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#### **Monetary Policy Transmission in Tonga**

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## **Abstract**

Tonga's monetary authority, National Reserve Bank of Tonga (NRBT) is entrusted with the responsibility of managing Tonga's monetary system and exchange rate stability. This paper undertakes an empirical study of monetary policies pursued by NRBT with specific focus on the transmission mechanism of monetary policy in Tonga. As the annual data time series cover only a short-period (1981-2008), we resort to bounds testing approach. The study findings show that monetary aggregate in Tonga is more important than short-term interest rate as a channel in transmitting impulses from the monetary sector to the real sector.

**Keywords:** Monetary policy transmission, output, money, prices. bounds testing approach

# Monetary Policy Transmission in Tonga<sup>1</sup>

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## 1. Introduction

Amongst the 14 Pacific island countries<sup>2</sup> (PICs), eight PICs are dollarised<sup>3</sup> economies using one or the other of the three currencies of the metropolitan countries in the region, as legal tender. The other six countries have their own independent currencies. Five of them, namely Fiji, Samoa, Solomon Islands, Tonga and Vanuatu, have a fixed exchange rate regime, while Papua New Guinea has a floating exchange rate regime.

Prior to the establishment of National Reserve Bank of Tonga (NRBT) in 1989 under the NRBT Act of 1988 with the main objectives of promoting monetary stability and the soundness of the financial system, and fostering conditions for economic development and growth, monetary policy was administered by the Treasury and the Bank of Tonga, a government owned bank to undertake certain central banking functions. Monetary stability, as a goal, includes price stability in terms of low inflation as well external stability of the *pa'anga*, the domestic currency. About two-thirds of the items in the consumer price index basket are dominated by imported goods. The NRBT, which is intensely aware that that exchange rate stability is critical for maintaining domestic price stability, as there is a high pass through of the exchange rate to the price level, aims at maintaining gross foreign reserves equivalent to three months of total imports or above.

The NRBT pursues these objectives with instruments of monetary policy, direct and indirect, with mixed success. These include statutory reserve requirement ratio and credit control measures as well open market operations in the NRBT issued securities, until May 2009, which were replaced by government treasury bills. There are no studies so far undertaken on monetary policy transmission in Tonga. The present paper seeks to fill the gap. Since the data available cover only a 28-year period (1981-2008), we employ the bounds testing approach which does not require large sample size data as well as other stricter requirements in regard to order of integration of variables employed. The paper is organized as follows: Section 2 provides a background of Tongan economy and monetary

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<sup>1</sup> The authors are grateful to Mrs. Siosi C. Mafi, Governor, National Reserve Bank of Tonga for her comments and suggestions on an earlier version of the paper.

<sup>2</sup> The 14 PICs are: Cook Islands, Fiji, Kiribati, Marshall Islands, Federated States of Micronesia, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu. These 14 PICs, together with two metropolitan countries, namely Australia and New Zealand form the regional inter-governmental organization, known as Pacific Islands Forum (the Forum).

<sup>3</sup> The eight dollarized economies, using one of the three major currencies as legal tender, are: Kiribati, Nauru, and Tuvalu (Aus\$); Cook Islands and Niue (NZ\$), Marshall Islands, Federated States of Micronesia and Palau (US\$).

policy instruments employed by NRBT. Section 3 is a short summary of the various transmission mechanisms as studied in advanced and developing economies and their limitations when applied to island economies; Section 4 deals with the methodology adopted for the empirical analysis; Section 5 reports the results; and Section 6 presents conclusions with policy implications.

## 2. A Background

Tonga (population 102,000), whose selected key indicators are given in Table 1 shares many commonalities with rest of PICs. Tonga is heavily subsistence oriented, providing livelihood to 80 percent of the population. Its manufacturing base is small, which is confined to processing coconut oil based soaps and detergents, and biscuits and breads.

**Table 1: Tonga: selected key indicators**

Land Area (Sq.km.'000)	0.72
Population (2006: '000)	104
Per Capita GDP (US\$) Current Prices (2008)	2,548
Aid Per Capita in US\$ (2007)	296
Aid as percentage of GDP (2007)	12.0
Annual Average Growth Rate in percent (2001-2008)	1.4
Annual Average Inflation in percent (2001-2008)	9.0
Overall Budget Balance as percent of GDP (2001-2007)	0.4
Current Account Balance as percent of GDP (2001-2007)	-6.6

Source: World Bank (2008), UNESCAP (2007)

Tonga's fixed exchange rate regime has served the country well. Since most of the imports have been sourced from Australia and New Zealand, whose monetary policies have been targeting inflation, inflation has been kept low. Being a small country with no mineral resources and limited commercial agriculture and negligible manufacturing base, Tonga is heavily dependent on imports ranging from food and beverages, to fuel and capital and transportation machinery and equipment. Exports have been bananas, squash and copra and fish. Export earnings have been far less than imports with the result that the trade balance has always remained negative. However, remittances from Tongans who are resident in New Zealand, USA and Australia, tourism receipts, and regular annual aid inflows have been a great source of support to country's current account balance, minimising the pressures on exchange rate.

### *Macroeconomic performance*

While the 1970s were characterized by relatively favourable macroeconomic conditions, economic situation in the 1980s and mid 1990s deteriorated. As Australia and New Zealand liberalised their imports of vegetables from rest of the world, Tonga ceased to enjoy the special treatment accorded to its exports of bananas and copra. However, emergence of squash as exports to Japan as an off season crop brought in the next few years a sustained level of export earnings. In the 1990s, Government announced its strategy of promoting manufacturing through tax holidays and tariff preferences.

However, after initial rise in domestic production, exports did not take off. The second-half of the 1990s and early years of 2000 witnessed a weakened budget discipline and policy slippages and poor governance threatened macroeconomic stability. Losses in the US stock market due to risky management of investments led to depletion of the Tonga Trust Fund, which was built through country's official reserves, amounting at one time to 20 percent of GDP (Singh 2006).

With limited monetary policy instruments, Tonga relied primarily on movements in foreign exchange reserves as indicators of the appropriateness of monetary policy. The NRBT resorted to moral suasion and persuaded the commercial banks to restrict lending. However, political developments since early 2000 slowed down economic growth, while adverse terms of trade shocks as well as rise in fuel and food prices contributed to rise in inflation. Pro-democracy riots that led to the burning and looting of the capital in November 2006 were estimated to have resulted in losses of nearly US\$60 million or about 30 percent of GDP). Despite a modest recovery following a rise in tourism and remittances and aid-funded construction activities, the economy shrank in 2007 by 3.5 percent (AusAID 2008). Although expansionary measures including fiscal deficits and monetary easing were appropriate to revive the economy in 2007, there were inflationary pressures lurking around the corner.

In mid 2008, worldwide increase in food prices as well as fuel and subsequent volatility in fuel prices exposed the weaknesses in handling the unforeseen impact on balance of payments. Along with inflation, decline in reserves was causing concerns. Although real exchange appreciated by 13 percent during the 2003-2007 due to domestic inflation relative to inflation in trading partners, government was not keen to adjust nominal exchange rate, as there is no visible advantage in depreciation of the currency. Already exports of squash to the niche market in Japan had weakened and Tonga's exports were only just 10 percent of total imports. Thus, containing inflation was a priority rather than promoting competitiveness of limited exports. Any further depreciation of nominal currency was likely to raise prices of imports of fertilizers and insecticides and other inputs which go into production of vegetables and fruits and squash, aside from increasing landed prices of all critical imports.

The policy actions now require coordination between finance ministry and monetary authorities to contain fiscal deficits by resisting any temptation to yield to pressures from civil service for wage rise and minimize deficit financing needs so that the objectives of monetary and exchange rate stability are within reach.

### **3. Monetary Policy Formulation and Implementation**

#### *Structure of the financial system and market*

As of December 2008, Tonga's financial sector consists of five institutions: the NRBT, three commercial banks, and one state-owned development bank (Table 2). Until 1993 only two banks operated in Tonga, including a state-owned development bank established

to promote rural development by investing resources obtained mainly from external borrowing. Another of the commercial banks established in 1993 was a branch of a foreign bank; the other was a locally incorporated bank. A small insurance sector completes the financial sector.

**Table 2: Tonga: Financial System Structure**

	<b>Assets (Millions of pa'anga)</b>	<b>Percent in Total Assets</b>	<b>Percent of GDP</b>	<b>Number of Institutions</b>
Commercial banks	200.4	81.6	72.3	3
State-owned development bank	45.1	18.4	16.3	1
Insurance companies	n.a.	n.a.	n.a.	6
Total	245.5	100.0	88.6	10

Source: IMF (2008)

Banking activities are largely confined to urban centres, where formal sector activities are concentrated. The deepening process of financial sector over the period, as reflected in the ratios of narrow and broad money, has been slow. As Tonga has no vibrant bond and equity markets, there are no attractive financial assets other than saving and time deposits for savers to invest in. Table 3 presents monetary statistics of Tonga.

Following liberalisation of the economy in general and financial sectors, with discontinuance of controls on lending and deposit rates from the late 1980s, the ratio of broad money to GDP has been on the rise.

**Table 3: Tonga: Monetary Statistics**

<b>Year</b>	<b>RGDP Growth Rate (%)</b>	<b>M2 (as ratio of GDP) (%)</b>	<b>Inflation (%)</b>	<b>Deposit Rate (%)</b>	<b>Lending Rate (%)</b>	<b>Exchange Rate (index) (US \$/ Pa'aanga)</b>
1981-85 (ave)	3.76	28.51	10.48	6.25	10.00	97.73
1986-90 (ave)	0.31	31.48	10.01	6.48	11.05	110.69
1991-95 (ave)	3.66	31.04	4.39	5.27	11.55	115.03
1996-2000 (ave)	1.79	36.77	3.83	5.50	11.21	124.37
2001	3.06	45.58	8.30	5.47	11.34	145.31
2002	1.67	44.69	10.36	5.47	11.40	139.20
2003	3.06	44.47	11.64	5.47	11.34	122.19
2004	1.13	47.54	10.98	5.85	11.59	111.79
2005	-3.27	52.56	8.32	5.90	11.38	109.25
2006	4.38	51.97	6.44	6.58	11.97	110.64
2007	-0.28	53.84	5.89	6.77	12.16	102.44
2008	1.20	50.72	10.44	6.53	12.46	101.33

Source: International Monetary Fund, *International Financial Statistics*, various issues.

## *Monetary framework*

Tonga's monetary policy is implemented in the context of a fixed exchange rate arrangement according to which the value of the pa'anga is determined based on a weighted basket of currencies comprising the Australian dollar, the Japanese yen, the New Zealand dollar, and the U.S. dollar.<sup>4</sup> The exchange rate is managed on a day-to-day basis by NRBT on the basis of the movement of the basket of currencies. Since there are foreign exchange control regulations in place, Tonga has some measure of monetary policy independence.

The principal objectives of NRBT as defined by the NRBT Act<sup>5</sup>, include regulation of issue of currency, and supply and availability of exchange of money; managing the external reserves; promoting monetary stability and the soundness of the financial system; and fostering conditions for economic development. The NRBT aims at maintaining low inflation, and gross foreign reserves equivalent to three months of total imports or above. Thus, NRBT recognizes that exchange stability is essential for the price stability in Tonga given the high pass-through of the exchange rate to the price level given that more than two thirds of the items on the CPI basket are composed of imported goods.

The NRBT Governor is appointed for a period of five years and is eligible for reappointment. Responsibility for policy and affairs lies with the Board of Directors, which comprises the Governor and six other directors who are appointed by government. The NRBT pursues these objectives in close consultation with the government and most changes in monetary and exchange rate operations require government approval. In order to improve transparency of monetary policy measures and accountability of NRBT for the conduct of its policies, amendments to the 1988 Act introduced in 2007 require NRBT issue a monetary policy statement every six months.

The amended legislation also enables NRBT to conduct its monetary policy with greater autonomy. The NRBT makes currency adjustments not only on the basis of competitive advantage only but also on the basis of factors including inflationary impact). Earlier, Furthermore, NRBT was under frequent strain when it had to pick up the unsold government bonds issued to finance annual budget deficits. Since the amendment of the Act, NRBT cannot and does not underwrite or pick up unsold government bonds. Consequently, in the past reserve money creation through monetization of deficits had contributed to the excess liquidity. Since NRBT has limited monetary policy instruments to mop up surplus funds in the system, inflation has been a recurrent phenomenon.

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<sup>4</sup> The pa'anga was pegged to the Australian dollar until 1991. The Asian crisis and the sharp drop in reserves in 1997–98 led the authorities to introduce a 2 percent band in March 1998. In 2000, the band was widened to 5 percent and the Japanese yen was included in the currency basket since Japan became more important as a trading partner.

<sup>5</sup> Section 4 of NRBT Act of 1988.

Monetary policy instruments of a central bank are generally categorized into two: (i) ruled-based instruments<sup>6</sup>, which are based on the regulatory power of the central bank and (ii) indirect instruments<sup>7</sup>, which are linked to money market operations. When the central bank uses its regulatory powers, its aim is to change the balance sheets of commercial banks. By so doing, there is one to one correspondence effect between, say credit ceiling and commercial loans. On the other hand, when central bank uses indirect instruments, the objective is to change its own balance sheet. For example, if central bank conducts open market sale of its own security, it acquires additional reserves, thereby absorbing the targeted excess surplus funds from the economy. If there is a stable relationship between reserve money and aggregate demand, indirect instrument will be effective.

The NRBT relied solely on direct instruments until mid 1990s (Box 1). The SRD ratio stands at 5 percent, having been reduced from 10 percent in 2009 as a measure to fight recessionary conditions following the global economic downturn. In 1993, NRBT embarked on open market operations (OMO) by auctioning the 28-day central bank paper, known as NRBT Notes. However, NRBT's OMO came to a halt in 2001, due to financial losses, mainly arising out of mounting interest payment obligations as well as rise in administrative costs. Since the government was unable to support the central bank in its liquidity management operations by meeting the OMO costs, NRBT experienced ultimate deterioration in its capital base (IMF 2006).

With some improvement in its own finances, NRBT resumed OMO in its paper in 2007. But success was eluding. With excess liquidity caused by frequent monetization of annual fiscal deficits had been causing problems. IMF (2008) observed that a continued reliance on NRBT Notes would only result in increased costs of operating cost, which in the absence of government support for meeting the inflationary pressures created in the first place by its own fiscal excesses, would only undermine the central bank financial position. NRBT Notes have now been discontinued since May 2009.

In addition to the excess liquidity created by monetization of fiscal deficits on a regular basis, there is also the phenomenon of structural excess liquidity, which is prevalent in economies with shallow financial markets characterized by a small number of participants. In such economies as in Tonga and other island countries, IMF (2004, 2005)

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<sup>6</sup> The rules-based instruments include: (i) liquid asset ratio, a requirement for a bank to hold minimum amounts of specified liquid assets, typically as a percentage of its liabilities; (ii) reserve requirements, a requirements for a bank to hold minimum balances with the central bank, typically as a percentage of its liabilities; and (iii) standing facilities, which are monetary instruments used at the initiative of banks and bearing a pre-specified interest rate, allowing banks to borrow from (refinance facility) or deposit funds with the central bank (deposit facility).

<sup>7</sup> Indirect instruments are linked to money market conditions. These are used at the discretion of the central bank. They include: open market operations, which are monetary operations conducted by the central bank as a participant in the money market. They involve: (i) buying/selling bonds issued by government and government agencies on the secondary market; and buying/selling assets under a repurchase agreement in the repo market, or foreign exchange swaps; and (ii) open market-type operations, which are monetary operations based on auction techniques that are regulated by the central bank. They involve primary market issuance of central bank's own securities or government securities issued exclusively for monetary policy purposes (IMF 2004)



notes that OMO in either government issued securities or the central bank's own paper would result in overshooting of interest rates and market volatility. In these circumstances, it has been recommended by IMF (2008) that direct instruments such as SRD and liquidity asset ratio (LAR) and other direct instruments, including credit ceilings and moral suasion, all aimed at effecting immediate changes in banks' balance sheets be used, as they would be more effective since they directly affect the volume of liquidity. Experiences of other PICs are also relevant here<sup>8</sup>.

### **Box 1. Tonga: Monetary Policy Instruments**

#### **Credit ceilings**

They are imposed on the private sector credit of each individual bank. Credit ceilings are set quarterly by the NRBT and they have been the main monetary policy instruments in Tonga since 2000 until early 2007.

#### **Reserve requirements**

Introduced in 1993; they are not remunerated. The ratio was raised from 5 to 10 percent in 1996, to 12 percent in 1998, and to 15 percent in 2000. The ratio was reduced to 12.5% in 2006, to 10% in 2007, and to 5% in 2009.

#### **Standing facilities**

*Short-term liquidity facility:* Allows the banks to borrow from the NRBT for a short term (normally for less than a month), using government bonds or the NRBT notes as collateral. The discount rate charged by the NRBT on these short-term loans was 17 percent per year during the first 10 days, and 19 percent thereafter, as of August 2002 until 2006. In December 29, 2006, the repo rate was reduced to 12%. Repo rate was set at 2% above inter-bank rate or 10% per annum whichever is higher. Repo rate was reduced to 10% in August 2008, to 6% in March 2009, and to 4.5% in May 2009.

#### **Money market instruments**

*Reserve Bank Notes:* NRBT Notes were introduced in 1993; they were discontinued in 2001 owing to high operating costs. NRBT reintroduced its 28-day Reserve Bank Notes in 2006; they were discontinued in March 2007; reintroduced in October 2008 and again discontinued in May 2009.

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<sup>8</sup> IMF (2004) reports that soon after the 1998 crisis caused by a run on Vanuatu National Provident Fund and the resultant rise in liquidity, Reserve Bank of Vanuatu had to rely on direct instruments, including LAR and credit ceilings for controlling liquidity. Fiji resorted to raising SRD from 5 percent to 6 percent and imposed credit controls (Jayaraman and Choong 2009). IMF (2005) cites the experiences of both developed countries and developing countries in other regions: use of reserve requirements (Spain), mandatory deposits (Mexico and the Netherlands) and moving deposits from commercial banks to the central bank (Malaysia and Thailand)

Although expansionary policies, including monetary easing in 2007 were appropriate to facilitate recovery of the economy from the after-effects of riots, lurking inflationary pressures due to volatility in fuel prices and rising food prices in 2008 caused concerns to policy makers. By July 2008, the Tongan economy was on a modest path to recovery, as growth was spurred by new investments financed by high lending growth. Simultaneously, imports increased and inflation rose, once again exerting pressures on foreign reserves. Although large aid inflows reversed this trend later, NRBT was aware of leading to more inflation and higher imports unless growth in lending is curbed. The NRBT has been using moral suasion to convey the message that domestic banks should “manage their lending prudently against the quality of their portfolio and their future payments obligations to ensure that adequate liquidity is maintained in the banking system at all times” (NRBT 2008).

Aside from NRBT closely monitoring the growth in lending against foreign payments obligations by the financial system and issuing NRBT notes to ensure financial stability and maintenance of adequate foreign reserves, both finance ministry and central bank have to coordinate their actions to minimize pressures on public finances, as civil service is pressing the government for increasing the wage bill, and consequent impact on balance of payments and reserve position.

#### **4. Monetary Policy Transmission: A Brief Literature Survey**

Monetary policy transmission is described a process through which monetary policy changes decisions are expected to influence aggregate demand, output and price level in economy (Meltzer 1995). The impact of monetary policy decision on the country’s GDP domestic product is through its influences on consumption and investment decisions of households, business and financial intermediaries. At least six channels through which monetary policy impacts economic activities have been identified. These include: (i) interest rate channel; (ii) money supply channel; (iii) credit channel; (iv) the balance sheet channel; (v) asset price channel; (vi) exchange rate channel; and (vii) expectations channel (Mishkin 2006, 2001, 1996, 1995).

##### *Interest Rate Channel*

The traditional view is that a fall in nominal interest rate, following a rise in nominal money stock, given the unchanged price level in the short run due to market rigidities, and hence a fall in real interest rate, would cause rise in investment spending, thereby increasing aggregate demand and rise in output. The key here is that it is fall in the real cost of borrowing that would promote investment. Taylor (1995) in his survey on empirical research studies on interest rate channel concluded that there is strong empirical evidence for substantial effects on consumer spending on semi-durables and investment spending, making the interest rate monetary transmission mechanism a strong one.

### *Money Supply Channel*

The money supply channel view is that an expansionary monetary policy increases bank reserves and relaxes the constraints to banks' ability to create more loans and as a result short-term interest rate falls (King 1986, Ramey 1993, Romer and Romer 1990, Thornton 1994). Here, money supply expansion would mean increases either in M1, narrow money (comprising currency outside the banks and demand deposits) or M2, broad (consisting of narrow money and savings and time deposits).

### *Credit Channel*

Increase in money supply through rise in bank reserves would raise the ability of banks to expand lending. Banks would make available loans to new borrowers as well, most of whom are dependent on bank loans. This will encourage further consumption spending in terms of purchases of semi-durables and business investment. The bank credit channel has assumed greater importance in recent years, not only in advanced but also in developing economies as documented in studies by Bernanke (1986), Bernanke and Blinder (1988), Kashyap *et al.* (1993) and Kashyap and Stein (1994).

### *Balance Sheet Channel*

The balance sheet channel view lays emphasis on the role of collateral in reducing moral hazards. An expansionary monetary policy causes increases in financial and physical asset prices, thereby raising the market net worth of firms and the value of collateral, company cash flow and ultimately the firms' credit worthiness. Further, a rise in asset prices increases the ratio of liquid financial assets to household debt, thereby reducing the probability of financial distress and therefore increases consumption and housing investment (Mishkin 2001).

### *Asset Price Channel*

This particular transmission channel rests on Tobin's  $q$  theory, which is applied to business investment (Mishkin 1995, 2001, 2006). An expansionary monetary policy raises price level of equities. Increase in its stock prices enables the firm to raise additional equity capital by issuing less number of stocks. Transmission mechanism through asset price increases is further strengthened by Modigliani's life cycle model, according to which increases in financial wealth raises consumption by households (Mishkin 1995, 2001, 2006).

### *Exchange Rate Channel*

Monetary policy influences the exchange rate through interest rates. An expansionary monetary policy would increase money supply, leading to a fall in interest rate. Under conditions of perfect capital mobility and perfect substitutability of financial assets, capital would flow out and domestic currency would depreciate. Depreciation would

make the country's exports more attractive to foreigners; an increase in net exports would result in greater aggregate demand leading to rise in output (Mishkin 2006).

### *Expectations Channel*

Monetary policy decisions have an impact on the economy through their influence on the expectations of economic agents about the future outlook of the economy. In particular, expectation effects may improve monetary policy transmission channels by shortening reaction lags (Mayes 2004). The expectation channel is likely to be more effective, if the central bank has already acquired a high degree of credibility through its past performance.

### *Limitations in the island economies*

There are constraints limiting the efficiency of transmission mechanisms acting through various channels. One of the constraints faced by Tonga and other PICs is the absence of a well-developed and deep financial sector and a vibrant secondary market, in which financial assets could be traded with considerable ease and speed, interest rate channel does not effectively operate (Worrell 2000, Fairbairn and Worrell 1996).

The balance sheet approach presupposes that financial assets are important constituents of firms'/consumers' portfolios and assumes the existence of convertibility between illiquid (consumer durables) and liquid (financial) assets. Empirical studies have shown that markets for assets in the PICs and the Caribbean region have not attained such sophistication to function as an efficient conduit for monetary policy (Baksh and Craigwell 1997). A recent study (Dabla-Norris and Floerkemeir 2006) notes that the inability of banks in developing countries to properly assess credit risk, due to both weak risk management expertise and opaque corporate accounting practices, increases banking spreads and reduces the effectiveness of balance sheet channel.

With reference to asset price channel mechanism and its variants of Tobin's  $q$  theory (valuation of equities), the required pre-condition, namely the presence of financial assets constituting a key component of borrowers' and wealth holders' portfolios, does not exist in any PICs, including Tonga. Commercial banks dominate the financial sector, since the non-bank financial sector institutions (stock, debt securities and mortgage market, insurance industry) are still in their infancy. Thus, market financing does not matter, which largely precludes the asset price channel's working through wealth and income effects (Dabla-Norris and Floerkemeir 2006).

The exchange rate channel transmission mechanism for its full efficiency presupposes a floating system, which adjusts to capital flows. Since Tonga has adopted a fixed exchange rate regime, this particular channel does not operate. In view of the constraints discussed above, it is more likely that in small island economies with undeveloped money markets, monetary pulses are transmitted to the real sector through money channel rather than through interest rate channel. The next section is devoted to testing the hypothesis that money channel is more effective than interest channel.

## 5. Variables, Data and Methodology

For our empirical study, the choice of variables is severely constrained by data deficiencies. Further, the number of annual observations is also small. Therefore, the model has to remain simple. For analysis, we choose two policy variables, monetary aggregate and interest rate. Monetary aggregate can be represented by narrow or broad money. Interest rate is proxied by average lending rate, since there is no consistent data series for short-term rate. Accordingly, the variables utilized in our empirical study include real gross domestic product (*RGDP*), either of the two monetary aggregate measure (*M1*, *M2*)<sup>9</sup>, consumer price index (*P*), average nominal lending rate (*IR*); and nominal exchange rate (units of US dollar per unit of domestic currency). The annual data for the empirical study are drawn from two sources: the monetary and exchange rate data from International Financial Statistics published by International Monetary Fund (2008) and output data from Asian Development Bank (2008) and UN ESCAP (2008). Table 4 presents data series employed in the study.

### *Bounds testing approach*

The data series for Tonga cover a 28-year period (1981-2008). Since the number of observations is not large enough for estimating a long-run money and output model, we resort to the autoregressive distributed lag (ARDL) procedure, developed by Pesaran, *et al.* (2001). The ARDL bounds testing model is a general dynamic specification, which applies lags of the dependent variable and the lagged and contemporaneous values of the explanatory variables, through which the short-run impacts can be directly estimated, and the long-run relationship can be indirectly estimated. For econometric analysis, all variables are duly transformed into their natural logs. We also add a trend variable<sup>10</sup>.

Bound test with ARDL framework has several advantages: (i) it allows testing for the existence of a cointegrating relationship between variables in levels irrespective of whether the underlying regressors are I(0) or I(1) (Pesaran and Shin, 1999; Pesaran et al., 2001); (ii) it is considered more appropriate than the Johansen-Juselius multivariate approach for testing the long run relationship amongst variables when the data are of a small sample size (Mah, 2000)<sup>11</sup>; (iii) Pesaran and Shin (1999) show that estimators of

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<sup>9</sup> M1 is the sum of currency in circulation plus demand deposits held with commercial banks by the rest of the domestic economy other than the central bank. M2 is M1 plus savings and time deposits. We tried both M1 and M2 (broad money), alternately representing the monetary aggregate.

<sup>10</sup> Narayan and Smyth (2006) have extensively discussed the inclusion of time trend variable in the estimation.

<sup>11</sup> Some previous studies have used ARDL model to relatively small sample sizes with as few as 20 observations in their research. For example, Pattichis (1999) apply the ARDL model to estimate an import demand function for Cyprus from 1975 to 1994 (20 observations). Tang (2001) applies the ARDL framework to study inflation in Malaysia for the period of 1973-1997 (25 observations) while Tang and Nair (2002) apply the ARDL technique to estimate an import demand function for Malaysia from 1970 to 1998 (29 observations).

the short-run parameters are consistent and the estimators of long-run parameters are super-consistent in small sample sizes.

There are two steps involved in estimating the long-run relationship between money, output and other variables. The first step is to examine the presence of a long-run relationship among all variables in the equation. Once the long run relationship is confirmed in the model, the long-run coefficients are estimated using the associated ARDL model. To examine for cointegration by the bounds test proposed by Pesaran et al., the following models are constructed.

$$\begin{aligned} \Delta LRGP_t &= \delta_1 + \beta_{11}LRGP_{t-1} + \beta_{21}LP_{t-1} + \beta_{31}LM2_{t-1} + \beta_{41}LIR_{t-1} + \beta_{51}LER_{t-1} \\ &+ \sum_{i=1}^p \alpha_{11i}\Delta LRGP_{t-i} + \sum_{i=0}^p \alpha_{21i}\Delta LP_{t-i} + \sum_{i=0}^p \alpha_{31i}\Delta LM2_{t-i} \\ &+ \sum_{i=0}^p \alpha_{41i}\Delta LIR_{t-i} + \sum_{i=0}^p \alpha_{51i}\Delta LER_{t-i} + \varepsilon_{1t} \end{aligned} \quad (1)$$

$$\begin{aligned} \Delta LP_t &= \delta_2 + \beta_{12}LRGP_{t-1} + \beta_{22}LP_{t-1} + \beta_{32}LM2_{t-1} + \beta_{42}LIR_{t-1} + \beta_{52}LER_{t-1} \\ &+ \sum_{i=1}^p \alpha_{12i}\Delta LRGP_{t-i} + \sum_{i=0}^p \alpha_{22i}\Delta LP_{t-i} + \sum_{i=0}^p \alpha_{32i}\Delta LM2_{t-i} \\ &+ \sum_{i=0}^p \alpha_{42i}\Delta LIR_{t-i} + \sum_{i=0}^p \alpha_{52i}\Delta LER_{t-i} + \varepsilon_{2t} \end{aligned} \quad (2)$$

$$\begin{aligned} \Delta LM2_t &= \delta_3 + \beta_{13}LRGP_{t-1} + \beta_{23}LP_{t-1} + \beta_{33}LM2_{t-1} + \beta_{43}LIR_{t-1} + \beta_{53}LER_{t-1} \\ &+ \sum_{i=1}^p \alpha_{13i}\Delta LRGP_{t-i} + \sum_{i=0}^p \alpha_{23i}\Delta LP_{t-i} + \sum_{i=0}^p \alpha_{33i}\Delta LM2_{t-i} \\ &+ \sum_{i=0}^p \alpha_{43i}\Delta LIR_{t-i} + \sum_{i=0}^p \alpha_{53i}\Delta LER_{t-i} + \varepsilon_{3t} \end{aligned} \quad (3)$$

$$\begin{aligned} \Delta LIR_t &= \delta_4 + \beta_{14}LRGP_{t-1} + \beta_{24}LP_{t-1} + \beta_{34}LM2_{t-1} + \beta_{44}LIR_{t-1} + \beta_{54}LER_{t-1} \\ &+ \sum_{i=1}^p \alpha_{14i}\Delta LRGP_{t-i} + \sum_{i=0}^p \alpha_{24i}\Delta LP_{t-i} + \sum_{i=0}^p \alpha_{34i}\Delta LM2_{t-i} \\ &+ \sum_{i=0}^p \alpha_{44i}\Delta LIR_{t-i} + \sum_{i=0}^p \alpha_{54i}\Delta LER_{t-i} + \varepsilon_{4t} \end{aligned} \quad (4)$$

$$\begin{aligned}
\Delta LER_t = & \delta_5 + \beta_{15}LRGDP_{t-1} + \beta_{25}LP_{t-1} + \beta_{35}LM2_{t-1} + \beta_{45}LIR_{t-1} + \beta_{55}LER_{t-1} \\
& + \sum_{i=1}^p \alpha_{15i}\Delta LRGDP_{t-i} + \sum_{i=0}^p \alpha_{25i}\Delta LP_{t-i} + \sum_{i=0}^p \alpha_{35i}\Delta LM2_{t-i} \\
& + \sum_{i=0}^p \alpha_{45i}\Delta LIR_{t-i} + \sum_{i=0}^p \alpha_{55i}\Delta LER_{t-i} + \varepsilon_{5t}
\end{aligned} \tag{5}$$

where  $\Delta$  is the first difference operator, and the  $\varepsilon_{it}$  are white noise error terms. The joint significance of the lagged levels in these equations is examined using the F-test, where the null and alternative hypotheses are expressed as follows:

For Equations (1) to (5):

$H_0 : \beta_{1i} = \beta_{2i} = \beta_{3i} = \beta_{4i} = \beta_{5i} = 0$  (there is no long-run level relationship)

$H_1 : \beta_{1i} \neq \beta_{2i} \neq \beta_{3i} \neq \beta_{4i} \neq \beta_{5i} \neq 0$  (there is a long-run level relationship)

where  $i = 1, 2, \dots, 5$

The distribution of the F-statistics is non-standard under the null and is derived and provided by Pesaran et al. (2001). Two sets of critical values are given based on Pesaran, et al. (2001) and Narayan (2005). Narayan and Narayan (2005) and Narayan (2005) show that the use of Pesaran, et al.'s (2001) critical values for small sample study may lead misleading inferences as the computed critical values are generally lower than those generated by Narayan who used similar GAUSS code provided by Pesaran, et al. (2001). Narayan (2005) has generated a set of critical values for small sample size ranging from 30 to 80 observations. Since the sample size in our study is small, and as the critical values provided by Pesaran, et al. (2001) are calculated on the basis of large sample sizes of 500 and 1000 observations and 2000 and 40000 replications respectively, we use the critical values generated by Narayan (2005)<sup>12</sup>.

If the computed F-statistic is greater than the upper critical bound value, the null hypothesis of no cointegration is rejected irrespective of whether the variable is I(0) or I(1). In contrast, when the F-statistic is smaller than the lower critical bound value, the null hypothesis is not rejected, and we conclude that there is no long-run level relationship between the variables under study. However, if the computed F-statistic lies inside the lower and upper critical bound values, there is inconclusive inference unless the order of integration of the series under consideration is clearly examined.

#### *Granger causality test*

If the variables are cointegrated, the next step is to perform the Granger causality test to examine the short-run dynamic causality relationship between variables. Equations (1) to (5) can be re-formulated into a vector error-correction model (VECM) framework in order to capture the short- and long-run effect of the cointegrating vector. Let  $Z_t$  as the

<sup>12</sup> See Table 2 for these critical values.

vector of a set of endogenous variables, we can model  $Z_t$  as an unrestricted vector autoregression (VAR) model with optimum lag-length<sup>13</sup>:

$$Z_t = A_1 Z_{t-1} + A_2 Z_{t-2} + \dots + A_k Z_{t-k} + U_t \quad \text{where } U_t \sim IN(0, \sigma) \quad (6)$$

where  $Z_t$  is (5 x 1) vector comprised of *LRGDP*, *LP*, *LM2*, *LIR* and *LER*. Each of the  $A_i$  is (5 x 5) matrix of parameters. The 5-variable VAR model as shown in Equation (6) is used if no long run relationship in the bound testing approach. Nevertheless, if there appears a cointegration vector, then the following VECM will be used to examine the long- and short-run causality relationship between variables under study.

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} + \dots + \Pi Z_{t-k} + U_t \quad (7)$$

where  $\Delta Z_t = [LRGDP, LP, LM2, LIR \text{ and } LER]'$ ,  $\Gamma_1 = -(I - A_1)$ ,  $\Gamma_2 = -(I - A_1 - A_2)$  and  $\Pi = -(I - A_1 - A_2 - A_3)$ .  $\Gamma_i$  reflects the short-run relationship of the changes in  $Z_t$ . The (5 x 5) matrix of  $\Pi (= \alpha\beta')$  contains both speed of adjustment to disequilibrium ( $\alpha$ ) and the long-run information ( $\beta$ ) such that the term  $\beta' Z_{t-3}$  embedded in Equation (7) represents the ( $n-1$ ) cointegrating relationship in the model.

## 6. Results and Discussions

### *Unit root tests*

We use three testing procedures for examining the order of integration of each series. The first test is proposed by Dickey and Fuller (1979, ADF) with the null hypothesis of contain a unit root process. However, one of the problems with the ADF tests is that the test has low power in examining the properties of the series. Indeed, Pantula, *et al.* (1994) have argued that unit root tests based on the ordinary least squares (OLS) estimator such as ADF tests, are the least powerful among the test statistics they examined. Hence, we also apply unit root test proposed by Ng and Perron (2001). The test suggested by Ng and Perron (2001) has a similar null hypothesis as ADF test. Table 4 reports the results for three unit root tests, both on levels and in first differences of the variables. There is strong evidence to conclude that the series are non-stationary in their levels but stationary in first difference.

### *Cointegration test*

Adopting the autoregressive distributed lag (ARDL) model proposed by Pesaran, *et al.* (2001), we proceed to test the long-run cointegration hypothesis between *LRGDP*, *LP*, *LM2*, *LIR* and *LER*. The results of cointegration test are reported in Table 5. The estimated coefficients of the long-run parameters have the theoretically expected correct signs. The explanatory variables are statistically significant at the 5 per cent level or better, except for exchange rate.

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<sup>13</sup> The optimum lag length is chosen based on the Akaike's information criterion.



$$LRGDP_t = 7.681 - 0.279LP_t^{**} + 0.361LM2_t^{***} + 0.055LIR_t + 0.041LER_t \quad (5)$$

$$t \quad = \quad (4.647) \quad (-2.669) \quad (4.205) \quad (0.666) \quad (0.523)$$

**Table 4: The results of unit root tests**

Variable	ADF		Ng and Perron		ERS	
	Level	First Difference	Level	First Difference	Level	First Difference
LRGDP	-2.5101	-4.5885**	-9.3994	-12.6951**	9.4827	2.6801**
LP	-1.6323	-3.4468**	-5.4411	-10.5867**	14.8291	2.3034**
LM2	-2.1031	-4.7478**	-4.9167	-11.0754**	19.6802	2.5756**
LIR	-3.3778	-4.3883**	-7.7511	-12.4575**	10.9876	1.8993**
LER	-2.4572	-3.3057**	-13.6198	-9.6340**	6.4833	2.7961**

Notes: The ADF critical values are based on Mckinnon. The optimal lag is chosen on the basis of Akaike Information Criterion (AIC). The null hypothesis for both ADF and Ng-Perron tests is a series has a unit root (non-stationary) while the null hypothesis of the KPSS test is does not contain unit root (stationary).

The asterisk \*\* denotes the rejection of the null hypothesis at the 5% level of significance.

**Table 5: Bound test for Tonga**

Dependent Variable	Computd F-statistic				
LRGDP	8.895***				
LP	1.506				
LM2	1.328				
LIR	0.954				
LER	1.085				
	Pesaran, et al. (2001) <sup>a</sup>		Narayan (2005) <sup>b</sup>		
	Critical Value	Lower bound value	Upper bound value	Lower bound value	Upper bound value
	1 per cent	3.41	4.68	4.537	6.370
	5 per cent	2.62	3.79	3.125	4.608
	10 per cent	2.26	3.35	2.578	3.858

<sup>a</sup> Critical values are obtained from Pesaran, et al. (2001), Table CI(iii) Case III: Unrestricted intercept and no trend, p. 300.

<sup>b</sup> Critical values are obtained from Narayan (2005), Table case III: unrestricted intercept and no trend, p. 10.

\*, \*\* and \*\*\* indicate significance at 10%, 5% and 1% levels, respectively.

The results indicate that coefficients of both interest rate and exchange rate are not significant. The estimated coefficient of price index has a negative sign and is found statistically significant, while the coefficient of monetary aggregate is positively associated with output and is also significant. Specifically, the magnitude of the estimated coefficient of M2, which denotes elasticity of RGDP with respect to M2, suggests that a 1% increase in M2 would lead to about 0.361% increase in real output.

The results of bounds test for LRGDP equation, shown in Table 4, pass all the diagnostic tests such as Breusch-Godfrey LM test (serial correlation), ARCH test (heteroscedasticity), Ramsey RESET test (functional form misspecification) and Jarque-Bera (normality) test. Further, cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) stability tests (Figures 2 and 3) suggest that all the estimated coefficients in the estimated LRGDP regression are stable over the sample period.

#### *Granger causality test*

In order to examine the dynamic causal relationship between the macroeconomic variables, we use the Granger causality test within parsimonious vector error correction model (PVECM). The error correction term (ECT) for LRGDP equation, which measures the speed at which LRGDP adjusts to changes in price, money variable, interest rate and exchange rate before converging to its long-run equilibrium level, is statistically significant at the 10 per cent level. The ECT has the correct sign, suggesting that the variable is non-explosive and the long-run steady state equilibrium is attainable. The magnitude of ECT (-0.1553) implies a slow speed of adjustment to equilibrium following a shock, that is, about 16 per cent of disparity of the current year's shock revert back to its long-run equilibrium within the next year. The ECTs for other equations are not statistically significant, although they have the correct negative signs. The results confirm the existence of only one cointegrating vector and that there is linkage running only from money and other explanatory variables to output.

**Table 6: Granger causality test for Tonga**

Dependent Variable	F-statistics					ECT (t-statistics)
	$\Delta$ LRGDP	$\Delta$ LP	$\Delta$ LM2	$\Delta$ LIR	$\Delta$ LER	
$\Delta$ LRGDP	-	7.7306***	9.8009***	9.2368***	12.4039***	-0.1553* (-1.9041)
$\Delta$ LP	4.1644*	-	17.9505***	1.5877	6.9994**	-0.0951 (-1.6028)
$\Delta$ LM2	0.7631	2.4896	-	1.3208	0.2909	-0.6901 (-0.7336)
$\Delta$ LIR	7.6422***	2.2797	3.2806*	-	2.8711	-0.3811 (-0.7474)
$\Delta$ LER	4.1780*	5.3782*	5.0283*	2.7755	-	-0.5253 (-1.7107)

Note: \*, \*\* and \*\*\* indicate significance at 10%, 5% and 1% levels, respectively. Figures in parentheses are t-statistics.

As regards short-run causality relationships, we observe the linkage runs from money variable to output, price, interest rate and exchange rate. Additionally, there is bi-directional causality exists between real output and price, real output and exchange rate, and exchange rate and price. Hence, changes in money variable are seen to have significant effects on real output establishing the role of money in stabilizing and controlling economic activity.

**Table 7: Results of Variance Decomposition Analysis**

<b>Period</b>	<b>S.E.</b>	<b>LRGDP</b>	<b>LP</b>	<b>LM2</b>	<b>LIR</b>	<b>LER</b>
<b>Variance Decomposition of LRGDP:</b>						
1	0.0257	35.7667	0.0964	32.2081	4.7112	27.2176
2	0.0344	21.3342	1.1548	58.9493	2.9757	15.5860
3	0.0397	19.4264	2.5010	55.9155	2.2814	19.8757
4	0.0415	17.8007	2.8761	56.9285	2.3960	19.9988
5	0.0453	14.9505	4.1099	62.0217	2.0128	16.9051
6	0.0508	13.4794	3.2903	58.8512	1.7395	22.6398
7	0.0531	12.6461	3.4407	57.7098	4.1841	22.0194
8	0.0553	11.7328	3.2341	59.3284	5.1274	20.5774
9	0.0595	13.4280	2.8556	60.2508	5.2075	18.2582
10	0.0630	15.8767	2.5531	57.7735	4.7134	19.0833
<b>Variance Decomposition of LP:</b>						
1	0.0227	0.0000	61.9942	28.1670	3.3735	6.4653
2	0.0403	3.1349	22.1566	43.0402	21.5561	10.1121
3	0.0496	2.4158	14.8985	44.9420	27.0109	10.7328
4	0.0523	5.3410	13.5514	45.0460	26.2696	9.7920
5	0.0658	12.3238	8.7898	51.4219	17.1980	10.2665
6	0.0916	9.2714	4.6879	62.6881	12.1998	11.1528
7	0.1118	6.3066	3.1510	70.0208	10.3692	10.1525
8	0.1300	5.5133	2.4249	75.2757	9.2213	7.5648
9	0.1450	5.7079	2.3631	77.3419	8.4853	6.1018
10	0.1563	6.5154	2.3773	76.9673	8.5124	5.6275
<b>Variance Decomposition of LM2:</b>						
1	0.0842	0.0000	0.0000	100.0000	0.0000	0.0000
2	0.1137	0.8124	0.1372	94.7236	0.6086	3.7182
3	0.1247	0.6799	0.1867	94.4845	1.2028	3.4462
4	0.1452	0.5856	1.3035	93.5859	1.2179	3.3070
5	0.1771	0.3975	1.0310	92.8206	2.3498	3.4011
6	0.1986	0.3290	0.8304	92.0683	3.6028	3.1696
7	0.2210	0.9717	0.9228	91.0051	4.5388	2.5617
8	0.2422	2.0833	0.9680	90.2521	4.5538	2.1428
9	0.2590	3.4716	0.9536	89.1470	4.2875	2.1404
10	0.2702	3.9916	1.0452	88.8164	4.0895	2.0573
<b>Variance Decomposition of LIR:</b>						
1	0.0571	0.0000	0.0000	14.3976	85.6025	0.0000
2	0.0719	6.9186	0.4731	9.4807	57.7364	25.3912
3	0.0999	30.1176	0.3580	17.1789	30.9919	21.3536
4	0.1137	30.8806	2.7143	13.8864	31.1910	21.3277
5	0.1198	27.9331	3.7064	16.5403	32.0766	19.7437
6	0.1358	28.5856	2.8861	24.2577	25.0101	19.2605
7	0.1445	31.0194	2.8227	22.7457	22.9131	20.4992
8	0.1520	29.1376	4.8267	20.7771	21.1207	24.1379
9	0.1541	29.2481	6.3060	20.2067	20.5826	23.6565
10	0.1600	29.2929	5.8931	19.7514	19.9711	25.0916

1	0.0502	0.0000	0.0000	38.7914	2.4053	58.8033
2	0.0687	2.1725	5.1342	58.8360	1.2914	32.5659
3	0.0863	2.9544	9.9240	58.5342	1.7069	26.8805
4	0.1047	4.9367	7.8334	59.3566	1.5862	26.2871
5	0.1305	5.5025	5.0444	56.6755	7.3453	25.4322
6	0.1450	4.6916	4.0988	54.6727	13.2973	23.2397
7	0.1597	7.6006	3.4951	53.4421	15.9834	19.4788
8	0.1782	15.1621	2.8072	49.2959	13.2914	19.4435
9	0.1952	20.7069	2.6546	42.5219	11.3359	22.7807
10	0.2023	21.6464	2.9957	39.7409	11.3180	24.2990

Notes: Cholesky Ordering: LM2, LIR, LER, LP, LRGDP. We have used different orderings of the variables under concerned, but the findings are robust to changes (see Footnote 17).

**Table 8: Correlation Matrix of the reduced form VAR residuals**

	<b>LRGDP</b>	<b>LP</b>	<b>LM2</b>	<b>LIR</b>	<b>LER</b>
<b>LRGDP</b>	1	0.0275	0.4636	-0.3961	-0.5252
<b>LP</b>		1	0.2786	0.2530	-0.2469
<b>LM2</b>			1	-0.1237	-0.6829
<b>LIR</b>				1	0.1831
<b>LER</b>					1

### *Variance decomposition analysis*

Table 7 shows the relative importance of each shock in terms of their contribution to the forecast-error variance of each variable. It is seen that money variable is the most crucial policy variable in explaining both RGDP and price level, both in the short- and long-run. While money variable explains more than 32 and 28 percent of total variation in output and price respectively in the short-run, it explains more than 50 percent of total variation in both variables in the long-run. Exchange rate shock explains about 27 percent of forecast-error variance of RGDP variation in the first year. However, it explains about 20 percent of forecast-error variance of RGDP variation in the remaining time horizon. Price and interest rate shocks explain less than 6 percent of the forecast-error variance of RGDP for the entire time horizon.

Looking at the forecast-error variance of price, even though interest rate's contribution relative to other policy variables is not so high as that of money variable in the short-run, its contribution to price is still relatively high in the medium-term, which explains about 20 percent on price (from second to fourth years). For the whole horizon, the percentage of the variance in price explained by RGDP and exchange rate is less than 16 percent.

Consistent with the Granger causality test, money variable emerges as an exogenous variable as over 88 percent of the forecast-error variance is explained by its own shock at all horizons. It is found that output, money and exchange rate are significant in explaining interest rate in the medium- and long-terms. On the other hand, money variable is crucial

in explaining exchange rate for the whole horizons. In contrast, RGDP, price and interest rate shocks are the least important to explain exchange rate, either in the short- or long-run.

#### *Correlation Matrix of Reduced-form VAR Residuals*

In order to examine the robustness of the variance decomposition results, which would be sensitive on different orderings of the variables, we resorted to testing the correlation of reduced-form VAR residuals. Table 8 shows the correlation matrix of the reduced-form VECM residuals based on the ordering of variables, namely: money, interest rate, exchange rate, price and RGDP. The elements of the correlation matrix between these variables are relatively low, implying that the contemporaneous feedback is not a problem. These correlations suggest that the ordering of the variables in a Choleski decomposition is not of any major concern.

#### *Impulse response function analysis*

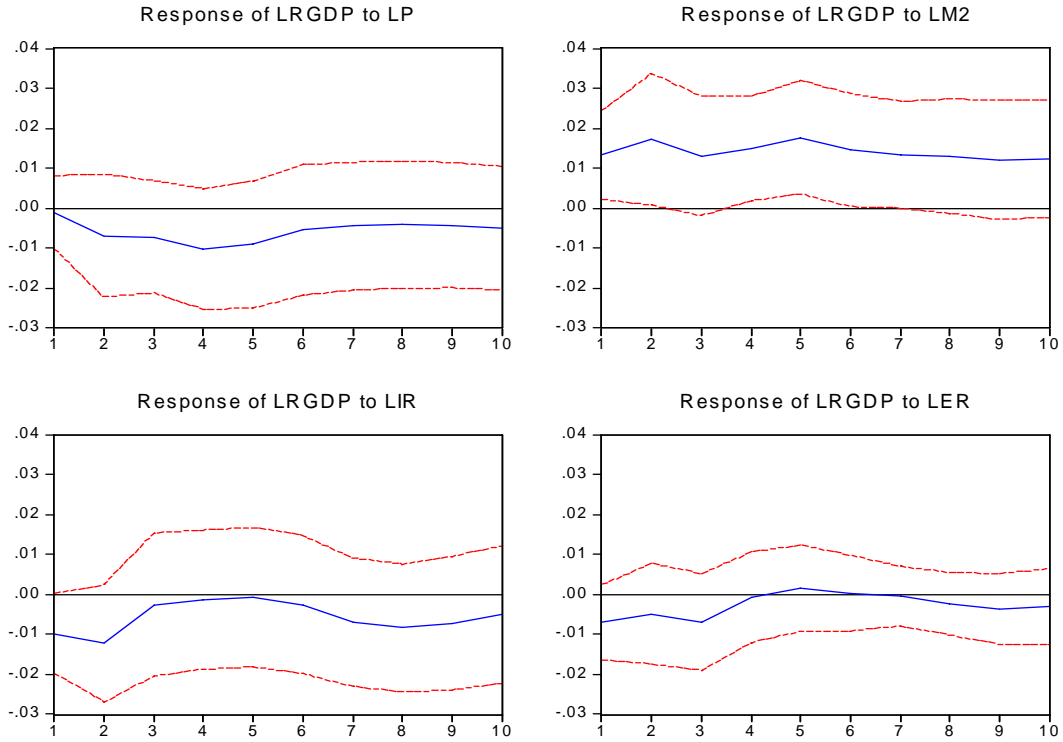
The study extends the analysis to impulse response function (IRF). Based on this analysis, a one-standard deviation shock to one variable not only directly influences another variable, but also the shock is also transmitted to other endogenous variables via the dynamic lag structure of the system. This technique traces the impact of a shock to one of the innovations on current and future values of the endogenous variables.

Figure 1 and Figure 2 show the results of IRF analysis for RGDP and price, respectively. The response of RGDP to a shock in price is negative, which is statistically not significant effect for the entire horizon. A shock to money variable evokes a positive and significant response in RGDP for the first five years and the effect dies out quickly after that. Response of output to shocks in both interest rate and exchange rate, though negative are statistically not significant.

Looking at the response of price to shocks in policy variables, we note that a one standard deviation shock in real output gives rise to a positive and significant response in price for the first two years, which decreases, becoming negative and eventually dying out. A shock in money variable evokes a positive and significant response in price, which decreases after the fifth year. In contrast, we do not observe any significant responses in price to shocks in interest rate and exchange rate for the entire time horizon.

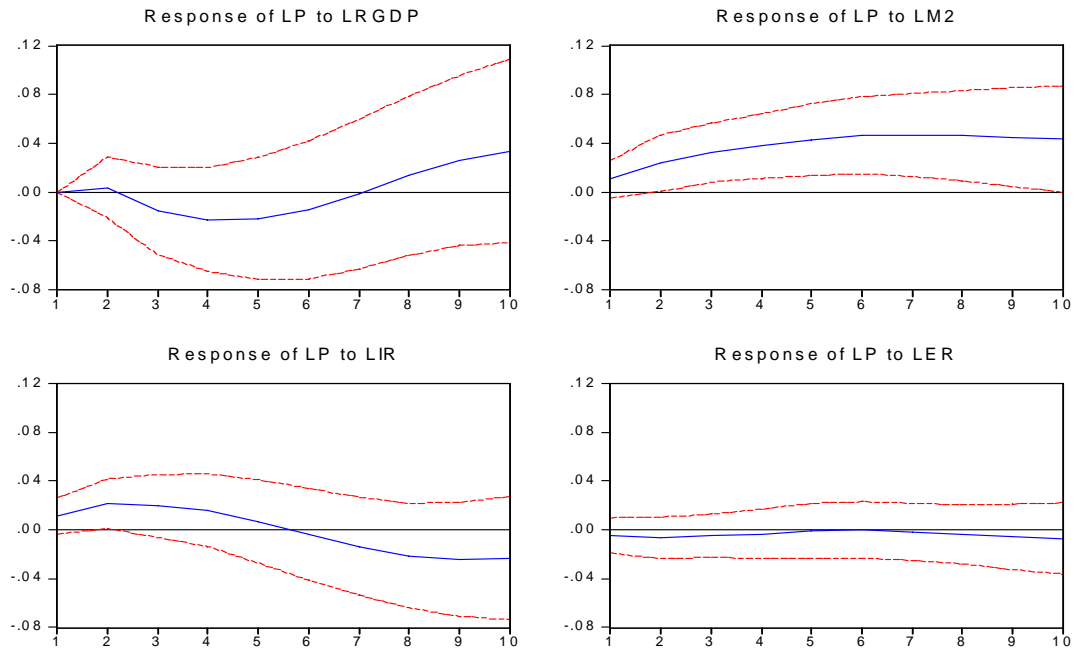
**Figure 1: The Results of Impulse Response Function Analysis for LRGDP**

Response to Cholesky One S.D. Innovations  $\pm 2$  S.E.



**Figure 2: The Results of Impulse Response Function Analysis for Prices**

Response to Cholesky One S.D. Innovations  $\pm 2$  S.E.



## **7. Summary and Conclusions**

There are no studies on monetary policy transmission mechanism in Tonga. Although monetary policy transmission mechanism in developed countries, as well as in many developing countries, documented in the growing body of empirical literature, is well understood and clear, it is not clear how monetary policy transmission mechanism works in Tonga. This paper seeks to fill the gap by undertaking a study on the monetary policy transmission mechanism in Tonga.

Tonga's financial sector is small. Its money market, where short-term interest rate is determined, is shallow. Further, there are no secondary markets for short- and long-term debt securities. The study findings show that monetary aggregate in Tonga is more important than short-term interest rate as a channel in transmitting impulses from the monetary sector to the real sector. The significant responses of both real output and price to money variable further reinforce our argument that policy makers should target monetary aggregate as policy instrument for controlling real activity and for price stabilization in Tonga. These are consistent with the findings of studies in other parts of the developing world that in countries where the money market is relatively undeveloped, the money market will not be the principal conduit of monetary policy shocks.

The study findings should be useful for policy makers involved in the design and implementation of monetary policy so as to ensure the maximum effect on investment and economic growth. With further economic liberalization and development of financial market in Tonga, the channels through which monetary policy works will continue to evolve. As such, the question of how monetary policy is transmitted to the real sector in Tonga would be of continuing interest to researchers and policy makers, especially when a longer time series of data become available, after some efflux of time, for a more detailed analysis of the impact of liberalization on the monetary transmission mechanism.



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