THE DYNAMIC CAUSAL RELATIONSHIPS AMONG MONEY, OUTPUT AND PRICES IN IRAN

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ABSTRACT

This paper examines dynamic causal relationships among money, GDP and prices for Iran using annual data over the period 1960-2008. The Gregory-Hansen (1996) cointegration technique, allowing for the presence of potential structural breaks in data, is applied to empirically examine the long-run co-movement between the variables. The results suggest that there is a long-run relationship between these variables. The Granger Causality test indicates a strong unidirectional effect from GDP and prices to money supply, with weak feedback effects from money to prices in short run. The evidence for Iran clearly supports the ‘classical duality’ between nominal variables and real ones.

Key Words: Granger Causality, Money Supply, Real GDP, Iran Economy
JEL classifications: C32, E31, E40, E51

1. INTRODUCTION

A well-known area of debate in economics literature have been the nature of the causation between money and real economic variables. This is basically because a clear understanding of the relationship between these variables is of key importance, particularly to the policymakers to ensure effectiveness of macroeconomic stabilization policies. If money supply is independent of output and prices, then money as an exogenous variable could influences the output and prices and policy makers would be powerful. On the other hand, if output and prices is the main determinant of supply of money, implying endogeneity of the money supply, then monetary policy actions would be powerless. If there is a two-way causal relationship between money and output, this indicate that monetary policy need to be formulated with special consideration of the feedback effects of output on money.

This relationship between money and economic activities has been broadly examined in both, theoretical and empirical literature for both developed and developing countries during different sample periods, providing conflicting evidences on this issue, see for example: Ramachandra (1986), Miller (1991), Friedman and Kuttner (1992), Stock and Watson (1993) Boucher and Flynn (1997), Jamie Emerson (2005), Herwartz and Reimers (2006) Majid (2007) Saatcioglu and Korap (2008). But there has been little empirical analysis for the long – run relationship and causality among between three important macroeconomic variables, namely real Gross Domestic Product (GDP), money supply (M), and the Price level (P), in the context of a oil dependent economy such as Iran. The focus of the paper is, therefore, to examine the relationship between these three variables health expenditure and income in the case of Iran country for the period from 1970-2008. The direction of causality between these variables is examined by utilizing a cointegration and error correction modeling framework, which provides a more comprehensive test of causality than the standard Granger causality test. We apply the Zivot and Andrews (1992) unit root tests and the Gregory and Hansen (1996) cointegration tests, allowing for the presence of potential structural breaks in data during the sample period. The paper is organized in four sections. In Section 2, a review of literature on
the relationship between money and income is provided. Section 3 discusses the methodology, data and results. Section 3 concludes

2. LITERATURE REVIEW

There has been a long dispute in economics about the role of money in the determination of income and prices. The proponents of Quantity Theory of Money claim that money supply is exogenous. While Cagan (1965) asserts that money supply exhibits both endogenous and exogenous properties. For short run and cyclical fluctuation, Cagan (1965) proposed a relation in which the money supply is endogenously determined by real variables. However, he stressed that in the long-run, money supply is independent of real sector and are determined exogenously.

The Monetarists maintain that money plays an active role regarding changes in income and prices. In other words, changes in income and prices in an economy are mostly unidirectionally caused by the monetary changes. Empirical monetarism argues that money supply fluctuations induced by the monetary authority were the principal cause of the U.S. business cycle, Palley(1993). Hence, the direction of causation runs from money to income and prices without any feedback.

The Keynesians, on the other hand, claim that money does play a passive role regarding the changes in income and prices. In fact income cause money supply via demand for money implying that the direction of causation runs from income to money without any feedback. Moreover, changes in prices are mainly effected by structural factors.

In the empirical literature, the causality tests among money, price, and output has provided conflicting evidences. Sims (1972) seminal paper, developed a test of causality and applied it to the US data to examine the causal relationship between money and income. His results indicated uni-directional causality from money to income as claimed by the Monetarists. However, his results were not supported by subsequent studies. Barth and Bannett (1974) showed a bi-directional causality between money and income in the Canadian. Williams et al. (1976) found the evidence of uni-directional causality from income to money in the UK. They also obtained evidence of uni-directional causality of money to prices. Dyreyes et al. (1980), showed bi-directional causality between money and income in the US, contrary to Sims (1972), pointing out uni-directional causality from money to income in Canada, contrary to Barth and Bannett (1974) and uni-directional causality from income to money in the UK in line with Williams et al. (1976).

Lee and Li (1983) investigated causality among money, income and prices in Singapore and concluded bi-directional causality between income and money and uni-directional causality from money to prices. Joshi and Joshi (1985) founded a bi-directional causality between money and income in India. Abbas (1991) performed a causality test between money and income for Asian countries and found bi-directional causality in Pakistan, Malaysia and Thailand. Bengali et al. (1999) identified a bi-directional causality between money and income and uni-directional causality from money to prices in Pakistan.

Sims Budina et al (2002) examined the relationship among Money, inflation and output in Romania for the period 1992-2000 and found that inflation was largely a monetary phenomenon. Gilman and Nakov (2004) indicate Granger causality running positively from money to inflation and negatively from inflation to growth for both Hungary and Poland with some feedback to money for Poland. Hossain (2005) used annual data for the period 1952-2002 to investigate the inflationary process in Indonesia within the cointegration-and error-correction modeling framework. The empirical results suggest that the consumer price index (CPI), the stock of narrow (M1) or broad money (M2) and real permanent income form a (weakly) cointegral relationship for the complete sample period. Abbas and Husain (2006) re-examines the causal relationship between money and income and between money and prices in Pakistan. The error correction and Granger causality framework suggest a one-way causation from income to money in the long run implying that real factors rather than money supply have played a major role in increasing Pakistan’s national income. Regarding the
causal relationship between money and prices, money supply seems to be the leader. Muhd Zulkhibri (2007) examines the causality relationship between monetary aggregates, output and prices in the case of Malaysia using the Granger causality procedure developed by Toda and Yamamoto (1995). The results indicate a two-way causality between monetary aggregates, M2 and M3 and output. Moreover, the results suggest that all monetary aggregates have strong effects on prices with no evidence for the opposite causality.

Saatcioglu and Korap (2008) examine the long-run relationships between monetary aggregates, prices and real output for the Turkish economy. The results reveal that monetary aggregates are endogenous for the long-run evolution of prices and real income. Chimobi and Uche (2010) study the empirical relationship between money, prices and output in Nigeria. Money supply was seen to Granger cause both output and prices. Also, M2 appears to have a strong causal effect on the real output as well as on prices. Sharma, Kumar and Hatekar (2010) indicate that output and prices do not Granger cause money supply reflecting exogeneity of money supply.

3. METHODOLOGY AND EMPIRICAL RESULTS

In this section we use the Granger causality to study the causal relationship among money, prices and GDP in Iran. The macroeconomic variables used in the model are (logarithm of) broad money (m), consumer price index (p) and real GDP (y) . The data series are obtained from Central Bank of Iran (CBI). The data are annual from 1960-2008, reflecting data availability. A tri-variate model is used to empirically examine the long-run co-movement and the causal relationship between money, prices and output.

3.1. Zivot and Andrews Unit Root Test

Conventional tests for identifying the existence of unit roots in a data series include that of the Augmented Dickey Fuller (ADF) (1979, 1981) or Phillips-Perron(1988). So in the first step of the empirical analysis, the Phillips - Perron unit-root tests have been carried out for the variables: broad money (m), prices (p) and real GDP (y), all in logarithm. The results reported in Table 1, indicate that all of the variables are nonstationary. However, recent contributions to the literature suggest that such tests may incorrectly indicate the existence of a unit root, when in actual fact the series is stationary around a one-time structural break (Zivot and Andrews, 1992; Pahlavani, et al, 2006). Zivot and Andrews (ZA) (1992) argue that the results of the conventional unit root tests may be reversed by endogenously determining the time of structural breaks. The null hypothesis in the Zivot and Andrews test is a unit root without any exogenous structural change. The alternative hypothesis is a stationary process that allows for a one-time unknown break in intercept and/or slope. Following Zivot and Andrews, we test for a unit root against the alternative of trend stationary process with a structural break both in slope and intercept. Table 1 provides the results. As in the Phillips-Perron case, the estimation results fail to reject the null hypothesis of a unit root for all variables. The same unit root tests have been applied to the first difference of the variables and in all cases we rejected the null hypothesis of unit root. Hence, we maintain the null hypothesis that each variable is integrated of order one or I(1).

<table>
<thead>
<tr>
<th>Broad money(m)</th>
<th>Prices(p)</th>
<th>Real GDP(y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZA(PP)</td>
<td>ZA(PP)</td>
<td>ZA(PP)</td>
</tr>
<tr>
<td>-2.60</td>
<td>-3.11(1979)</td>
<td>-2.94</td>
</tr>
<tr>
<td>-3.21(1979)</td>
<td>-2.05</td>
<td>-2.78(1979)</td>
</tr>
</tbody>
</table>

Note: The break point in ZA unit root test is presented in brackets. Empirical results indicate that the null hypothesis of unit-root is rejected in all cases. The lag lengths for the ZA and PP tests are chosen by using SC’s information criterion and Newey and West (1987) method respectively. Critical values for ZA tests were obtained from Zivot and Andrews (1992). Break points are reported in ( )

3.2 The Gregory-Hansen Cointegration Analysis

As noted by Perron(1989), ignoring the issue of potential structural breaks can render invalid
the statistical results not only of unit root tests but also of cointegration tests. Kunitomo (1996) argues that in the presence of a structural change, traditional cointegration tests, which do not allow for this, may produce spurious cointegration. Therefore one has to be aware of the potential effects of structural effects on the results of a cointegration test, as they usually occur because of major policy changes or external shocks in the economy.

The Gregory-Hansen approach (1996) (hereafter, GH) addressed the problem of estimating cointegration relationships in the presence of a potential structural break by introducing a residual-based technique so as to test the null hypothesis (no cointegration) against the alternative of cointegration in the presence of the break (such as a regime shift). In this approach the break point is unknown, and is determined by finding the minimum values for the ADF t-statistic.

By taking into account the existence of a potential unknown and endogenously determined one-time break in the system, GH introduced three alternative models. The first model includes an intercept constant (C) and a level shift dummy. The second alternative model (C/T) contains an intercept and trend with a level shift dummy. The third model is the full break model (C/S), which includes two dummy variables, one for the intercept and one for the slope, without including trend in model. This model allows for change in both the intercept and slope.

These tests detect the stability of cointegrating vectors over time in the presence of structural breaks in the form of level shift, level shift with trend, and regime shift. Table 2 reports all cases. When dependent variable is broad money, the null hypothesis of no cointegration relationships is rejected in favor of the existence of one cointegrating relationship, allowing for a one time structural break (although not rejected when GDP is dependent variable). The results show that the variables under examination do not drift apart for Iran. The estimated long run relationship, identified as demand for money, using the C/S is of the form:

\[
m = -3.31 + 1.26y - 4.32D + 0.51DUM(y) + 1.34p - 0.38DUM(p)\\
\]

\[
t = (3.20) (4.19) (-3.11) (3.01) (2.78) (-2.36) \] (1)

where dummy \( DUM_y = 0 \) if \( t \leq 1979 \) and \( DUM_y = 1 \) if \( t > 1979 \). Both the intercept and the intercept at the time of regime shift (Islamic Revolution in Iran) are significant. Both the income elasticity before the regime shift and at the time of regime shift are significant. The income elasticity before the regime shift is 1.26 that is closer to unity. The change of income elasticity at the time of regime shift is 0.51. The slope of the function is interpreted as the change in the growth of the series. Therefore, we can see that income elasticity increased after regime shift and took a different path. So, the income elasticity of demand for money in Iran, at least after the revolution, amounting to 1.77, is greater than 1. The elasticity of nominal demand for money reduced from 1.34 to 0.96 after regime shift.

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Model</th>
<th>Test Statistic</th>
<th>Break Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>m</td>
<td>C</td>
<td>-6.71*</td>
<td>1979</td>
</tr>
<tr>
<td></td>
<td>C/T</td>
<td>-5.21*</td>
<td>1979</td>
</tr>
<tr>
<td></td>
<td>C/S</td>
<td>-6.90*</td>
<td>1979</td>
</tr>
</tbody>
</table>

Notes: C denotes level shift, C/T denotes level shift with trend, and C/S denotes regime shift. The lag length is chosen based on minimum SC.* denotes significant at the 5% level. Critical values were obtained from Gregory and Hansen (1996).

3.3. Granger Causality Tests

Cointegration implies that causality exists between the series but it does not indicate the direction of the causal relationship. With an affirmation of a long run relationship among m, y and p, we test for Granger causality in the long run relationship at the final step of
Granger causality itself is a two-step procedure. The first step relates to the estimation of the residual from the long run relationship. Incorporating the residual as a right hand side variable, the short run error correction model is estimated at the second step. Defining the error term from equation (1) to be ECT, the dynamic error correction model of our interest by focusing on broad money(m) and GDP(y) is specified as follows:

\[
\Delta y_t = \alpha_y + \beta_y ECT_{t-1} + \gamma_m \Delta m_{t-1} + \gamma_p \Delta p_{t-1} + \delta_{\alpha} \Delta y_{t-1} + \delta_{\beta} \Delta GDP_{t-1} + \delta_{\gamma} \Delta m_{t-1} + \delta_{\lambda} \Delta p_{t-1} + \epsilon_y
\]

(2)

\[
\Delta m_t = \alpha_m + \beta_m ECT_{t-1} + \gamma_m \Delta m_{t-1} + \gamma_p \Delta p_{t-1} + \delta_{\alpha} \Delta y_{t-1} + \delta_{\beta} \Delta GDP_{t-1} + \delta_{\gamma} \Delta p_{t-1} + \epsilon_m
\]

(3)

Where \( \Delta \) is a difference operator; ECT is the lagged error-correction term derived from the long-run cointegrating relationship; the \( \beta_y \) and \( \beta_m \) are adjustment coefficients and the \( \epsilon_y \) and \( \epsilon_m \) are disturbance terms assumed to be uncorrelated with mean zero.

Sources of causation can be identified by testing for significance of the coefficients on the lagged variables in Eqs (2) and (3). First, by testing \( H_y : \gamma_{\alpha(i)} = \gamma_{\beta(i)} = 0 \) for all \( i \) in Eq. (2) or \( H_m : \delta_{\alpha(i)} = \delta_{\beta(i)} = 0 \) for all \( i \) in Eq. (3), we evaluate Granger weak causality. Masih and Masih (1996) and Asafu-Adjaye (2000) interpreted the weak Granger causality as ‘short run’ causality in the sense that the dependent variable responds only to short-term shocks to the stochastic environment.

Another possible source of causation is the ECT in Eqs. (2) and (3). In other words, through the ECT, an error correction model offers an alternative test of causality (or weak exogeneity of the dependent variable). The coefficients on the ECTs represent how fast deviations from the long run equilibrium are eliminated following changes in each variable. If, for example, \( \beta_y \) is zero, then GDP does not respond to a deviation from the long run equilibrium in the previous period. Indeed \( \beta_y = 0 \) or \( \beta_m = 0 \) for all \( i \) is equivalent to both the Granger non-causality in the long run and the weak exogeneity (Hatanaka, 1996).

It is also desirable to check whether the two sources of causation are jointly significant, in order to test Granger causality. This can be done by testing the joint hypotheses \( H_y : \gamma_{\alpha(i)} = \gamma_{\beta(i)} = 0 \) and \( H_m : \delta_{\alpha(i)} = \delta_{\beta(i)} = 0 \) for all \( i \) in Eq. (2) or \( H_m : \beta_{\alpha(i)} = 0 \) and \( \delta_{\alpha(i)} = \delta_{\beta(i)} = 0 \) for all \( i \) in Eq. (3). This is referred to as a strong Granger causality test. The joint test indicates which variable(s) bear the burden of short run adjustment to re-establish long run equilibrium, following a shock to the system (Asafu-Adjaye, 2000).

The results of the F test for both long run and short run causality are reported in Table 3. As is apparent from the Table, the coefficients of the ECT, \( y \) and \( p \) are significant in the money equation which indicates that long-run and short run causality run from \( y \) and \( p \) to broad money. So, \( y \) and \( p \) strongly Granger-cause money. \( m \) has a weak effect on \( p \) just at short run at 10% level, without any significant effect on output. Weak exogeneity of \( y \) indicate that this variable does not adjust towards long-run equilibrium.

Moreover, the interaction terms in the money equation are significant at 1% level. These results imply that, there is Granger causality running from \( y \) and \( p \) to money in the long-run and short run, while money have a neutral effect on \( y \) in both the short- and long-run. In other words, \( y \) is strongly exogenous and whenever a shock occurs in the system, money would make short-run adjustments to restore long-run equilibrium. So, the results can be interpreted as money supply does not have expected effect on price level, while it is affected by the lagged GDP and price levels.
4. CONCLUSION

The purpose of this study was to test for Granger causality between money and income for Iran over the period 1960-2008. Prices are also included in the model along with these two variables. The cointegration analysis are applied to investigate the relationship between the three economic series: money, output and prices. Utilizing Granger Causality within the framework of a vector error correction model, our findings suggest that there is strong causality running from GDP and prices to money supply with no feedback effects from money to GDP. Moreover, money have weak effects on prices just in short run. So they are the real activities that drive the money, not vice versa. Granger causality tests do not establish a clear cut unidirectional causality running from money to prices. This may have been the effect of formation of monetary changes based upon the existing price level and setting the targets but not capable to attain the monetary targets.

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REFERENCES