272041	0.0576679	0.0528952	-0.0079855	0.094541
L11D.	-0.0353241	0.067472	-0.1052465	0.26125	0.0121628	0.0507969	-0.0377448	0.090791
L12D.	0.1063947	0.067075	-0.1937489	0.259714	-0.0609365	0.0504982	-0.0849004	0.090257
L13D.	-0.196649*	0.06431	0.1197566	0.249008	0.0268552	0.0484167	0.1550055	0.086537
L14D.	0.1567155*	0.033886	0.2483697	0.131207	-0.0141927	0.0255116	-0.040721	0.045598
inf_p								
LD.	-0.1198272	0.063442	-0.567576*	0.245648	0.8565156*	0.0477634	0.0922194	0.085369
L2D.	0.0166304	0.078535	-0.0023937	0.304089	-0.0331914	0.0591264	-0.0581907	0.105678
L3D.	0.0159652	0.070957	0.0920205	0.274746	-0.27497*	0.0534211	-0.0600463	0.095481
L4D.	0.0477081	0.072225	0.1635062	0.279653	0.2649956*	0.0543753	0.0559096	0.097187
L5D.	-0.1168998	0.074486	-0.5010091	0.288408	-0.0013284	0.0560776	0.0006553	0.100229
L6D.	0.1024758	0.074558	0.4662168	0.28869	-0.0100459	0.0561323	-0.066227	0.100327
L7D.	0.0352596	0.074633	0.101461	0.288979	0.0326103	0.0561885	0.0291855	0.100427
L8D.	-0.0512021	0.074411	-0.2244837	0.28812	0.001442	0.0560216	-0.0059193	0.100129
L9D.	0.061629	0.074269	0.2640361	0.28757	0.0252996	0.0559147	-0.0292049	0.099938
L10D.	-0.03796	0.073478	-0.1914196	0.284505	0.0047067	0.0553187	-0.0323858	0.098873
L11D.	-0.0127905	0.071483	0.0134597	0.276783	0.0267664	0.0538172	-0.0598802	0.096189
L12D.	0.0518676	0.070821	0.2370503	0.274218	-0.513046*	0.0533185	-0.1132767	0.095298
L13D.	0.0119043	0.069171	0.0034238	0.267828	0.4429908*	0.0520761	0.1394638	0.093077
L14D.	0.0222581	0.046607	0.0234412	0.180464	-0.0618563	0.035089	-0.0484083	0.062716
lnexrate								
LD.	0.0245457	0.029548	0.1134909	0.11441	0.0084589	0.0222457	1.815414*	0.03976
L2D.	-0.0362075	0.058159	-0.2042585	0.22519	-0.0324531	0.0437856	-0.833022*	0.078259
L3D.	0.0559751	0.060296	0.3032145	0.233468	0.0307126	0.045395	-0.253610*	0.081136
L4D.	-0.0874712	0.060414	-0.4165267	0.233921	-0.0031188	0.0454832	0.4707704*	0.081293
L5D.	0.0195311	0.06264	0.0900159	0.242543	-0.0078335	0.0471595	-0.239257*	0.08429
L6D.	0.0688489	0.063147	0.3114731	0.244506	0.0120485	0.0475414	-0.0221631	0.084972
L7D.	-0.0330658	0.063239	-0.1801505	0.244862	-0.0154442	0.0476106	0.0671003	0.085096
L8D.	-0.0749624	0.063252	-0.2702489	0.244912	0.0146381	0.0476202	-0.0332172	0.085113
L9D.	0.0924858	0.063315	0.351396	0.245156	-0.0080844	0.0476676	0.0125422	0.085198
L10D.	0.0172087	0.062977	0.1020516	0.243848	0.0030128	0.0474133	-0.045822	0.084743
L11D.	-0.136173*	0.060918	-0.586584*	0.235873	0.0010988	0.0458627	0.0406784	0.081972
L12D.	0.1560677*	0.060805	0.7677113*	0.235437	0.1063794*	0.0457779	-0.523508*	0.08182
L13D.	-0.0312448	0.057565	-0.3077362	0.222893	-0.195789*	0.0433388	0.9573212*	0.077461
L14D.	-0.0332162	0.028971	-0.0703774	0.112176	0.0932313*	0.0218114	-0.451425*	0.038984
Cons	0.0001516	9.57E-05	-7.40E-06	0.00037	-0.0000309	0.000072	-0.0000172	0.000129

Co-Integration Relation 1:

$$\ln mpl_t = 4.759512 + \underset{(.2308822)}{.5000031} \ln exrate_t - \underset{(28.31719)}{135.4336} Inflation_t - \underset{(.9590428)}{.7668298} \ln klratio_t + u_t$$

Table 8 (*indicates significant at 5% level)

Error Correction Model	D_lnapk	Std. Err.	D_inf_p	Std. Err.
CointEq L1	-0.0000452	5.41E-05	0.0000455*	8.70E-06
lnapk				
LD.	0.4410848*	0.043016	0.0020537	0.006916
L2D.	0.372061*	0.047065	0.001612	0.007567
L3D.	0.1289842*	0.049451	-0.0081481	0.007951
L4D.	-0.025987	0.049501	-0.0069167	0.007959
L5D.	0.0177486	0.049379	0.0075355	0.007939
L6D.	0.0943195	0.049256	-0.0041848	0.00792
L7D.	-0.063795	0.049232	-0.0064737	0.007916
L8D.	0.0447151	0.04915	0.0163418*	0.007902
L9D.	-0.0441267	0.049259	0.0047443	0.00792
L10D.	-0.137772*	0.049266	-0.025746*	0.007921
L11D.	-0.129752*	0.049333	-0.0030021	0.007932
L12D.	0.0279262	0.046581	0.0098425	0.007489
L13D.	0.1134267*	0.042036	0.0122743	0.006759
inf_p				
LD.	1.008079*	0.224034	0.8309075*	0.03602
L2D.	-0.2204219	0.244046	0.0186711	0.039238
L3D.	-0.3415027	0.208538	-0.258759*	0.033529
L4D.	0.1583215	0.21906	0.2530744*	0.035221
L5D.	0.3273739	0.225104	0.0172233	0.036192
L6D.	-0.5334372	0.223014	-0.0134549	0.035856
L7D.	-0.1184329	0.223784	0.0341993	0.03598
L8D.	0.4519402*	0.223397	0.0204869	0.035918
L9D.	-0.478495*	0.224206	0.0177907	0.036048
L10D.	-0.0603646	0.220551	-0.0155576	0.03546
L11D.	0.2858817	0.211609	0.0305471	0.034023
L12D.	-0.0857197	0.20624	-0.501527*	0.033159
L13D.	-0.0448208	0.177325	0.4136766*	0.02851
Constant	0.0000725	0.000179	0.000072*	2.88E-05

Co-Integration Relation 1:

$$\ln apk_t = - .9205552 + \underset{(117.9288)}{643.9903} Inflation_t + u_t$$

Table 9 (*indicates significant at 5% level)

Error Correction Model	D_lnapk	Std. Err.	D_lnklratio	Std. Err.	D_inf_p	Std. Err.	D_lnexrate	Std. Err.
CointEq L1	0.000744	0.002272	0.0007775	0.001876	0.0001791	0.000367	0.0028641*	0.000643
CointEq L2	0.0042033	0.0018	-0.003006*	0.001486	0.0001057	0.000291	0.0020304*	0.00051
CointEq L3	0.0025172	0.039372	-0.0362888	0.032506	-0.024218*	0.006367	-0.0126288	0.01115
lnapk								
LD.	0.1437481*	0.06633	0.088658	0.054763	0.0111255	0.010726	-0.0252793	0.018785
L2D.	0.3014993*	0.068046	0.022421	0.05618	0.0100232	0.011004	-0.0230406	0.019271
L3D.	0.2247812*	0.07123	-0.0061377	0.058809	-0.0023701	0.011519	-0.0077219	0.020173
L4D.	0.1500193*	0.07103	-0.0063801	0.058644	-0.0016213	0.011486	0.0080527	0.020116
L5D.	-0.0242463	0.071421	0.0019275	0.058966	-0.0060269	0.011549	0.0119351	0.020227
L6D.	0.002435	0.071284	-0.0541907	0.058853	-0.0082524	0.011527	0.0282675	0.020188
L7D.	-0.020418	0.071503	0.0503234	0.059034	-0.0141902	0.011563	0.0014932	0.02025
L8D.	0.02843	0.071631	-0.0320482	0.05914	0.0089339	0.011583	0.0075973	0.020286
L9D.	-0.0114685	0.071302	0.0240667	0.058869	0.0124088	0.01153	-0.0145681	0.020193
L10D.	-0.0364326	0.071099	0.0131715	0.058701	0.0121923	0.011497	-0.0136014	0.020135
L11D.	-0.24283*	0.070328	0.0212556	0.058064	-0.0021659	0.011373	-0.0006133	0.019917
L12D.	-0.0398517	0.070339	0.1059164	0.058073	-0.0088331	0.011374	-0.0123862	0.01992
L13D.	-0.0351221	0.067476	-0.0014097	0.055709	-0.0080368	0.010911	-0.0008927	0.019109
L14D.	0.0823825	0.065684	-0.0824435	0.05423	-0.0022376	0.010622	-0.0226283	0.018602
lnklratio								
LD.	-0.386682*	0.079608	0.6840416*	0.065725	0.0119831	0.012873	-0.0433488	0.022545
L2D.	-0.0204372	0.087797	0.3674131*	0.072487	0.0049479	0.014198	-0.0050192	0.024865
L3D.	0.1598361	0.090765	0.0376334	0.074938	0.0066703	0.014678	-0.0005388	0.025705
L4D.	0.2502759*	0.090687	-0.1036812	0.074873	0.0072431	0.014665	0.0014402	0.025683
L5D.	-0.1227997	0.091014	0.0920033	0.075142	-0.0229081	0.014718	0.0100278	0.025775
L6D.	-0.1381923	0.090983	0.0291199	0.075117	0.0017564	0.014713	0.0384189	0.025767
L7D.	0.0758432	0.09117	-0.0411536	0.075272	-0.0024886	0.014743	-0.014596	0.02582
L8D.	-0.016994	0.09091	-0.010988	0.075057	-0.0126888	0.014701	0.0036055	0.025746
L9D.	0.002716	0.090629	0.0044251	0.074825	-0.0012709	0.014656	-0.0069654	0.025666
L10D.	0.1384459	0.09052	-0.151040*	0.074735	0.0659819*	0.014638	-0.0342294	0.025636
L11D.	-0.193218*	0.091174	-0.0179848	0.075275	-0.0036334	0.014744	-0.0215678	0.025821
L12D.	0.0340655	0.09131	-0.0424519	0.075387	-0.030063*	0.014766	-0.02808	0.025859
L13D.	-0.1537981	0.086251	0.1606933*	0.07121	-0.031007*	0.013948	0.0549301*	0.024427
L14D.	-0.0126231	0.07962	0.0559769	0.065735	0.0096871	0.012875	-0.0202414	0.022549
inf_p								
LD.	1.01889*	0.268308	-0.838976*	0.22152	0.836209*	0.043388	0.1203983	0.075986
L2D.	-0.3892293	0.314471	0.310967	0.259633	-0.0247766	0.050853	-0.072159	0.089059
L3D.	-0.0721033	0.250202	-0.0744712	0.206571	-0.267369*	0.04046	-0.0018369	0.070858
L4D.	0.2134662	0.233897	0.058611	0.19311	0.2479824*	0.037823	0.0547929	0.06624
L5D.	0.2659049	0.243034	-0.2793324	0.200653	0.0153943	0.039301	0.0038239	0.068828
L6D.	-0.356067	0.239508	0.433776	0.197742	-0.0197136	0.038731	-0.0031802	0.067829
L7D.	-0.0235382	0.23844	-0.0630598	0.196861	0.0375939	0.038558	0.0206274	0.067527
L8D.	0.276848	0.237896	-0.1091574	0.196411	0.0178967	0.03847	-0.0003723	0.067373
L9D.	-0.2941644	0.237681	0.2903806	0.196234	0.0135873	0.038435	-0.0101943	0.067312
L10D.	0.1053908	0.237145	-0.1858445	0.195792	0.001134	0.038349	-0.0006327	0.06716
L11D.	0.1388367	0.232511	-0.0727705	0.191965	0.0471893	0.037599	-0.0431992	0.065848
L12D.	0.0069408	0.22592	0.0432251	0.186524	-0.557631*	0.036533	-0.202910*	0.063981
L13D.	0.0664072	0.261075	-0.0997463	0.215548	0.4872697*	0.042218	0.2049626*	0.073937
L14D.	-0.0867308	0.216319	0.0173996	0.178597	-0.071144*	0.034981	-0.0468353	0.061262
lnexrate								
LD.	-0.1833826	0.138935	0.0566446	0.114708	-0.0009579	0.022467	1.768732*	0.039347
L2D.	0.1261586	0.265163	-0.0452632	0.218924	-0.0216453	0.042879	-0.805204*	0.075095
L3D.	-0.0209102	0.269312	0.1944787	0.222349	0.0322397	0.04355	-0.230374*	0.07627
L4D.	0.2423586	0.265328	-0.441554*	0.21906	-0.00987	0.042906	0.4518841*	0.075142
L5D.	-0.0841705	0.274755	0.1943783	0.226843	-0.0030828	0.044431	-0.235279*	0.077812
L6D.	-0.3957582	0.277036	0.2260616	0.228726	0.0090991	0.044799	0.002899	0.078457
L7D.	0.3409731	0.277033	-0.1808739	0.228724	-0.0127714	0.044799	0.0413112	0.078457
L8D.	0.1167822	0.277171	-0.2093553	0.228837	0.0197881	0.044821	-0.0262361	0.078496
L9D.	-0.3678928	0.277249	0.318841	0.228902	-0.0138397	0.044834	0.0115663	0.078518
L10D.	0.114692	0.275914	0.1178985	0.227799	0.0063917	0.044618	-0.0439776	0.07814
L11D.	0.3096854	0.268187	-0.605888*	0.22142	0.0049755	0.043368	0.0400162	0.075951
L12D.	-0.3949211	0.268029	0.7268352*	0.22129	0.0903912*	0.043343	-0.547758*	0.075907
L13D.	0.0959487	0.253971	-0.2984427	0.209683	-0.19009*	0.041069	0.9631498*	0.071925
L14D.	0.0563707	0.128428	-0.0306084	0.106032	0.0973171*	0.020768	-0.435279*	0.036371

Constant	0.0001823	0.000434	0.0001896	0.000358	-0.000220*	7.01E-05	-0.000085	0.000123

Co-Integration Relation 1:

$$\ln apk_t = 1.575738 + \underset{(.0378862)}{.1715251} \ln exrate_t - 8.88\text{e-}16\, Inflation_t + u_t$$

Co-Integration Relation 2:

$$\ln klratio_t = 2.324393 + \underset{(.0448577)}{.2670922} \ln exrate_t - 4.44\text{e-}16\, Inflation_t + u_t$$

Co-Integration Relation 3:

$$Inflation_t = .0132988 - \underset{(.0012219)}{.0012867} \ln exrate_t + 8.67\text{e-}19 \ln klratio_t + u_t$$

Table 10 (*indicates significant at 5% level)

Error Correction Model	D_lnmpk	Std. Err.	D_inf_p	Std. Err.
CointEq L1	7.99E-06	1.23E-05	-0.000015*	3.15E-06
lnmpk				
LD.	0.6435416*	0.042098	0.0035105	0.010763
L2D.	0.357852*	0.050256	-0.0014287	0.012849
L3D.	0.032253	0.052533	-0.0089943	0.013431
L4D.	-0.120558*	0.05197	-0.0100963	0.013287
L5D.	0.0699322	0.052101	0.0226273	0.01332
L6D.	0.1055363*	0.052221	-0.0142133	0.013351
L7D.	-0.109296*	0.052023	-0.0103925	0.0133
L8D.	-0.0014188	0.051945	0.0336958	0.01328
L9D.	-0.0032979	0.052123	0.0084878	0.013326
L10D.	-0.191941*	0.051739	-0.062088*	0.013228
L11D.	-0.009185	0.052957	-0.0020218	0.013539
L12D.	-0.115712*	0.049992	0.027716*	0.012781
L13D.	0.2284785*	0.041285	0.01425	0.010555
inf_p				
LD.	0.4006682*	0.141664	0.8229587*	0.036218
L2D.	-0.1044288	0.152886	0.0277927	0.039087
L3D.	-0.1789854	0.129464	-0.268191*	0.033099
L4D.	-0.0064978	0.136268	0.2493015*	0.034839
L5D.	0.3233192*	0.139552	0.0186158	0.035678
L6D.	-0.423103*	0.138691	-0.0268062	0.035458
L7D.	0.0297219	0.1395	0.0316694	0.035665
L8D.	0.2276909	0.139217	0.0171603	0.035593
L9D.	-0.2454791	0.139376	0.0151727	0.035633
L10D.	-0.0267791	0.136882	-0.024256	0.034996
L11D.	0.1425515	0.131441	0.0292432	0.033605
L12D.	-0.0081381	0.128062	-0.502953*	0.032741
L13D.	-0.0661185	0.109872	0.405127*	0.02809
Constant	0.0000939	0.000105	0.0000474	2.69E-05

Co-Integration Relation 1:

$$\ln mpk_t = 8.013382 - \underset{(335.3618)}{1708.642} Inflation_t + u_t$$

Table 11 (*indicates significant at 5% level)

Error Correction Model	D_lnmpk	Std. Err.	D_lnklratio	Std. Err.	D_inf_p	Std. Err.	D_lnexrate	Std. Err.
CointEq L1	0.0001667	0.000172	-0.0002106	0.000226	-0.000184*	4.39E-05	0.0000354	7.85E-05
lnmpk								
LD.	0.5376276	0.420038	1.581875*	0.553368	0.1523078	0.107599	0.1301583	0.192313
L2D.	1.41207	0.809506	-2.857336*	1.066462	-0.1458801	0.207367	0.0693863	0.370629
L3D.	-1.665924*	0.848531	1.788953	1.117875	0.009611	0.217364	-0.3144283	0.388496
L4D.	0.4035908	0.835821	0.1254319	1.101129	0.1143965	0.214108	0.2164495	0.382677
L5D.	0.8287781	0.864142	-1.379966	1.138441	-0.1124344	0.221363	0.0169705	0.395644
L6D.	-0.6955305	0.870595	0.8595727	1.146942	0.0619595	0.223016	-0.2107225	0.398598
L7D.	-0.2718862	0.867717	0.4640693	1.14315	-0.046073	0.222279	0.2004711	0.39728
L8D.	0.6509833	0.866931	-0.9118742	1.142115	-0.027741	0.222077	-0.0284092	0.39692
L9D.	-0.1776138	0.866598	0.2318225	1.141676	0.0738908	0.221992	-0.0346429	0.396768
L10D.	-0.0843593	0.858759	0.0913925	1.131348	-0.0166167	0.219984	-0.0690439	0.393179
L11D.	-0.2478552	0.827644	0.3596631	1.090357	-0.0581862	0.212013	0.0663672	0.378933
L12D.	-0.8198304	0.824449	0.3021707	1.086149	0.1802257	0.211195	0.3099429	0.37747
L13D.	0.9626508	0.781888	0.0468267	1.030077	-0.2124009	0.200292	-0.4044783	0.357984
L14D.	-0.0196323	0.399781	-0.5667259	0.526681	0.1030797	0.10241	0.1401475	0.183038
lnklratio								
LD.	-0.0526675	0.321455	1.818208*	0.423492	0.1174924	0.082345	0.0718843	0.147177
L2D.	0.8141548	0.621156	-1.834264*	0.818326	-0.11639	0.159119	0.0676692	0.284394
L3D.	-1.307719*	0.649162	1.407441	0.855221	0.0149539	0.166293	-0.2330318	0.297216
L4D.	0.37389	0.639813	0.0041127	0.842904	0.0960155	0.163898	0.1584366	0.292935
L5D.	0.5672286	0.661303	-0.9573589	0.871215	-0.1026518	0.169403	0.0115457	0.302774
L6D.	-0.5933508	0.665657	0.7225403	0.876951	0.0572221	0.170518	-0.1468541	0.304768
L7D.	-0.1447272	0.663835	0.2754936	0.874552	-0.0231539	0.170051	0.1393369	0.303934
L8D.	0.4928013	0.663411	-0.6765764	0.873992	-0.0420992	0.169943	-0.0201549	0.303739
L9D.	-0.1118721	0.663344	0.1512402	0.873904	0.0429565	0.169926	-0.0204339	0.303709
L10D.	0.0477562	0.657275	-0.1066561	0.865909	0.0409494	0.168371	-0.0760257	0.30093
L11D.	-0.1764314	0.634883	0.2525246	0.836409	-0.046202	0.162635	0.0280852	0.290678
L12D.	-0.5186117	0.632877	0.1064719	0.833766	0.1195225	0.162121	0.2251445	0.28976
L13D.	0.6440203	0.59803	0.1702006	0.787858	-0.1856624	0.153194	-0.2495959	0.273805
L14D.	-0.1102384	0.30772	-0.3200561	0.405398	0.0888937	0.078827	0.0995344	0.140888
inf_p								
LD.	0.4481398*	0.186444	-0.568004*	0.245625	0.8561965*	0.04776	0.0919769	0.085362
L2D.	0.0189576	0.230776	-0.0024491	0.304029	-0.0326608	0.059117	-0.0582856	0.10566
L3D.	-0.0763513	0.2085	0.0921807	0.274683	-0.275277*	0.05341	-0.058773	0.095461
L4D.	-0.1158611	0.212271	0.1642341	0.279651	0.264784*	0.054376	0.0540537	0.097187
L5D.	0.3846436	0.218933	-0.5023285	0.288428	-0.0007588	0.056083	0.0014418	0.100238
L6D.	-0.3647314	0.219152	0.4677819	0.288716	-0.0103961	0.056139	-0.0653752	0.100338
L7D.	-0.0653203	0.219379	0.1004212	0.289015	0.0324402	0.056197	0.0278987	0.100442
L8D.	0.1735448	0.218734	-0.225082	0.288165	0.0018467	0.056032	-0.0057212	0.100146
L9D.	-0.2040808	0.218326	0.2664587	0.287627	0.025118	0.055927	-0.0283699	0.099959
L10D.	0.1552623	0.215981	-0.1939188	0.284538	0.0045771	0.055327	-0.03317	0.098886
L11D.	-0.0263941	0.210079	0.0136056	0.276763	0.0270111	0.053815	-0.0597121	0.096184
L12D.	-0.186601	0.208148	0.2391576	0.274219	-0.513277*	0.05332	-0.1133848	0.0953
L13D.	0.0098208	0.20333	0.0014285	0.267872	0.4430785*	0.052086	0.1396276	0.093094
L14D.	-0.0012469	0.136986	0.0235393	0.180469	-0.0618869	0.035091	-0.0485097	0.062719
lnexrate								
LD.	-0.0887069	0.086832	0.1132029	0.114395	0.0083948	0.022243	1.815339*	0.039756
L2D.	0.1675724	0.170893	-0.2037384	0.225139	-0.0322446	0.043777	-0.833015*	0.078243
L3D.	-0.2470256	0.177161	0.3031022	0.233396	0.0304857	0.045382	-0.253174*	0.081112
L4D.	0.3292308	0.177495	-0.4168062	0.233836	-0.0030825	0.045468	0.4699576*	0.081265
L5D.	-0.0706545	0.184021	0.0900811	0.242434	-0.0076375	0.04714	-0.238631*	0.084253
L6D.	-0.2428611	0.185506	0.3119564	0.244389	0.0117825	0.04752	-0.0221706	0.084933

L7D.	0.1476064	0.185777	-0.1807967	0.244747	-0.0153467	0.04759	0.0666682	0.085057
L8D.	0.1950955	0.185817	-0.2702546	0.244799	0.0147707	0.0476	-0.0328724	0.085075
L9D.	-0.259412	0.186004	0.3523792	0.245046	-0.0082979	0.047648	0.0125588	0.085161
L10D.	-0.0840511	0.185021	0.1007635	0.243751	0.003123	0.047396	-0.0460391	0.084711
L11D.	0.4501222*	0.178986	-0.586101*	0.2358	0.0011421	0.04585	0.0408764	0.081948
L12D.	-0.612097*	0.178659	0.7683034*	0.235369	0.1062454*	0.045766	-0.523685*	0.081798
L13D.	0.2771613	0.169149	-0.3086323	0.222841	-0.195663*	0.04333	0.9574668*	0.077444
L14D.	0.036864	0.085136	-0.069981	0.11216	0.0931825*	0.021809	-0.451478*	0.038979
Constant	0.0001076	0.000308	0.0000575	0.000406	0.0000261	7.89E-05	-0.0000282	0.000141

Co-Integration Relation 1:

$$\ln mpk_t = 4.348289 + \underset{(.2309287)}{.50008761}\ln exrate_t - \underset{(28.32289)}{135.4646}\, Inflation_t - \underset{(.9592355)}{1.767309}\ln klratio_t + u_t$$

Table 12

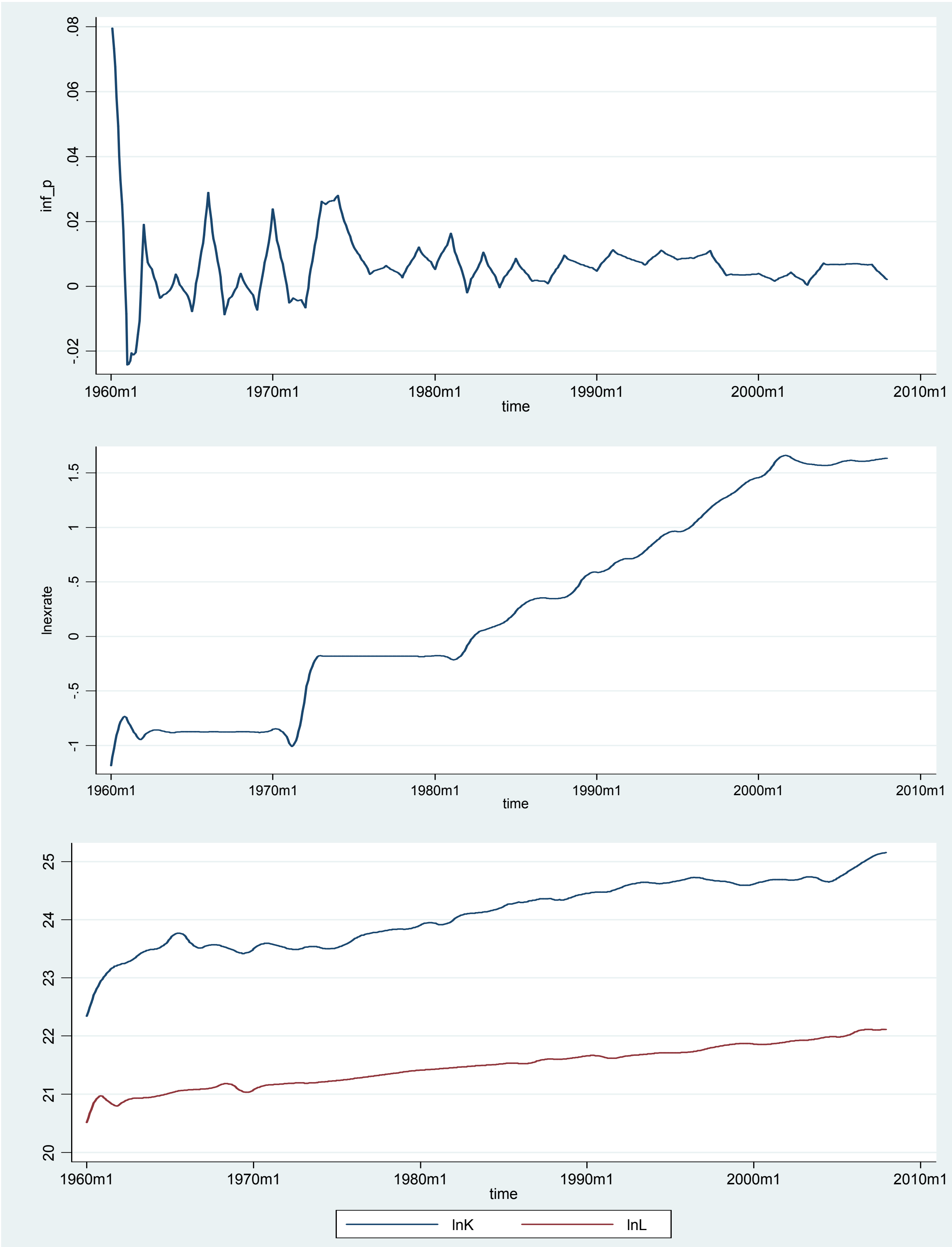
Equation	Excluded	chi2	Df	Prob>chi2
lntfp	**lnklratio**	58.082	15	0
lntfp	**inf_p**	22.549	15	0.094
lntfp	**lnexrate**	40.033	15	0
lntfp	**ALL**	121.92	45	0
lnklratio	**lntfp**	8.418	15	0.906
lnklratio	**inf_p**	38.607	15	0.001
lnklratio	**lnexrate**	29.077	15	0.016
lnklratio	**ALL**	88.499	45	0
inf_p	**lntfp**	12.93	15	0.608
inf_p	**lnklratio**	34.831	15	0.003
inf_p	**lnexrate**	40.105	15	0
inf_p	**ALL**	123.69	45	0
lnexrate	**lntfp**	35.945	15	0.002
lnexrate	**lnklratio**	20.361	15	0.159
lnexrate	**inf_p**	19.81	15	0.179
lnexrate	**ALL**	92.742	45	0

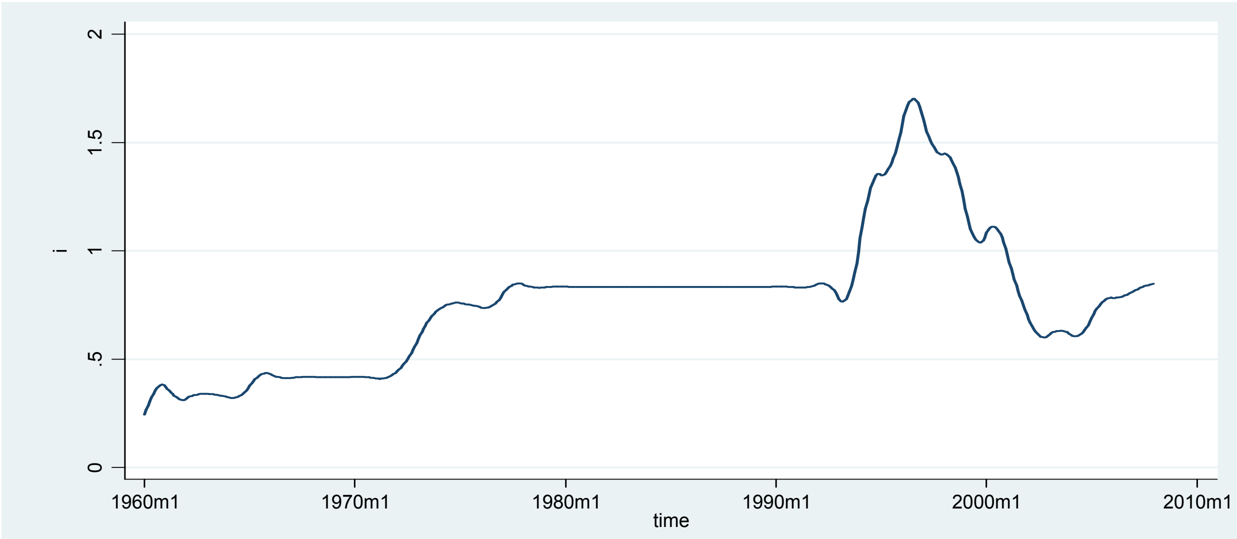
Impulse Response Functions and Cholesky Variance Decomposition Graphs:

Description of Variables

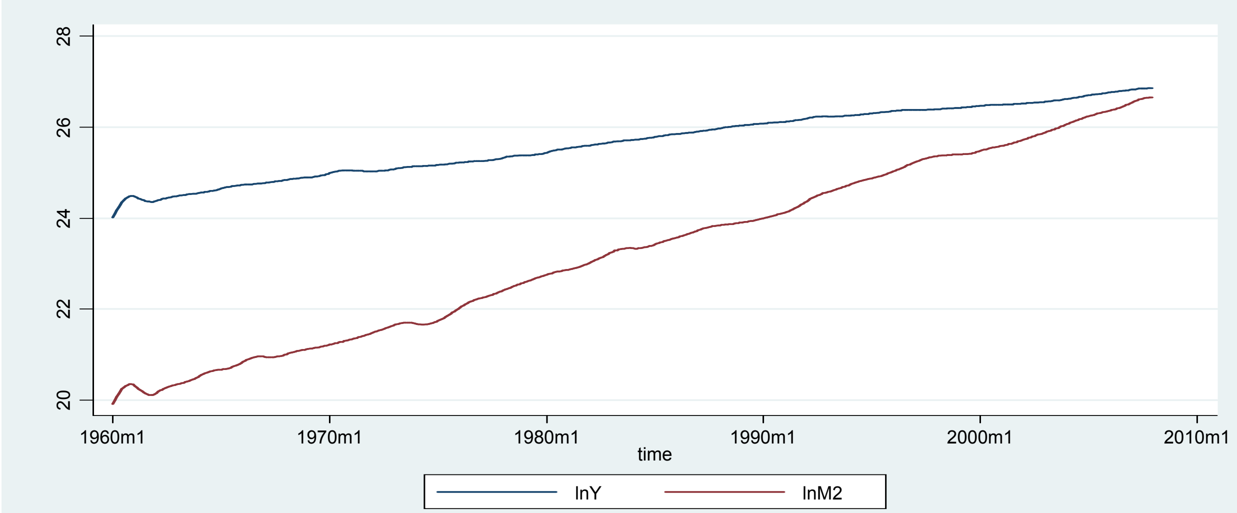
Variable Name	Variable Symbol
Inflation	inf_p
Exchange Rate	lnexrate
Capital	K
Labor	L
Discount rate	i
Real GDP	Y
Broad Money	M2
Capital Labor Ratio	klratio
Average Product of Labor	apl
Marginal product of Labor	mpl
Average Product of Capital	apk
Marginal Product of Labor	mpk
Total Factor Productivity	TFP

Note: In the graphs lnexrate refers to natural logarithm of monthly exchange rate (Rupee/US$)

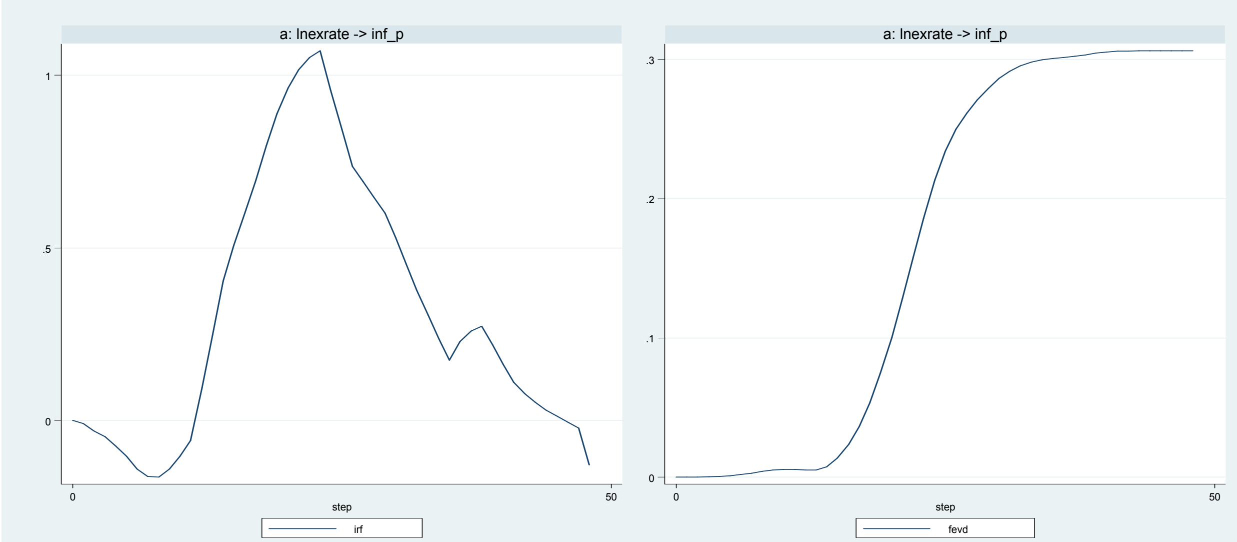

inf_p
.08
.06
.04
.02
0
-.02
1960m1
1970m1
1980m1
1990m1
2000m1
2010m1
time
lnexrate
1.5
1
.5
0
-.5
-1
1960m1
1970m1
1980m1
1990m1
2000m1
2010m1
time
25
24
23
22
21
20
1960m1
1970m1
1980m1
1990m1
2000m1
2010m1
time
lnK
lnL



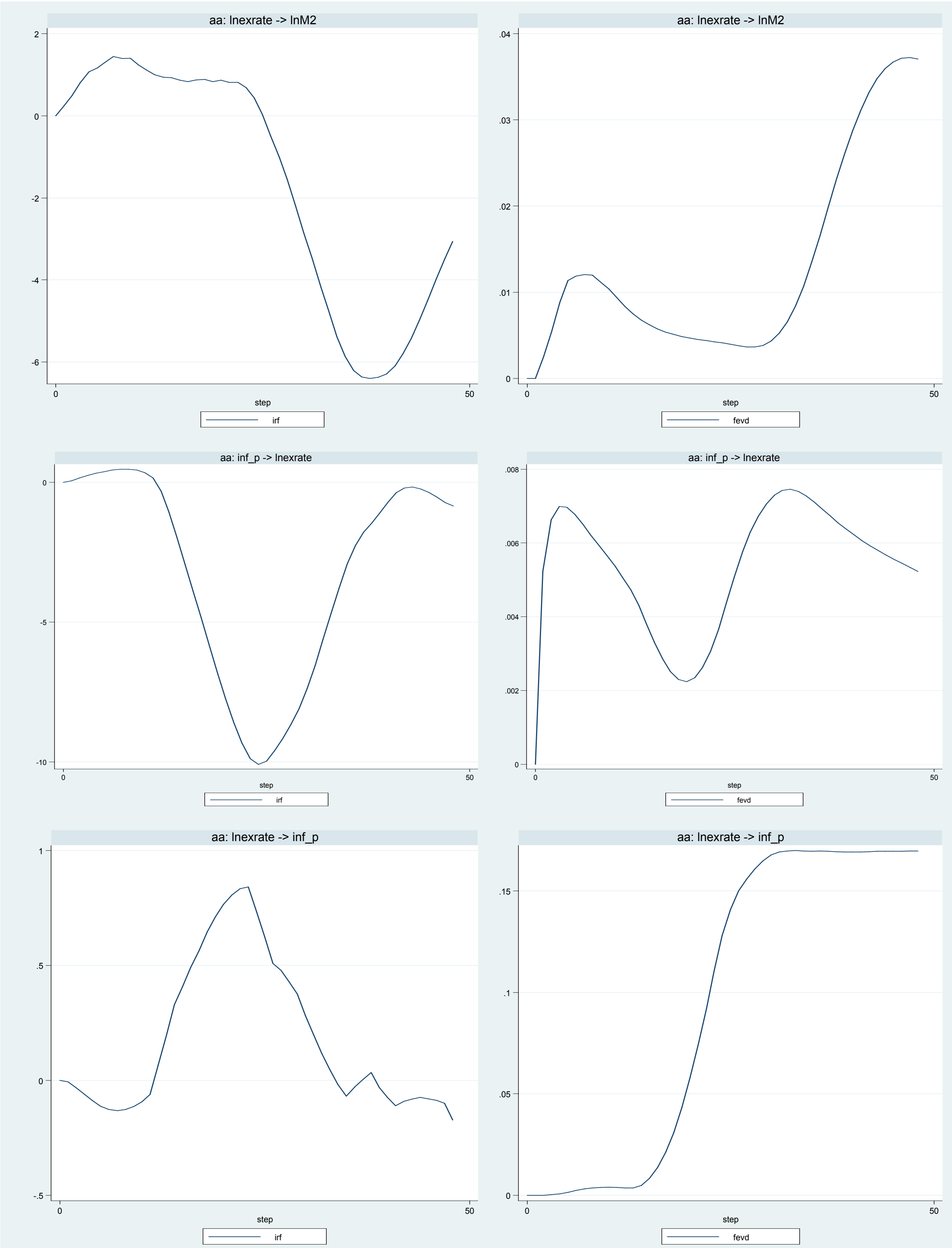
i
0
.5
1
1.5
2
1960m1
1970m1
1980m1
1990m1
2000m1
2010m1
time

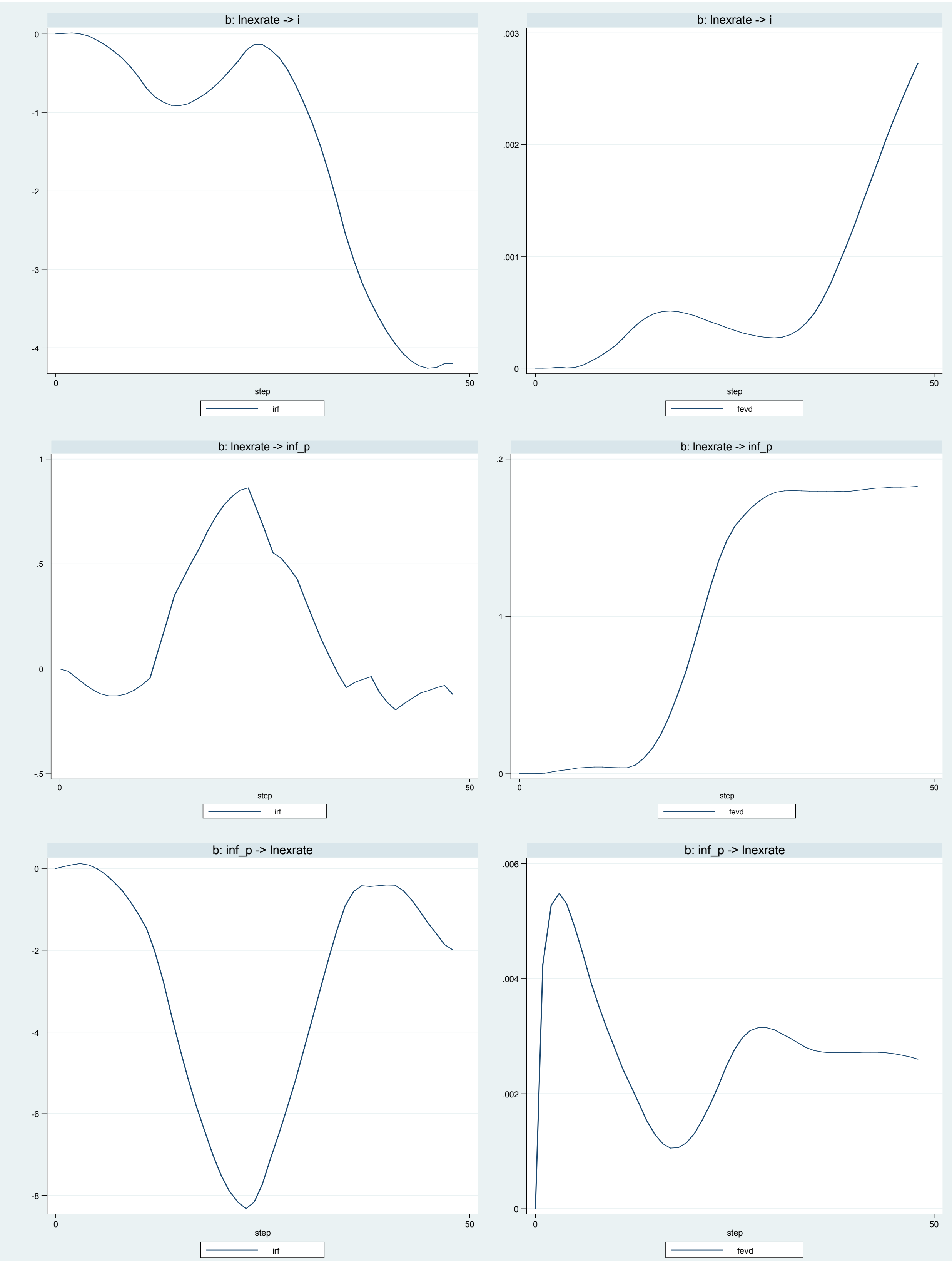


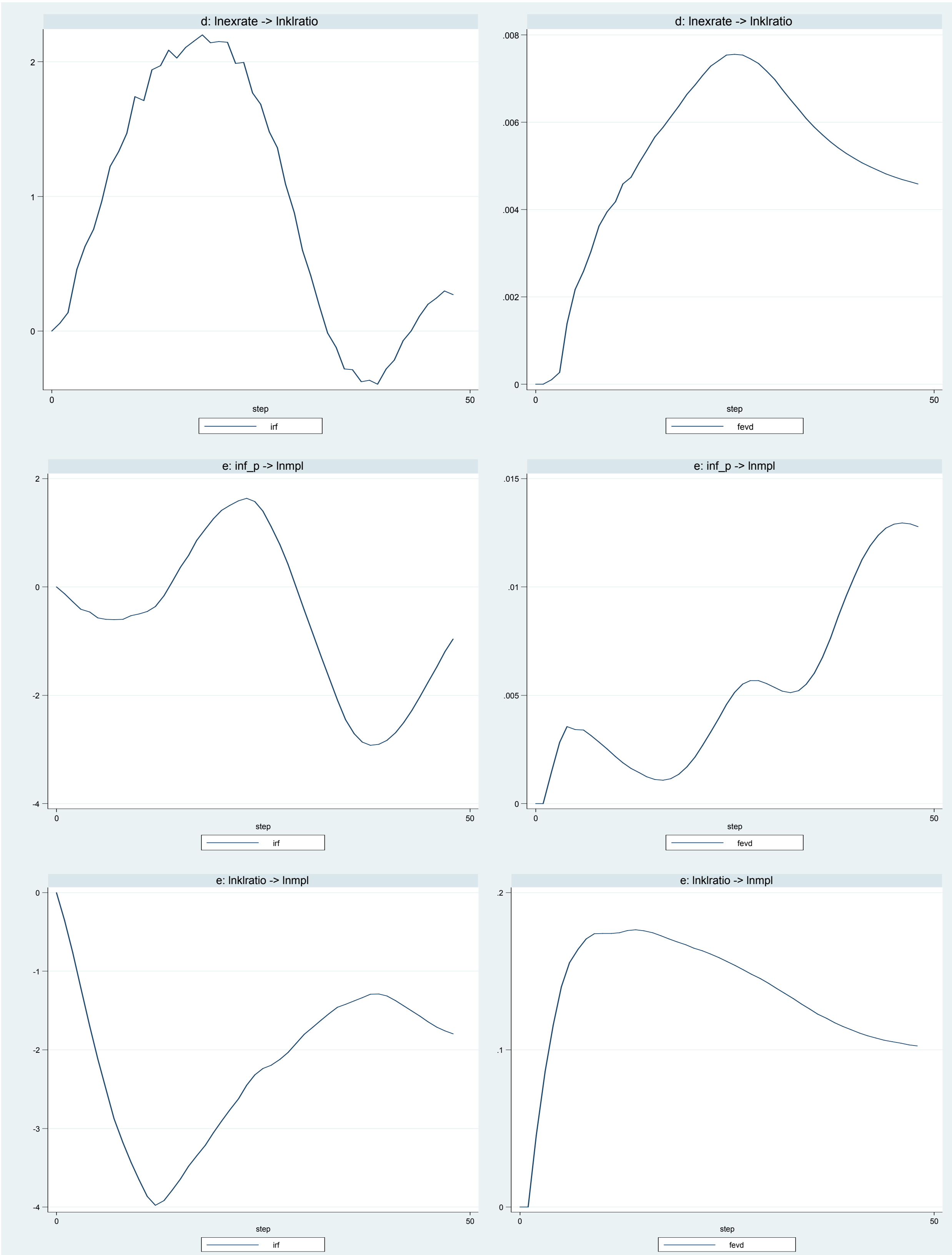
20
22
24
26
28
1960m1
1970m1
1980m1
1990m1
2000m1
2010m1
time
lnY
lnM2

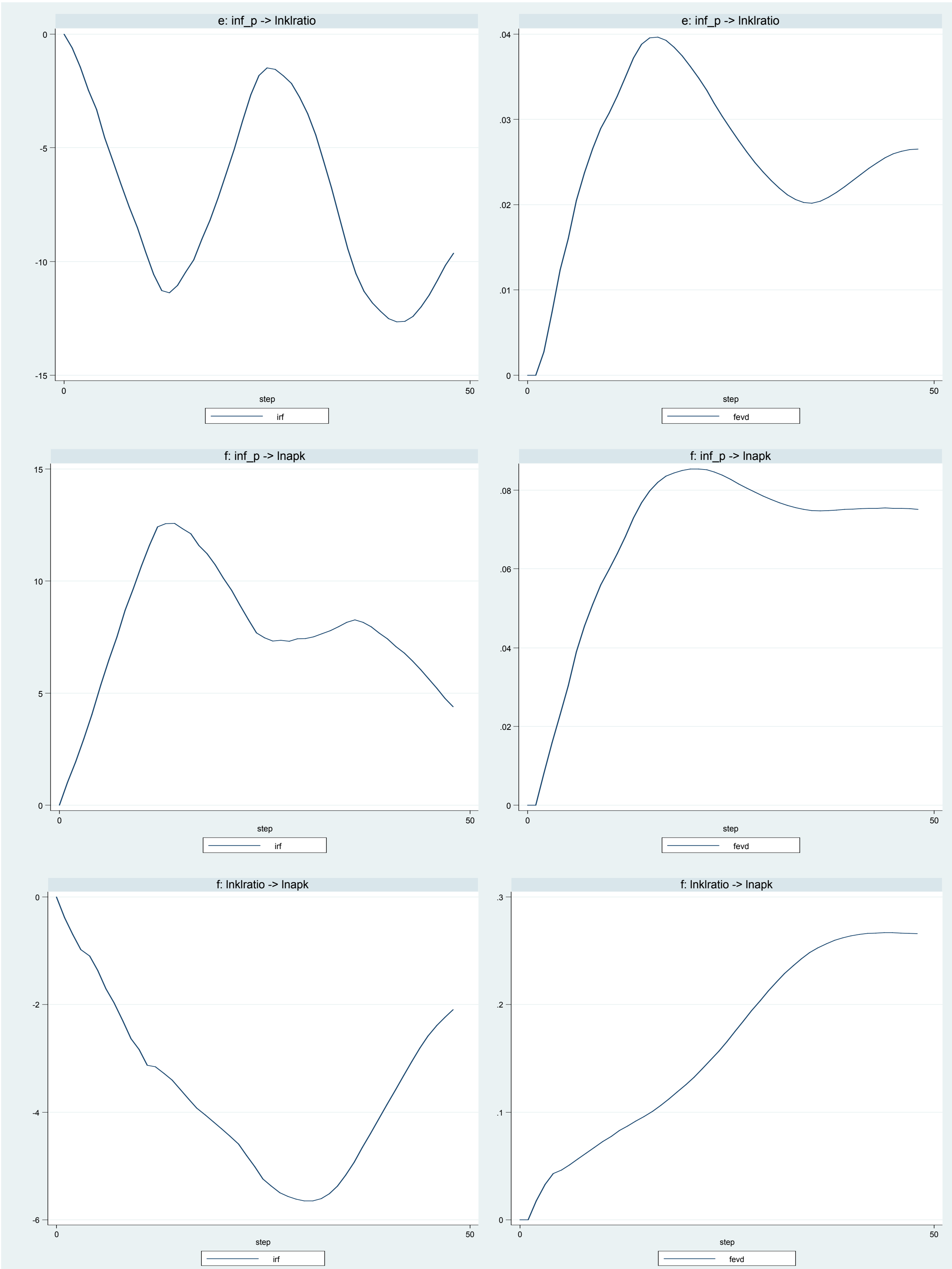


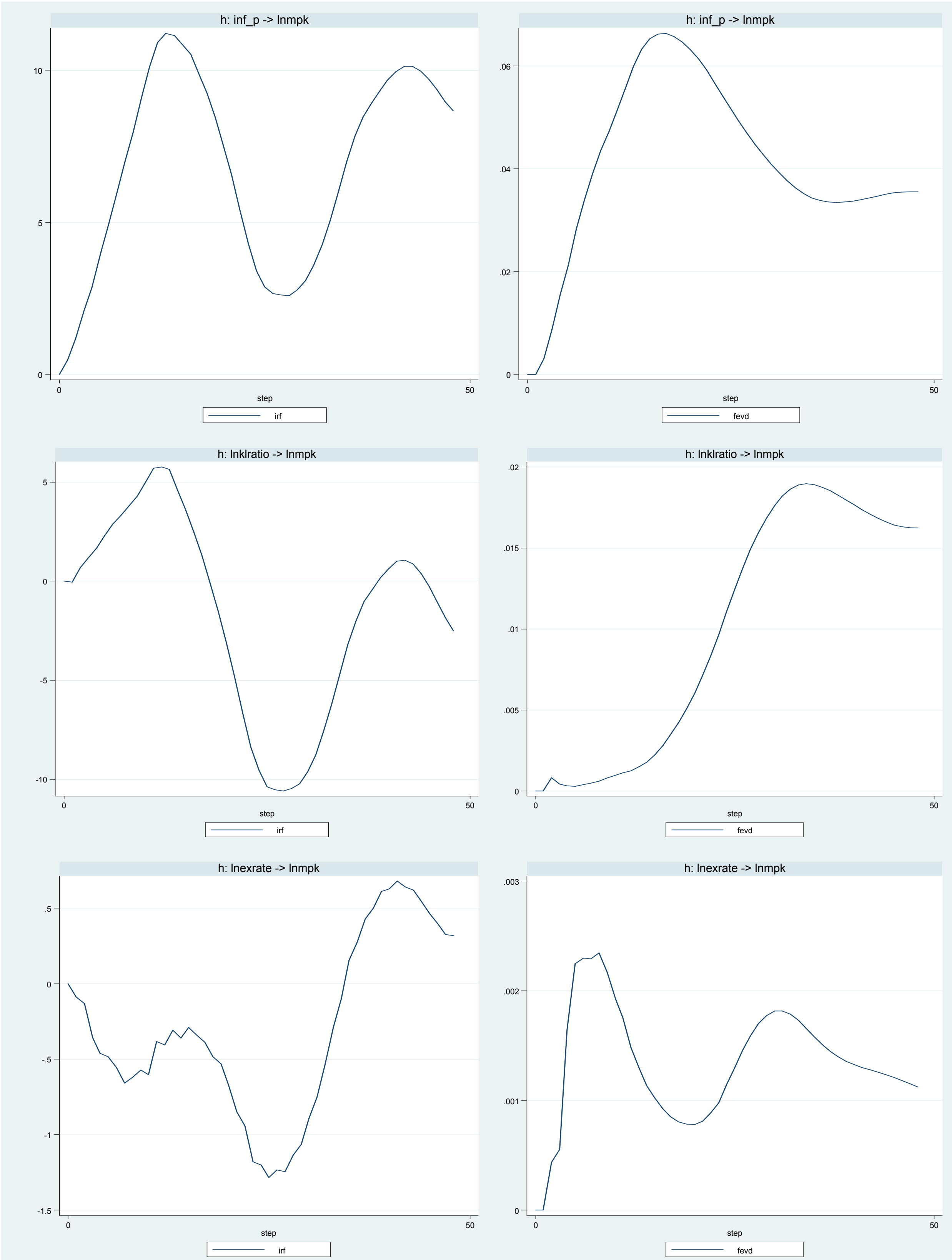
a: lnexrate -> inf_p
0
.5
1
0
50
step
irf
a: lnexrate -> inf_p
0
.1
.2
.3
0
50
step
fevd


aa: lnexrate -> lnM2
2
0
-2
-4
-6
0
50
step
irf
aa: lnexrate -> lnM2
.04
.03
.02
.01
0
0
50
step
fevd
aa: inf_p -> lnexrate
0
-5
-10
0
50
step
irf
aa: inf_p -> lnexrate
.008
.006
.004
.002
0
0
50
step
fevd
aa: lnexrate -> inf_p
1
.5
0
-.5
0
50
step
irf
aa: lnexrate -> inf_p
.15
.1
.05
0
0
50
step
fevd


b: lnexrate -> i
0
-1
-2
-3
-4
0
50
step
irf
b: lnexrate -> i
.003
.002
.001
0
0
50
step
fevd
b: lnexrate -> inf_p
1
.5
0
-.5
0
50
step
irf
b: lnexrate -> inf_p
.2
.1
0
0
50
step
fevd
b: inf_p -> lnexrate
0
-2
-4
-6
-8
0
50
step
irf
b: inf_p -> lnexrate
.006
.004
.002
0
0
50
step
fevd


d: lnexrate -> lnklratio
step
irf
d: lnexrate -> lnklratio
step
fevd
e: inf_p -> lnmpl
step
irf
e: inf_p -> lnmpl
step
fevd
e: lnklratio -> lnmpl
step
irf
e: lnklratio -> lnmpl
step
fevd


e: inf_p -> lnklratio
0
-5
-10
-15
step
0
50
irf
e: inf_p -> lnklratio
.04
.03
.02
.01
0
step
0
50
fevd
f: inf_p -> lnapk
15
10
5
0
step
0
50
irf
f: inf_p -> lnapk
.08
.06
.04
.02
0
step
0
50
fevd
f: lnklratio -> lnapk
0
-2
-4
-6
step
0
50
irf
f: lnklratio -> lnapk
.3
.2
.1
0
step
0
50
fevd


h: inf_p -> lnmpk
step
irf
h: inf_p -> lnmpk
step
fevd
h: lnklratio -> lnmpk
step
irf
h: lnklratio -> lnmpk
step
fevd
h: lnexrate -> lnmpk
step
irf
h: lnexrate -> lnmpk
step
fevd