How the banking system is creating a two-way inflation in an economy?

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Abstract

Here we argue that due to the difference between the real GDP growth rate and nominal deposit rate, a demand pull inflation is induced into the economy. On the other hand, due to the difference between real GDP growth rate and nominal lending rate, a cost push inflation is created. We quantitatively measure the amount of nominal interest income the depositors spend on each unit of consumed goods and the amount of nominal interest expense the borrowers pay on each unit of produced goods which is not supported by the accompanying real GDP growth rate and thereby causing inflation in the economy. We examine the process of creating two-fold inflation by the interplay between real GDP growth rate and nominal deposit & lending rate and provide two metrics that tend to link the overall inflation prevailing at any point of time in an economy to the nominal deposit & lending rate in the long run. We compare the performance of our model to the Fisherian one [8] by using Toda and Yamamoto [16] approach of testing Granger Causality [9] in the context of non-stationary data. We then use ARDL Bounds Testing approach [14], [15] to cross-check the results obtained from T-Y approach.

1 Introduction

We propose a new model that describes the role of the banking system in creating a two-way inflation in an economy. According to the proposed model, when the nominal deposit interest rate of the bank is set to a value which is higher than the underlying real GDP growth rate then the money in the depositors' account grows faster than the goods in the real sector. So, it will lead to *too much money chasing too few goods* type of scenario which eventually shifts the demand curve upward. On the contrary, when the nominal deposit interest rate is lower than the underlying real GDP growth rate then the money in the depositors' accounts grows slower than the goods in the real sector which increases the purchasing power of the money and thereby decreases the general price level. On the other hand, when the borrowers (investors) are charged at a rate higher than the real GDP growth rate, they (borrowers/investors) have to pay more money than they actually earn by investing the borrowed fund into the real sector. In order to compensate for this, the borrowers (investors) will raise the price of the goods and services produced by them which will shift the supply curve upward. The opposite holds true also. When the economy grows at a rate higher than the nominal lending rate charged by the bank, then the borrowed fund injected into the economy will earn more than it costs. Thus, interest expense of the leveraged business concerns are compensated by the rapid growth of the economy and producers do not feel the urge to raise the price level. Apart from nominal deposit and lending rate, we also consider the total volume of deposit and credit in the banking system in establishing the relationship between interest rate and inflation. Because, if the amount of deposit and credit in the banking channel is not substantial as compared to the overall size of the economy then the causality running from nominal interest rate to inflation becomes weak. Here, we try to quantify the combined impact of the aforementioned variables on the inflation and provide two metrics which, according to our point of view, can be linked to inflation. The rest of this paper is organized as follows: Section 2 describes the rational behind adopting a new model that relates nominal interest rate and inflation, Section 3 & 4 show how nominal deposit & lending rate can induce a demand pull & cost push inflation respectively. Section 5 determines the combined effect of nominal deposit and lending rate on inflation. Section 6 explains the methodology used to statistically verify our claim. Section 7 presents the data obtained in statistical analysis. Section 8 compares the result of our model to that of the Fisherian one and finally, Section 9 makes some concluding remarks.

2 Rational Behind Adopting a New Model

The only well known and most studied relationship between interest rate and inflation is the so-called Fisher Hypothesis [8] which says that the nominal interest rate rises point-for-point basis with the expected inflation assuming the real interest rate to be constant. Since its inception in 1930, a number of empirical studies have been carried out to judge its effectiveness in describing the relationship between interest rate and inflation and the results of these vast amount of empirical analysis are mixed: Some studies find the evidence of Fisherian link while the others reject it. Atkins (1989) [1] has shown that the post-tax nominal interest rates and inflation in Australia and USA for the period 1953-1981 are cointegrated in the sense of Engle and Granger (1987) [6] and these variables have a joint error correction representation. Findings of Atkins (1989) [1] suggest existence of long run Fisher Effect in the aforementioned economies for the designated period. However, using the same Engle-Granger approach of cointegration, Macdonald and Murphy (1989) [13] has found no evidence of Fisher Effect in the data of USA, UK, Canada and Belgium for the period 1955-1986. Macdonald and Murphy (1989) [13] then divides the data depending upon the exchange rate regime and in the modified experimental set-up they have found evidence of Fisherian link only for USA and Canada. Moreover, Dutt and Ghosh (1995) [5] studies the validity of the Fisher Effect under both fixed and floating exchange rate regime. Johansen test of cointegration [10] methodology is applied to test the weak form of Fisher Effect while Phillips-Hansen fully modified ordinary least square (FM-OLS) technique is applied to test the strong form of Fisher Effect. However, in both cases and in both fixed and floating exchange rate regimes, the Fisher Effect is soundly rejected. But, Crowder (1997) [3] has found significant evidence of the existence of Fisher Effect in Canadian data of inflation and nominal interest rate although the Fisherian relationship was not found to be stable in the period examined. Crowder and Hoffman (1996) [4] also finds evidence of tax adjusted Fisher Effect on the US and Canadian data using Johansen Test of co-integration [10]. All the above approaches uses the concept of cointegration in one form or another and cointegration requires each of the variables under consideration to be of I(1): Variables must be stationary at first difference, but non-stationary at level. So, we need some form of robust test for the presence of unit root in time series before we go for checking cointegration and none of the standardized tests of checking stationarity of time series is that much robust. Different tests of stationarity or even the same test with different parameter setting may give different results regarding the order of integration of the time series under consideration [2]. So, the success of all the above literature highly depends on determining the correct order of integration of the time series. To overcome this difficulty, Frank J. Atkins, Patrick J. Coe (2002) [2] applies the ARDL Bounds testing approach developed by Pesaran, Shin and Smith [15] to study the existence of long run cointegrating relationship between nominal interest rate and inflation. ARDL Bounds Testing approach can be comfortably applied to the data which can be any mixture of I(0) and I(1) processes. Their results do not support tax adjusted Fisher Effect for Canada during the period 1953-1999 and for the US data in the same period, their conclusion regarding the existence of the so-called Fisher Effect is somewhat in the grey region. However, Koustas (1999) [12] applies King and Watson (1997) [11] methodology to test Fisher Effect in the post-war quarterly data of nine industrialized country (Belgium, Canada, Denmark, France, Germany, Greece, Ireland, Japan, the Netherlands, the United Kingdom and the United States) and they eventually find no evidence in favor of Fisher Effect. All the exhaustive literature regarding interest rates and inflation hinges around the empirical verification of the Fisher Effect in different set up and varying time frame with no attempt to augment the model with some core elements it has been missing. From our point of view, Fisher Effect, albeit elegant, is too simple to be true. First of all, it overlooks the impact of contemporary real GDP growth rate while establishing the long run relationship between interest rate and inflation. As we have already mentioned in the introductory section of this article, the difference between real GDP growth rate and nominal deposit rate can give birth to demand pull inflation (deflation) in the economy. When the nominal deposit rate is higher than the real GDP growth rate then the money in the depositors' accounts grows faster than the goods in the real sector and it leads to a situation where *too much money is chasing too few goods* and vice versa. On the other hand, when the nominal lending rate is set to a value which is higher than the contemporary real GDP growth rate then the borrowers (investors) have to pay more money than they actually earn by investing it (the borrowed fund) into the real sector which provokes them to raise the price level of the goods and services they produce. This eventually creates a cost push inflation in the economy. Secondly, the Fisher Effect does not discriminate between two different types of interest rate namely, deposit interest rate and lending interest rate, which may effect inflation in different ways. As we have mentioned previously, the deposit interest rate is tied to demand pull inflation while the lending interest rate is tied to the cost push one: One intends to shift the aggregate demand curve upward while the other raises the general price level by pushing up the aggregate supply curve. Fisher Effect, being overly simplified, does not make any mention to these two very different forms of inflation existing in the economy who are inherently different from their point of origin. Next, Fisher Effect fails to account for the volume of deposit and credit which, from our point of view, can not be ignored. When the size of the deposit (credit) is insignificant as compared to the total GDP of the economy, the effect of interest rate on inflation will be negligible. This is because, when the amount of deposit (credit) is insignificant, then it will effect only a handful of people in the economy and thereby its effect on the general price level would be insignificant. On the other hand, when the amount of deposit (credit) is comparable to the GDP of the economy, then the effect of interest rate (both deposit and lending interest rate) on inflation will be very much pronounced. One last point about the Fisher Effect, although it algebraically relates the interest rate and inflation, it mostly ignores the overall macro-economic mechanism that links them together. The points aforementioned encourages us to provide a new model that more clearly captures the dynamic relationship between interest rate and inflation and shed some light on the macro-economic mechanism that holds them together.

3 Relationship Between Inflation and Nominal deposit rate

Let, d be the nominal deposit rate, g be the real GDP growth rate and D be the total amount of deposit in the banking system.

Then the total amount of nominal interest income annually received by the depositors is given the following construct:

$$d \times D$$

If the nominal deposit rate d becomes equal to real GDP growth rate g then money in the depositors' accounts grows at the same pace as the goods grow in the real sector. Depositors in this case tend to spend the same amount of money on each unit of produced goods as both goods and depositors' money grow equally over the time. The nominal interest income thus received annually by the depositors is given by:

$$g \times D$$

Any nominal interest income above and beyond $g \times D$ will increase the depositors' ability to spend more money on goods & services and this increase in depositors' ability to spend more money on goods & services can be quantified by the following:

$$d \times D - g \times D$$

$$= (d - g) \times D$$

The above quantity represents a portion of nominal interest income received by the depositors which are not supported by an equivalent increase in goods and services in the real sector. A portion of this *extra* nominal interest income will be spent while the other portion will be saved. If the average propensity to consume is given by APC then the portion of *extra* nominal interest income spent by the depositors on goods and services is given by:

$$APC \times (d - g) \times D$$

If the nominal GDP of the economy is given by G then the amount of *extra* nominal interest income spent by the depositors on each unit of produced goods is given by:

$$\frac{APC \times (d - g) \times D}{G} \tag{1}$$

The last quantity will be our metric to quantify the demand pull inflation caused by the banking channel. We name this quantity as *extra* amount of nominal interest income the depositors pay on each unit of consumed goods and services. It is so named as it represents only a 'monetary' increase which is not backed by the real sector.

4 Relationship Between Inflation and Nominal lending rate

Let, l be the nominal lending rate, g be the real GDP growth rate and L be the total amount of credit in the banking system.

Then the nominal interest expense incurred by the borrower is given by:

$$l \times L$$

If the nominal lending rate l becomes equal to the real GDP growth rate g then borrower's loan in the banking channel grows at the same pace as the goods grow in the real sector. Other things remaining unchanged borrowers do not feel any urge to raise the price level as they can compensate for the interest expense by producing more goods and services. So, the nominal interest income thus incurred by the borrowers in this case is given by:

$$g \times L$$

Any nominal interest expense above and beyond $g \times L$ will cause the borrowers to charge more money on each unit of produced goods in order to compensate for the difference between the growth rate of loan amount and the real growth achieved. So, we can quantify the total amount of nominal interest expense over and above $g \times L$ by the following construct:

$$l \times L - g \times L$$

$$= (l - g) \times L$$

The above amount of *extra* nominal interest expense will be incurred to produce all the goods and services in the economy. So, the amount of *extra* nominal interest expense incurred by borrowers to produce each unit of goods and services is given by:

$$\frac{(l-g) \times L}{G} \tag{2}$$

The last quantity will be our metric to quantify the cost push inflation caused by the banking channel. We name this quantity as *extra* amount of nominal interest expense incurred by the borrowers on each unit of produced goods and services. It is so named as it represents only a 'monetary' increase which is not backed by the real sector.

5 Combined effect of nominal deposit rate and nominal lending rate on inflation

Prevoiously we calculate the impact of nominal deposit rate and nominal lending rate on inflation individually. Here we will calculate the combined impact of these two rates on inflation. To do this, we first divide the depositors into 2 classes: One class of depositors have only deposit but no loan with the bank while other type of depositors have both deposit and loan with the bank. Let us assume that $\alpha, 0 \leq \alpha \leq 1$ be the portion of deposit whose owners do not have loan accounts with the bank. So, $(1-\alpha)$ will be portion of deposit whose owners have both loan and deposit account with the bank. We also assume that β is portion of credit of those borrowers who do not have deposits with the bank. So, $(1-\beta)$ will be the portion of credit of those borrowers who have both deposits and credits with the bank.

So the *extra* amount of nominal interest income spent on per unit of goods by the depositors who do not have credit with the bank is given by the following construct.

$$\frac{\alpha \times APC \times (d-g) \times D}{G} \tag{3}$$

On the other hand, the *extra* amount of nominal interest expense paid by the borrowers on per unit of goods produced who do not have deposits with the bank, will be given by the following expression.

$$\frac{\beta \times (l-g) \times L}{G} \tag{4}$$

Remaining $(1-\alpha)$ portion of deposits is owned by the customers who have borrowed $(1-\beta)$ portion of the total loan. Whether this segment of customers get or pay more money over and above the real GDP growth, will depend upon the sign of the following quantity.

$$\frac{(1-\alpha)\times(d-g)\times D}{G}-\frac{(1-\beta)\times(l-g)\times L}{G} \tag{5}$$

If the sign of the above quantity is positive then the segment of customers who have both loan and deposit with the bank will receive more money than they pay for their loan and the difference between amount received & amount paid, will create demand pull inflation. So combining the contribution of these two segements of customers (who have only deposit and who have both deposit & loan), we found overall *extra* amount of nominal interest income spent on per unit of goods produced (EM) which will be given by the following equation:

$$EM = APC \times \left(\frac{\alpha\times(d-g)\times D}{G}+\left(\frac{(1-\alpha)\times(d-g)\times D}{G}-\frac{(1-\beta)\times(l-g)\times L}{G}\right)\right)$$

$$EM = APC \times \left(\frac{(d-g)\times D}{G}-\frac{(1-\beta)\times(l-g)\times L}{G}\right) \tag{6}$$

In this case, the total amount of *extra* nominal interest expense incurred by the customers who borrow to produce, will be given by the construct given in Equation: 4.

However, if the sign of the quantity given in 5 is negative then the segment of customers who have both deposit and loan accounts, will pay more money than they recieve on top of the real GDP growth. So, then the overall amount of *extra* nominal interest expense incurred by the two segments of customers (one who have only loan and the one who have both loan & deposit with the bank) to produce per unit of goods will be given by:

$$EC = \frac{\beta\times(l-g)\times L}{G}+\left(\frac{(1-\beta)\times(l-g)\times L}{G}-\frac{(1-\alpha)\times(d-g)\times D}{G}\right)$$

$$EC = \frac{(l-g)\times L}{G}-\frac{(1-\alpha)\times(d-g)\times D}{G} \tag{7}$$

In this case, the *extra* amount of nominal interest income spent by the depositors on each unit of produced goods and services will be given by construct given in equation: 3.

The *extra* amount of nominal interest income the depositors spend on per unit of produced goods (EM) will shift the demand curve upward while the *extra* amount of nominal interest expense (EC) incurred by the borrowers will shift the supply curve upward. Let us assume a parallel shift of demand and supply curve by an amount d_1 and d_2 respectively. Let us also assume that, initially, the demand and supply curve are given by the following two equations:

$$P = m_d \times Q + c_1$$

$$P = m_s \times Q + c_2$$

Let the shifted set of equations are given by:

$$P = m_d \times Q + c_3$$

$$P = m_s \times Q + c_4$$

In the above equations, m_d and m_s are the slope of demand and supply curve. As we

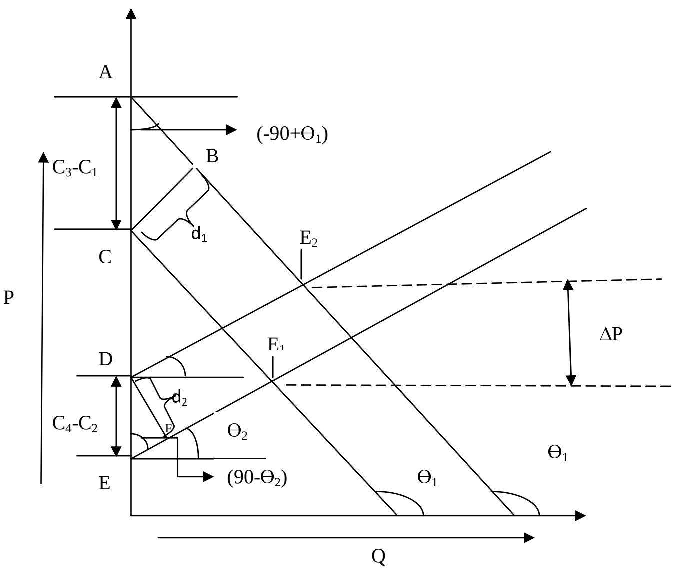

Figure 1: Impact of *EM* and *EC* on demand and supply.

assume parallel shifts in demand and supply curve, m_d and m_s remain unchanged in the shifted equations. Then using simple geometric analysis, it can be shown that the change in price (ΔP) in response to the shifts in demand and supply curve is given by the following:

$$\Delta P = \frac{m_d}{m_d - m_s} \times d_2 \times sec(\theta_2) + \frac{m_s}{m_d - m_s} \times d_1 \times sec(\theta_1) \tag{8}$$

where θ_1 and θ_2 are the angle of inclination of demand and supply curve respectively. As we only assume parallel shifts, m_d, m_s, θ_1 and θ_2 remain unchanged. So, the above equation turns out to be:

$$\Delta P = K_1 \times d_1 + K_2 \times d_2$$

Where K_1 and K_2 are constants. As we mentioned previously, d_1 and d_2 are the parallel shifts of demand and supply curve, they will depend upon EM and EC. Higher the value of EM and EC, higher will be the value of d_1 and d_2 respectively. So, we can safely assume that d_1 & d_2 are proportional to EM & EC respectively. Considering this, we can rewrite the above equation as follows:

$$\Delta P = K_3 \times EM + K_4 \times EC \tag{9}$$

Where K_3 and K_4 are constants. Now, if the sign of the quantity given in equation:5 is positive, then we can substitute the value of EM and EC from equation: 6 and equation: 4 into equation: 9. Then we get the following equation that relates change in price (ΔP) to EM and EC:

$$\Delta P = \frac{K_3 \times APC \times (d - g) \times D}{G} + \frac{(K_4 \times \beta - K_3 \times (1 - \beta) \times APC) \times (l - g) \times L}{G} \tag{10}$$

So,

$$\frac{\Delta P}{P} = \frac{K_3 \times APC \times (d - g) \times D}{P \times G} + \frac{(K_4 \times \beta - K_3 \times (1 - \beta) \times APC) \times (l - g) \times L}{P \times G} \tag{11}$$

But, if the sign of the quantity given in equation:5 is negative, then we substitute the value of EM and EC from equation: 3 and equation: 7 into equation: 9. And, we get the following after simplification:

$$\Delta P = \frac{(K_3 \times \alpha \times APC - K_4 \times (1 - \alpha)) \times (d - g) \times D}{G} + \frac{K_4 \times (l - g) \times L}{G} \tag{12}$$

So,

$$\frac{\Delta P}{P} = \frac{(K_3 \times \alpha \times APC - K_4 \times (1-\alpha)) \times (d-g) \times D}{P \times G} + \frac{K_4 \times (l-g) \times L}{P \times G} \tag{13}$$

6 Methodology

We can see from equation: 11 and equation: 13, in all cases (whether the sign of the quantity given in equation: 5 is positive or negative), inflation is some linear combination of the constructs given in equation: 1 and 2. So, we build a model where inflation is the dependent variable and the quantities given in equation: 1 & 2 namely, $\frac{APC \times (d-g) \times D}{GDP}$ and $\frac{(l-g) \times L}{GDP}$ are the two independent variables.

On the other hand, to model Fisher effect, we invoke rational expectation and assume the expected inflation at any point of time, is given by the actual inflation one period ahead of the present time. Assuming this, the Fisher equation turns out to be:

$$i_t = A_0 + A_1 \times \pi_{t+1} + \epsilon_t$$

where i_t is the nominal interest rate at time t, π_{t+1} is the expected inflation at time t which is the actual inflation at time $(t+1)$ and A_0, A_1 are constants, ϵ_t is the error term. We use nominal lending interest rate to model nominal interest rate and annual GDP deflator to model inflation.

If the Fisherian equation succeeds as an algebraic equality then it must confer the following two things among others:

- Inflation and (time lagged) interest rate are cointegrated.
- There must have been a bidirectional causality running amongst the aforesaid variables.

The above two statements provide us a solid ground upon which we can empirically compare the performance of our model to the Fisherian one. To do so, the following steps are followed:

6.1 Unit Root Testing

We begin our analysis by testing for unit roots in the underlying time series. Five different time series namely, inflation, nominal deposit rate, nominal lending rate, $\frac{APC \times (d-g) \times D}{GDP}$

and $\frac{(l-g)\times L}{GDP}$ of five OECD countries (Australia, Japan, Korea, Switzerland and UK) are tested for the presence of unit roots using Augmented Dickey Fuller (ADF) Unit Root Test. The countries are arbitrarily chosen depending upon the availability of data. As we know, the ADF test comes up with different variants: 1) having intercept only 2) having trend and intercept and 3) no trend, no intercept in the equation, all these variants are tested.

6.2 Granger Causality Test Using Toda and Yamamoto Approach [16]

One of the most popular approaches of testing Granger non-causality in the context of non-stationary time series is the T-Y approach proposed by Toda and Yamamoto [16]. The following steps are taken to check for Granger non causality in the context of non stationary data under T-Y approach:

1. Determine the maximum order of integration of the underlying time series. Let this be denoted by m.
2. Determine the appropriate lag length for the VAR model having the data in level using some information criterion like LR, FPE, AIC, SC, HQ etc. The lag length that minimizes the chosen information criterion is selected.
3. Build a VAR model using all the endogenous variables in level each having number of lags as determined in the previous step.
4. Test for the presence of any serial correlation in the aforesaid VAR model. If there is serial correlation amongst the residuals, then increase the lag length until the serial correlation is removed. Let, this lag length be denoted by p.
5. Test the dynamic stability of the VAR model having p lags by plotting the inverse roots of the AR characteristic polynomial. The model is said to be stable dynamically, if all the roots lie within the unit circle.
6. Now rebuild the VAR model by adding extra m lags of each of the variables. These additional m lags appear as exogenous in the VAR representation.
7. On the above manuever of adding m additional lags of each variable in the VAR model as exogenous, the Wald Test Statistics will be asymptotically Chi-square distributed under the null hypothesis of no Granger Causality.
8. Now perform VAR Granger Causality/Block Exogeneity Wald Test and note down the corresponding p-value.

9. The rejection of null hypothesis denotes the existence of Granger Causality amongst the variables.

6.3 ARDL Bounds Testing

After causality is conferred by the T-Y procedure, we can cross check the result by performing cointegration test amongst the same set of variables. If there is cointegration amongst the variables, then there must exist causality in either direction or both. In order to cross check the result obtained at the previous step, we will check for cointegration using ARDL Bounds Testing approach proposed by Pesaran, Shin and Smith [14], [15]. This is indeed a special kind of cointegration testing that is intended to handle both $I(0)$ and $I(1)$ variables simultaneously. Unlike other popular approaches of testing cointegration like the Johansen Test of Cointegration [10], ARDL Bounds Testing approach can be applied to any combination of $I(0)$ and $I(1)$ variables which made it a more generic choice.

7 Data

We collect annual data of nominal lending rate, nominal deposit rate, inflation (GDP deflator), money supply (M2) as percentage of GDP, domestic credit provided by the financial sector as a percentage of GDP and gross savings as a percentage of GDP from World Bank which is publicly available through the URL: `data.worldbank.org/indicator`. To ensure consistency among datasets, we only use data from that single source. We approximate the total deposit of the banking sector by the Broad Money (M2) on the ground that Broad Money (M2) is positively correlated to the banks' total demand and time liabilities. Average Propensity to Consume (APC) is measured by (1-gross savings as a perentage of GDP). The sampling period is from 1960 to 2014 although some series are truncated (listwise deletion) between this range depending upon the availability of the data. Data of some 5 (five) OECD countries are collected and analyzed. Countries are chosen by the availability of the data.

7.1 ADF Unit Root Test and the Value of m for T-Y Procedure

The results obtained by performing ADF Unit Root Test are presented in Table: 1, 2, 3, 4 and 5. From these tables, the value of m (the maximum order of integration of any group for any country) can be determined. It is revealed from these tables that the value of m for our proposed model is: 1 (one) for Australia & Switzerland, 0 (zero) for Japan

& Korea and 2 (two) for UK while for Fisherian Model, the value of m is: 1 for Australia, Japan, Korea & Switzerland and 2 (two) for UK.

7.2 Lag Length Selection for VAR Model

For the proposed model, we build country-wise VAR representations with inflation, $\frac{APC \times (d-g) \times D}{GDP}$ and $\frac{(l-g) \times L}{GDP}$ as endogenous variables. Lag length in the range $[1, 5]$ are tested. The lag length that minimizes different information criteria like LR, FPE, AIC, SC and HQ are noted. Lag numbers suggested by majority of the information criteria are selected. When there is a tie, we choose the minimum one. The lag length is thereby chosen to be: 4 (four) for Australia, 1 (one) for Japan & Korea and 2 (two) for Switzerland & UK. The summary of the lag order selection test for the proposed model is presented in Table: 6.

After determining the appropriate lag length, we run our country-wise VAR model to check for the presence of serial correlation in the residuals. Serial Correlation LM Test is performed for lag length $[1-10]$ and the results are presented in Table: 8 for Australia, Table: 9 for Japan, Table: 10 for Korea, Table: 11 for Switzerland and Table: 12 for UK. From these tables, it is evident that none of the VAR models with lag length selected in the above manner suffers from the problem of serial correlation which is desirable.

We also check for the dynamic stability of the VAR models with selected lag length. It can be seen from Figure: 2, 3, 4, 5 and 6 that all the models are dynamically stable (having their roots lying within the unit circle).

For the Fisherian model, we build country-wise VAR representations with inflation$(t+1)$ and nominal lending rate(t) as endogenous variables. The optimal lag length is selected to be: 1 (one) for Australia, Korea, Switzerland & UK and 2 (two) for Japan. The summary of the lag order selection test for the Fisherian model is presented in Table:17.

After determining the appropriate lag length, we run our country-wise VAR model to check for the presence of serial correlation in the residuals. Serial Correlation LM Test is performed for lag length $[1-10]$ and the results are presented in Table: 20 for Australia, Table: 21 for Japan, Table: 22 for Korea, Table: 23 for Switzerland and Table: 24 for UK. From these tables, it is evident that none of the VAR models with lag length selected in the above manner suffers from the problem of serial correlation which is desirable.

We then check for the dynamic stability of the VAR models with selected lag length. It can be seen from Figure: 7, 8, 9, 10 and 11 that all the models are dynamically stable (having their roots lying within the unit circle).

7.3 VAR Granger Causality/Block Exogeneity Wald Test (T-Y Approach)

Having determined the value of m and p, we are now in the position to run the VAR Granger Causality/Block Exogeneity Wald Test. We insert inflation, $\frac{APC\times(d-g)\times D}{GDP}$ and $\frac{(l-g)\times L}{GDP}$ as endogenous variables in unrestricted VAR estimation while the lag number p for the endogenous variables are already calculated in previous sections. We add additional m lags of inflation, $\frac{APC\times(d-g)\times D}{GDP}$ and $\frac{(l-g)\times L}{GDP}$ as exogenous variables in the VAR. With this specification, we perform VAR Granger Causality/Block Exogeneity Wald Test on our data. The results of the test for our model are presented in Table: 7. From Table: 7, it is evident that we have found Granger Causality from two of our proposed metrics namely, $\frac{APC\times(d-g)\times D}{GDP}$ and $\frac{(l-g)\times L}{GDP}$ to inflation @1% level for Australia, Japan, Korea and Switzerland. However, no causality is conferred by the test for the British data.

On the other hand, the results of performing VAR Granger Causality under Fisherian framework are presented in Table: 18 and 19. From 18, we find evidence in favour of Granger Causality running from expected inflation (actual inflation at time $(t+1)$) to (current) nominal lending rate (nominal lending rate at time t). However, the causality in the opposite direction i.e., from nominal lending rate(t) to inflation($t+1$) does not hold true in any of the cases as depicted in Table: 19.

7.4 ARDL Bounds Test

ARDL Bounds Testing approach proposed by Pesaran, Shin and Smith [14], [15] can be performed on different parametric settings. For example, different kind of fixed regressors can be incorporated into the model: intercept, intercept and trend, no intercept no trend etc. We try all these three variants. We set the maximum lag for dependent variable and regressors to be 5. On these specification, ARDL Bounds Testing is performed.

For our model, we insert inflation as dependent variable and $\frac{APC\times(d-g)\times D}{GDP}$ & $\frac{(l-g)\times L}{GDP}$ as two dynamic regressors. The results are presented in Table: 13, 14, 15 and 16. From these tables, it can be seen the presence of long run relationships in Australian and Korean data for all three variants. For Japanese and Swiss data, we find the existence of long run relationship amongst the variables for 2 out of 3 variants of ARDL Bounds Testing approach.

ARDL Bounds Testing under Fisherian framework is performed with nominal lending rate(t) as dependent variable and inflation($t+1$) as independent variable. Maximal lag length for dependent variable and dynamic regressors are chosen to be 5 as before. All three variants with different kinds of fixed regressors are tested. The results are presented in Table: 25, 26, 27 and 28. We find evidence in favour of long run relationships for all the countries under investigation.

8 Discussion

If two or more time series are cointegrated then there is supposed to be Granger Causality amongst them in either direction or both. Results obtained here mostly agree with the above statement. To be precise, both of our variables namely $\frac{APC\times(d-g)\times D}{GDP}$ and $\frac{(l-g)\times L}{GDP}$ are found to be cointegrated with inflation for 4 out of 5 countries (as can be seen from table: 13, 14, 15 and 16). For UK, we can not run the ARDL Bounds Test as one of the variables namely inflation is found to be non-stationary even after first difference (see table: 5) which invalidates the test. For the remaining four countires, cointegration amongst the proposed variables has been found. As cointegrations amongst the variables are found, then we might assume the presence of Granger causality amongst the variables in at least one direction if not both. The presence of Granger causality from $\frac{APC\times(d-g)\times D}{GDP}$ and $\frac{(l-g)\times L}{GDP}$ to inflation for all the countries except UK has also been observed (as can be seen from table: 7) which reinforces our claim.

On the other hand, Fisher equation being an equality posits the presence of a bi-directional causality running between interest rate and inflation. As can be seen from Table: 18, the Fisher equation can successfully explain the causal relationship running from expected (future) inflation to the (current) nominal lending rate. However, no causality is conferred in the reverse direction (see Table: 19). So, although, inflation alone can explain interest rate, the converse is not necessarily true which implies it is better to view the Fisher effect as a unidirectional causality instead of a (bidirectional) equality. Infact, apart from interest rate, we need more variables to explain inflation and this is where lies the main essence of this paper. Here we argue interest rate when combined with real GDP growth rate, total amount of domestic credit and the total volume of deposit in the aforementioned manner can explain inflation. The empirical evidence in 4(four) out of 5(five) countries also suggests our intuitive arguments as can be seen from Table: 7.

9 Conclusion

We compare the performance of our model with the Fisherian one using VAR Granger Causality Test and ARDL Bounds Test. This comparison is indeed necessary to provide a justification about why we should rethink the relationship between interest rate and inflation in greater detail above and beyond the Fisher equation. Fisher equation seeks to establish a relationship between interest rate and inflation based upon a causality which runs from expected inflation (future inflation) to the (current) nominal lending rate. Intuitively, when the lender anticipates a rise in inflation, he/she will set the nominal lending rate to a relatively higher value in order to compensate for the loss of purchasing power of money due to inflation. This is one angle from which we can see the dynamic relationship between interest rate and inflation. However, in this paper, we view the relationship from an angle different from the Fisherian one. In our proposed model, the causality goes from interest rate to inflation. Here, we argue that a change in nominal interest rate, if not accompanied by the same change in real GDP growth rate, can give birth to inflation. In almost all of the cases, the statistical analysis suggests long run (causal) relationship between the two proposed metrics and inflation. However, for a single case, we fail to find a causal relationship in our proposed direction. It is because, we have only considered a hand full of variables (two types of interest rate, total volume of deposit & credit in the banking system and the real GDP growth rate) to explain inflation. There is a whole set of other macro-economic phenomena which can influence inflation significantly. When the effect of the two proposed metrics are suppressed by the effect of some other phenomena acting on inflation in the opposite direction, then we think, we fail to find any significant cointegrating relationship and these deviations require detailed case-by-case analysis for every individual incident which is beyond the scope of this study. Yet, these two metrics can be used to explain inflation in the long run under broad head.

10 Obligatory Copyright Note

References

[1] Atkins, F.J., 1989. Co-integration, error correction and the Fisher effect. Applied Economics 21, 1611-1620.

[2] Atkins,F.J., Coe, P.J, An ARDL bounds test of the long-run Fisher effect in the United States and Canada. Journal of Macroeconomics 24 (2002) 255-266.

[3] Crowder, W.J., 1997. The long-run Fisher relation in Canada. Canadian Journal of Economics 30, 1124-1142.

[4] Crowder, W.J., Hoffman, D.L., 1996. The long-run relationship between nominal interest rates and inflation: the Fisher equation revisited. Journal of Money Credit and Banking 28, 102-118.

[5] Dutt, S.D., Ghosh, D., 1995. The Fisher hypothesis: examining the Canadian experience. Applied Economics 27, 1025-1030.

[6] Engle, R.F., Granger, C.W.J. *Co-integration and error correction: representation, estimation and testing.*. Econometrica: 55 (2), 251-276.

[7] Fisher, M., Seater, J. *Long-run neutrality and superneutrality in an ARIMA framework.*. American Economic Review 83, 402-415, 1993.

[8] Fisher, I. (1930). The Theory of Interest, Macmillan, New York.

[9] Granger, C. W. J. *Investigating Causal Relations by Econometric Models and Cross-spectral Methods.* Econometrica 37 (3): 424-438, 1969.

[10] Johansen, S. "Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models". Econometrica 59 (6): 1551-1580. JSTOR 2938278, 1991.

[11] King, R.G., Watson, M.W. *Testing long-run neutrality.*. Federal Reserve Bank of Richmond Economic Quarterly 83, 69-101, 1997.

[12] Koustas Z., Serletis A. *On the Fisher effect.* Journal of Monetary Economics 44, 105-130, 1999.

[13] MacDonald, R., Murphy, P.D., 1989. Testing the long-run relationship between nominal interest rates and inflation using co-integration techniques. Applied Economics 21, 439-447.

[14] Pesaran, M.H. and Shin, Y. (1999). "An Autoregressive Distributed Lag Modelling Approach to Cointegration Analysis." Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium, Strom, S. (ed.) Cambridge University Press.

[15] Pesaran, M.H., Shin, Y. and Smith, R. "Bounds Testing Approaches to the Analysis of Level Relationships." Journal of Applied Econometrics, 16, 289-326, 2001.

[16] Toda, H. Y and T. Yamamoto (1995). "Statistical inferences in vector autoregressions with possibly integrated processes." Journal of Econometrics, 66, 225-250.

11 Tables

11.1 ADF Unit Root Test

Country	Series	Date Range	ADF Type	Level/ Differenced	p-value	Remark @ 5%
Australia	Inflation	1975-2013	Intercept	L	0.0805	NS
		„		FD	0	S
		„	Trend and Intercept	L	0.1094	NS
		„		FD	0	S
		„	None	L	0.0083	S
		„		FD	0	S
	Nominal deposit rate	1975-2013	Intercept	L	0.7614	NS
		„		FD	0.0002	S
		„	Trend and Intercept	L	0.5587	NS
		„		FD	0.0013	S
		„	None	L	0.2377	NS
		„		FD	0	S
	Nominal lending rate	1975-2013	Intercept	L	0.6253	NS
		„		FD	0	S
		„	Trend and Intercept	L	0.4679	NS
		„		FD	0	S
		„	None	L	0.3475	NS
		„		FD	0	S
	APCx(d-g)xD/GDP	1975-2013	Intercept	L	0.2795	NS
		„		FD	0	S
		„	Trend and Intercept	L	0.253	NS
		„		FD	0	S
		„	None	L	0.1008	NS
		„		FD	0	S
	(l-g)xL/GDP	1975-2013	Intercept	L	0.0438	S
		„		FD	0	S
		„	Trend and Intercept	L	0.1293	NS
		„		FD	0	S
		„	None	L	0.3454	NS
		„		FD	0	S

Table 1: ADF Unit Root Test

Country	Series	Date Range	ADF Type	Level/ Differenced	p-value	Remark @ 5%
Japan	Inflation	1977-2013	Intercept	L	0.0232	S
		„		FD	0	S
		„	Trend and Intercept	L	0.0187	S
		„		FD	0	S
		„	None	L	0.0008	S
		„		FD	0	S
	Nominal deposit rate	1977-2013	Intercept	L	0.4554	NS
		„		FD	0.0003	S
		„	Trend and Intercept	L	0.0545	NS
		„		FD	0.0018	S
		„	None	L	0.1681	NS
		„		FD	0	S
	Nominal lending rate	1977-2013	Intercept	L	0.8317	NS
		„		FD	0.0002	S
		„	Trend and Intercept	L	0.4698	NS
		„		FD	0.0014	S
		„	None	L	0.0833	NS
		„		FD	0	S
	APCx(d-g)xD/GDP	1977-2013	Intercept	L	0.0001	S
		„		FD	0	S
		„	Trend and Intercept	L	0.0004	S
		„		FD	0	S
		„	None	L	0	S
		„		FD	0	S
	(l-g)xL/GDP	1977-2013	Intercept	L	0.0001	S
		„		FD	0	S
		„	Trend and Intercept	L	0.0005	S
		„		FD	0	S
		„	None	L	0.0003	S
		„		FD	0	S

Table 2: ADF Unit Root Test

Country	Series	Date Range	ADF Type	Level/ Differenced	p-value	Remark @ 5%
Korea	Inflation	1980-2013	Intercept	L	0.0001	S
		„		FD	0.0008	S
		„	Trend and Intercept	L	0.0007	S
		„		FD	0.0048	S
		„	None	L	0	S
		„		FD	0	S
	Nominal deposit rate	1980-2013	Intercept	L	0.0225	S
		„		FD	0.0002	S
		„	Trend and Intercept	L	0.0089	S
		„		FD	0.0014	S
		„	None	L	0.0102	S
		„		FD	0	S
	Nominal lending rate	1980-2013	Intercept	L	0.0661	NS
		„		FD	0.0002	S
		„	Trend and Intercept	L	0.0511	NS
		„		FD	0.0009	S
		„	None	L	0.0301	S
		„		FD	0	S
	APCx(d-g)xD/GDP	1980-2013	Intercept	L	0	S
		„		FD	0	S
		„	Trend and Intercept	L	0.0002	S
		„		FD	0	S
		„	None	L	0	S
		„		FD	0	S
	(l-g)xL/GDP	1980-2013	Intercept	L	0.0001	S
		„		FD	0	S
		„	Trend and Intercept	L	0.0002	S
		„		FD	0	S
		„	None	L	0.0001	S
		„		FD	0	S

Table 3: ADF Unit Root Test

Country	Series	Date Range	ADF Type	Level/ Differenced	p-value	Remark @ 5%
Switzerland	Inflation	1981-2013	Intercept	L	0.1038	S
		„		FD	0	S
		„	Trend and Intercept	L	0.0765	NS
		„		FD	0	S
		„	None	L	0.0183	S
		„		FD	0	S
	Nominal deposit rate	1981-2013	Intercept	L	0.1477	NS
		„		FD	0.0002	S
		„	Trend and Intercept	L	0.1127	NS
		„		FD	0.0019	S
		„	None	L	0.0135	S
		„		FD	0	S
	Nominal lending rate	1981-2013	Intercept	L	0.5547	NS
		„		FD	0.0056	S
		„	Trend and Intercept	L	0.3216	NS
		„		FD	0.0308	S
		„	None	L	0.1722	NS
		„		FD	0.0004	S
	APCx(d-g)xD/GDP	1981-2013	Intercept	L	0.1654	NS
		„		FD	0	S
		„	Trend and Intercept	L	0.1023	NS
		„		FD	0	S
		„	None	L	0.014	S
		„		FD	0	S
	(l-g)xL/GDP	1981-2013	Intercept	L	0.0838	NS
		„		FD	0	S
		„	Trend and Intercept	L	0.0942	NS
		„		FD	0.0001	S
		„	None	L	0.0699	NS
		„		FD	0	S

Table 4: ADF Unit Root Test

Country	Series	Date Range	ADF Type	Level/ Differenced	p-value	Remark @ 5%
UK	Inflation	1970-1998	Intercept	L	0.3424	NS
		„		FD	0.4762	NS
		„		SD	0	S
		„	Trend and Intercept	L	0.6807	NS
		„		FD	0.7904	NS
		„		SD	0	S
		„	None	L	0.0012	S
		„		FD	0.17	NS
		„		SD	0	S
	Nominal deposit rate	1970-1998	Intercept	L	0.2857	NS
		„		FD	0.0004	S
		„	Trend and Intercept	L	0.5305	NS
		„		FD	0.0032	S
		„	None	L	0.3704	NS
		„		FD	0	S
	Nominal lending rate	1970-1998	Intercept	L	0.0736	NS
		„		FD	0.0006	S
		„	Trend and Intercept	L	0.1727	NS
		„		FD	0.0017	S
		„	None	L	0.5273	NS
		„		FD	0	S
	APCx(d-g)xD/GDP	1970-1998	Intercept	L	0.0212	S
		„		FD	0.0039	S
		„	Trend and Intercept	L	0.0886	NS
		„		FD	0.0142	S
		„	None	L	0.0363	S
		„		FD	0.0002	S
	(l-g)xL/GDP	1970-1998	Intercept	L	0.0317	S
		„		FD	0.003	S
		„	Trend and Intercept	L	0.0713	NS
		„		FD	0.013	S
		„	None	L	0.2658	NS
		„		FD	0.0001	S

Table 5: ADF Unit Root Test

11.2 VAR Granger Causality/Block Exogeneity Wald Test Under Proposed framework

Country	Time range	Max Lag	p [min LR]	p [min FPE]	p [min AIC]	p [min SC]	p [min HQ]
Australia	1975-2013	5	4	4	5	2	4
Japan	1977-2013	5	1	1	1	1	1
Korea	1980-2013	5	1	1	1	1	1
Switzerland	1981-2013	5	2	2	2	2	2
UK	1970-1998	5	1	2	2	1	2

Table 6: Model Selection for VAR Granger Causality/Block Exogeneity Wald Test (Proposed Model)

Country	Time Range	m	p	Dependent variable	APCx(d-g)xD/GDP	(l-g)xL/GDP	Chi-Sq	df	p-value	Remark
Australia	1975-2013	1	4	Inflation	excluded	excluded	27.62508	8	0.0006	Causality @1%
Japan	1977-2013	0	1	Inflation	excluded	excluded	9.226999	2	0.0099	Causality @1%
Korea	1980-2013	0	1	Inflation	excluded	excluded	12.17776	2	0.0023	Causality @1%
Switzerland	1981-2013	1	2	Inflation	excluded	excluded	20.76112	4	0.0004	Causality @1%
UK	1970-1998	2	2	Inflation	excluded	excluded	6.529262	4	0.163	No Causality

Table 7: VAR Granger Causality/Block Exogeneity Wald Test (Proposed Model)

11.3 Stability Diagnostics of the Selected VAR Model Under Proposed Framework

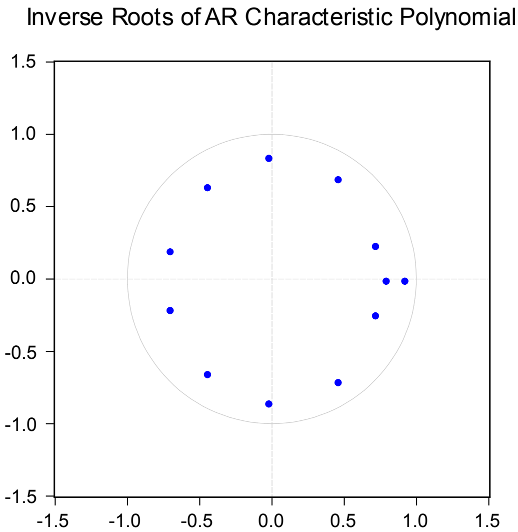

Figure 2: Inverse Roots of AR Characteristic Polynomial for Australian Data When P = 4 (Proposed Model)

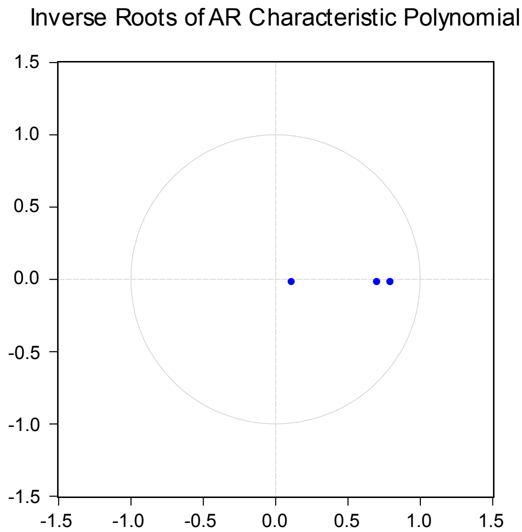

Figure 3: Inverse Roots of AR Characteristic Polynomial for Japanese Data When P = 1 (Proposed Model)

Lags	LM-Stat	Prob
1	7.579139	0.5771
2	7.692969	0.5654
3	9.598352	0.384
4	7.814252	0.553
5	7.925114	0.5417
6	15.90506	0.0689
7	16.50035	0.0571
8	11.25349	0.2587
9	9.900822	0.3586
10	8.496971	0.4849

Table 8: Serial Correlation LM Test for Australian Data When P = 4 (Proposed Model)

Lags	LM-Stat	Prob
1	13.56717	0.1386
2	16.97337	0.0491
3	2.601459	0.978
4	3.873359	0.9195
5	3.502116	0.941
6	18.13745	0.0336
7	6.485064	0.6906
8	3.056369	0.962
9	8.485173	0.4861
10	3.423177	0.9451

Table 9: Serial Correlation LM Test for Japanese Data When P = 1 (Proposed Model)

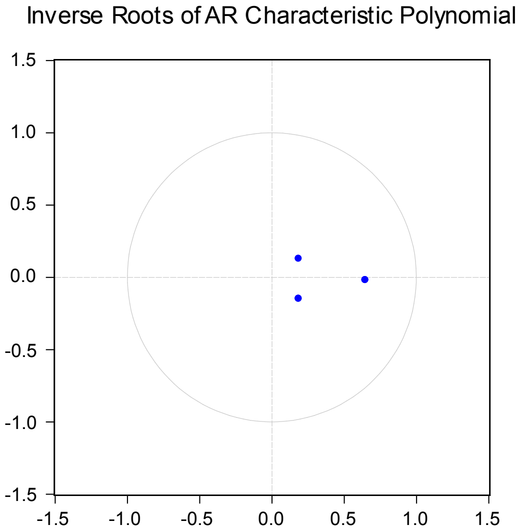

Figure 4: Inverse Roots of AR Characteristic Polynomial for Korean Data When P = 1 (Proposed Model)

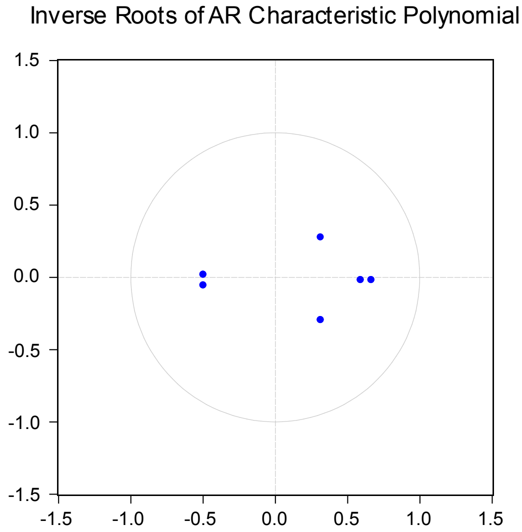

Figure 5: Inverse Roots of AR Characteristic Polynomial for Swiss Data When P = 2 (Proposed Model)

Lags	LM-Stat	Prob
1	7.258296	0.6102
2	7.983905	0.5358
3	4.182982	0.899
4	3.797664	0.9242
5	7.003602	0.6367
6	2.864117	0.9694
7	5.647841	0.7746
8	12.00255	0.2132
9	10.33387	0.3241
10	2.735622	0.9739

Table 10: Serial Correlation LM Test for Korean Data When P = 1 (Proposed Model)

Lags	LM-Stat	Prob
1	18.03033	0.0348
2	7.984452	0.5357
3	13.04658	0.1605
4	6.731945	0.665
5	6.747347	0.6634
6	6.531909	0.6857
7	7.680773	0.5666
8	7.815361	0.5529
9	7.452108	0.5902
10	3.901727	0.9178

Table 11: Serial Correlation LM Test for Swiss Data When P = 2 (Proposed Model)

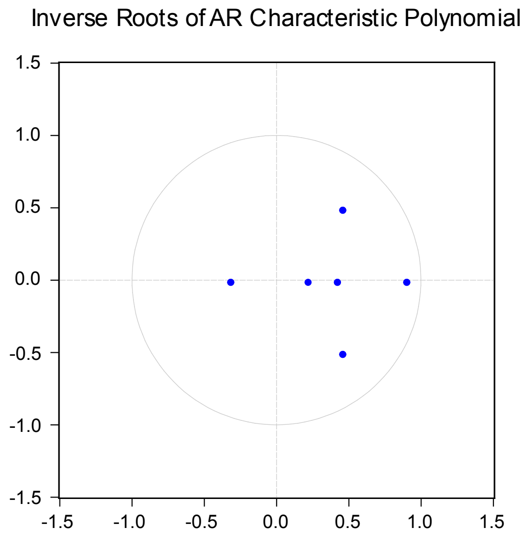

Figure 6: Inverse Roots of AR Characteristics Polynomial for British Data When P = 2 (Proposed Model)

Lags	LM-Stat	Prob
1	10.74953	0.2933
2	9.332814	0.4071
3	5.886589	0.7512
4	5.679308	0.7715
5	4.020521	0.9101
6	4.642957	0.8643
7	7.417018	0.5938
8	9.108675	0.4273
9	4.024058	0.9098
10	7.625389	0.5723

Table 12: Serial Correlation LM Test for British Data When P = 2 (Proposed Model)

11.4 ARDL Bounds Testing Under Proposed Framework

Country	Australia		
Date Range	1975-2013		
Dependent Variable	Inflation		
Independent Variable-1	APCx(d-g)xM2/GDP		
Independent Variable-2	(l-g)xL/GDP		
Dependent Variable: Max Lag	5		
Regressor: Max Lag	5		
Fixed Regressors	Constant	Linear Trend	None
Selected Model	(5, 5, 5)	(5, 3, 5)	(4, 4, 4)
F-Stat (Bound Test)	6.155656	17.13076	5.809287
I0 Bound (@5%)	3.79	4.87	2.72
I1 Bound (@ 5%)	4.85	5.85	3.83
Remark	Long run relationship exists	Long run relationship exists	Long run relationship exists

Table 13: ARDL Bounds Testing (Proposed Model)

Country	Japan		
Date Range	1977-2013		
Dependent Variable	Inflation		
Independent Variable-1	APCx(d-g)xM2/GDP		
Independent Variable-2	(l-g)xL/GDP		
Dependent Variable: Max Lag	5		
Regressor: Max Lag	5		
Fixed Regressors	Constant	Linear Trend	None
Selected Model	(3, 2, 2)	(1, 0, 2)	(3, 2, 2)
F-Stat (Bound Test)	3.346849	10.19052	5.185616
I0 Bound (@5%)	3.79	4.87	2.72
I1 Bound (@ 5%)	4.85	5.85	3.83
Remark	No long run relationship	Long run relationship exists	Long run relationship exists

Table 14: ARDL Bounds Testing (Proposed Model)

Country	Korea		
Date Range	1980-2013		
Dependent Variable	Inflation		
Independent Variable-1	APCx(d-g)xM2/GDP		
Independent Variable-2	(l-g)xL/GDP		
Dependent Variable: Max Lag	5		
Regressor: Max Lag	5		
Fixed Regressors	Constant	Linear Trend	None
Selected Model	(1, 1, 1)	(1, 0, 1)	(1, 0, 1)
F-Stat (Bound Test)	10.29754	10.60872	6.816165
I0 Bound (@5%)	3.79	4.87	2.72
I1 Bound (@ 5%)	4.85	5.85	3.83
Remark	Long run relationship exists	Long run relationship exists	Long run relationship exists

Table 15: ARDL Bounds Testing (Proposed Model)

Country	Switzerland		
Date Range	1981-2013		
Dependent Variable	Inflation		
Independent Variable-1	APCx(d-g)xM2/GDP		
Independent Variable-2	(l-g)xL/GDP		
Dependent Variable: Max Lag	5		
Regressor: Max Lag	5		
Fixed Regressors	Constant	Linear Trend	None
Selected Model	(1, 3, 4)	(1, 4, 5)	(3, 5, 4)
F-Stat (Bound Test)	10.96167	10.65164	0.346987
I0 Bound (@5%)	3.79	4.87	2.72
I1 Bound (@ 5%)	4.85	5.85	3.83
Remark	Long run relationship exists	Long run relationship exists	No long run relationship

Table 16: ARDL Bounds Testing (Proposed Model)

11.5 VAR Granger Causality/Block Exogeneity Wald Test Under Fisherian Framework

Country	Time range	Max Lag	p [min LR]	p [min FPE]	p [min AIC]	p [min SC]	p [min HQ]
Australia	1975-2013	5	3	5	5	1	1
Japan	1977-2013	5	5	2	5	1	2
Korea	1980-2013	5	1	1	1	1	1
Switzerland	1981-2013	5	1	1	1	1	1
UK	1970-1998	5	1	3	3	1	1

Table 17: Model Selection for VAR Granger Causality/Block Exogeneity Wald Test (Fisherian Model)

Country	Time Range	m	p	Dependent variable(t)	Inflation (t+1)	Chi-Sq	df	p-value	Remark
Australia	1975-2013	1	1	Nominal lending rate	excluded	3.638865	1	0.0564	Causality @ 10%
Japan	1977-2013	1	2	Nominal lending rate	excluded	18.57663	2	0.0001	Causality @ 1%
Korea	1980-2013	1	1	Nominal lending rate	excluded	8.830656	1	0.003	Causality @ 1%
Switzerland	1981-2013	1	1	Nominal lending rate	excluded	13.35468	1	0.0003	Causality @ 1%
UK	1970-1998	2	1	Nominal lending rate	excluded	2.826149	1	0.0927	Causality @ 10%

Table 18: VAR Granger Causality/Block Exogeneity Wald Test (Fisherian Model)

Country	Time Range	m	p	Dependent variable(t+1)	Nominal lending rate(t)	Chi-Sq	df	p-value	Remark
Australia	1975-2013	1	1	Inflation	excluded	1.423563	1	0.2328	No Causality
Japan	1977-2013	1	2	Inflation	excluded	0.593624	2	0.7432	No Causality
Korea	1980-2013	1	1	Inflation	excluded	0.052633	1	0.8185	No Causality
Switzerland	1981-2013	1	1	Inflation	excluded	1.642179	1	0.2	No Causality
UK	1970-1998	2	1	Inflation	excluded	0.927286	1	0.3356	No Causality

Table 19: VAR Granger Causality/Block Exogeneity Wald Test (Fisherian Model)

11.6 Stability Diagnostics of the Selected VAR Model Under Fisherian Framework

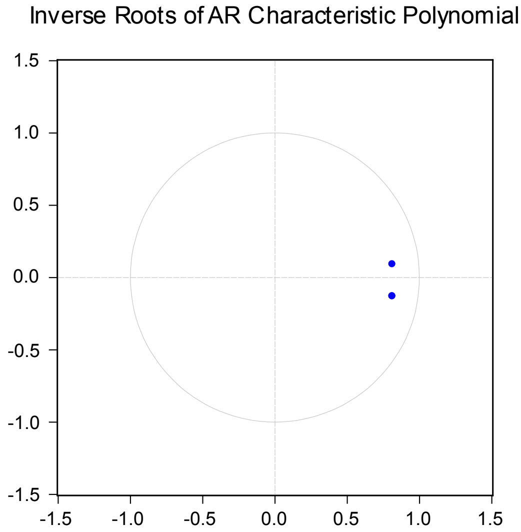

Figure 7: Inverse Roots of AR Characteristic Polynomial for Australian Data When P = 1 (Fisherian Model)

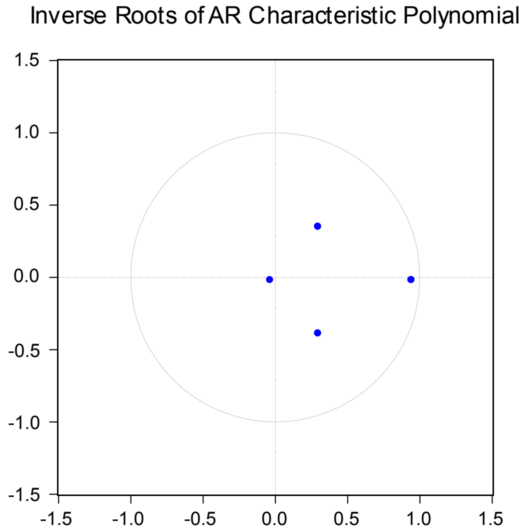

Figure 8: Inverse Roots of AR Characteristic Polynomial for Japanese Data When P = 2 (Fisherian Model)

Lags	LM-Stat	Prob
1	3.904531	0.4191
2	11.02384	0.0263
3	1.698263	0.791
4	10.34965	0.0349
5	2.402226	0.6622
6	4.183825	0.3817
7	1.812245	0.7702
8	3.530322	0.4733
9	2.554443	0.6349
10	1.840608	0.765

Table 20: Serial Correlation LM Test for Australian Data When P = 1 (Fisherian Model)

Lags	LM-Stat	Prob
1	17.04802	0.0019
2	3.793051	0.4347
3	2.516511	0.6417
4	2.223534	0.6947
5	5.986499	0.2002
6	5.760069	0.2178
7	1.054205	0.9015
8	2.743471	0.6016
9	3.63647	0.4574
10	1.831837	0.7667

Table 21: Serial Correlation LM Test for Japanese Data When P = 2 (Fisherian Model)

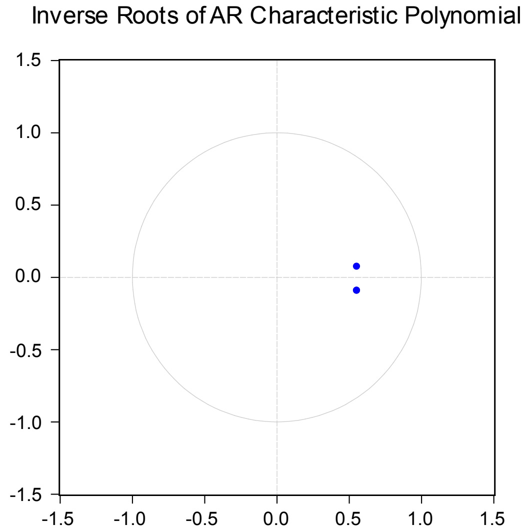

Figure 9: Inverse Roots of AR Characteristic Polynomial for Korean Data When P = 1 (Fisherian Model)

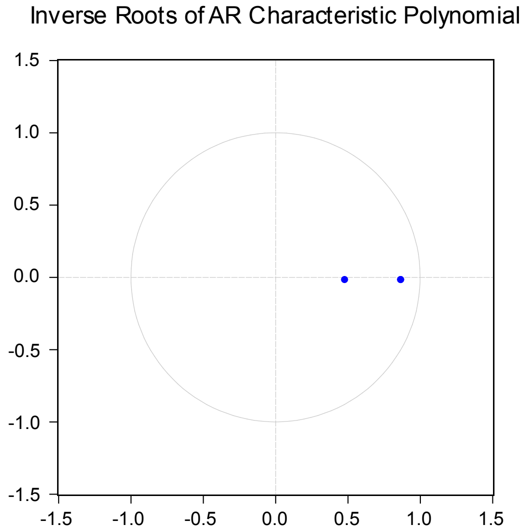

Figure 10: Inverse Roots of AR Characteristic Polynomial for Swiss Data When P = 1 (Fisherian Model)

Lags	LM-Stat	Prob
1	9.898649	0.0422
2	3.595524	0.4635
3	3.274675	0.513
4	2.716095	0.6064
5	2.152406	0.7078
6	1.362994	0.8506
7	7.61194	0.1069
8	4.757626	0.3131
9	10.35274	0.0349
10	0.587677	0.9644

Table 22: Serial Correlation LM Test for Korean Data When P = 1 (Fisherian Model)

Lags	LM-Stat	Prob
1	4.831434	0.305
2	7.917815	0.0946
3	0.827042	0.9348
4	3.456057	0.4846
5	1.131897	0.8892
6	4.763078	0.3125
7	4.528915	0.3391
8	7.925324	0.0944
9	0.382637	0.9839
10	4.806577	0.3077

Table 23: Serial Correlation LM Test for Swiss Data When P = 1 (Fisherian Model)

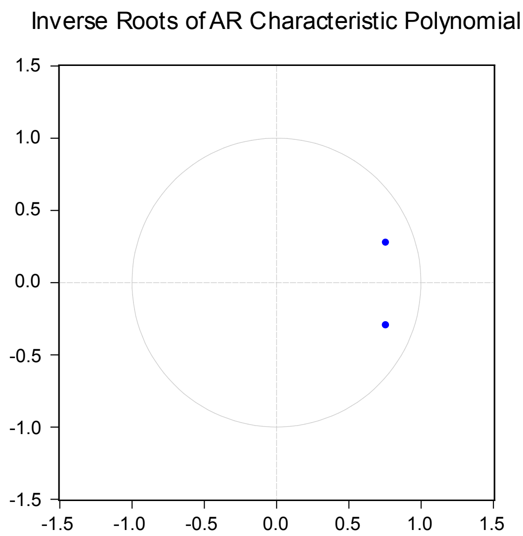

Figure 11: Inverse Roots of AR Characteristic Polynomial for British Data When P = 1 (Fisherian Model)

Lags	LM-Stat	Prob
1	2.874381	0.5791
2	3.893729	0.4206
3	1.916448	0.7511
4	4.494705	0.3432
5	4.824935	0.3057
6	9.797158	0.044
7	1.708896	0.7891
8	3.464464	0.4833
9	1.616533	0.8058
10	3.829458	0.4296

Table 24: Serial Correlation LM Test for British Data When P = 1 (Fisherian Model)

Country	Australia		
Date Range	1975-2013		
Dependent Variable	Nominal lending rate(t)		
Independent Variable	Inflation(t+1)		
Dependent Variable: Max Lag	5		
Regressor: Max Lag	5		
Fixed Regressors	Constant	Linear Trend	None
Selected Model	(3, 0)	(4, 5)	(3, 0)
F-Stat (Bound Test)	4.562675	6.361843	4.823703
I0 Bound (@5%)	4.94	6.56	3.15
I1 Bound (@ 5%)	5.73	7.3	4.11
Remark	No long run relationship	No long run relationship	Long run relationship exists

Table 25: ARDL Bounds Testing (Fisherian Model)

Country	Japan		
Date Range	1977-2013		
Dependent Variable	Nominal lending rate(t)		
Independent Variable	Inflation(t+1)		
Dependent Variable: Max Lag	5		
Regressor: Max Lag	5		
Fixed Regressors	Constant	Linear Trend	None
Selected Model	(4, 5)	(4, 5)	(3, 0)
F-Stat (Bound Test)	3.020623	4.391565	5.324548
I0 Bound (@5%)	4.94	6.56	3.15
I1 Bound (@ 5%)	5.73	7.3	4.11
Remark	No long run relationship	No long run relationship	Long run relationship exists

Table 26: ARDL Bounds Testing (Fisherian Model)

Country	Korea		
Date Range	1980-2013		
Dependent Variable	Nominal lending rate(t)		
Independent Variable	Inflation(t+1)		
Dependent Variable: Max Lag	5		
Regressor: Max Lag	5		
Fixed Regressors	Constant	Linear Trend	None
Selected Model	(1, 1)	(1, 1)	(1, 1)
F-Stat (Bound Test)	9.011595	10.18812	4.76759
I0 Bound (@5%)	4.94	6.56	3.15
I1 Bound (@ 5%)	5.73	7.3	4.11
Remark	Long run relationship exists	Long run relationship exists	Long run relationship exists

Table 27: ARDL Bounds Testing (Fisherian Model)

Country	Switzerland		
Date Range	1981-2013		
Dependent Variable	Nominal lending rate(t)		
Independent Variable	Inflation(t+1)		
Dependent Variable: Max Lag	5		
Regressor: Max Lag	5		
Fixed Regressors	Constant	Linear Trend	None
Selected Model	(2, 5)	(1, 5)	(1, 5)
F-Stat (Bound Test)	2.23778	3.943364	4.456717
I0 Bound (@5%)	4.94	6.56	3.15
I1 Bound (@ 5%)	5.73	7.3	4.11
Remark	No long run relationship	No long run relationship	Long run relationship exists

Table 28: ARDL Bounds Testing (Fisherian Model)