Monetary policy transmission in Pacific Island Countries

A study of Tonga

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Abstract

This paper undertakes an empirical study on how the monetary policy transmission mechanisms work in Tonga. Adopting a bounds testing approach, as the time series data cover a short period (1981–2008), the study shows that monetary aggregate 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 the money variable confirm that policy makers should target monetary aggregate as the policy instrument, rather than interest rate, for controlling real activity and for price stabilisation in Tonga.

Keywords: Monetary aggregates, output, bounds test, Granger causality test

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Introduction

Among the 14 Pacific island countries (PICs),[1] Tonga is one of the six that have their own independent currencies. The other eight PICs are dollarised[2] economies, with one or the other of the three currencies of the metropolitan countries in the region used as legal tender. Tonga has a fixed exchange rate regime, as also do four other PICs with independent currencies, namely Fiji, Samoa, Solomon Islands and Vanuatu, whereas the sixth country, Papua New Guinea, has a floating exchange rate regime.

The National Reserve Bank of Tonga (NRBT) was established in 1989. under the National Reserve Bank of Tonga 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. Prior to that, 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 then and now, includes price stability in terms of low inflation as well as external stability of the *pa'anga,* the domestic currency. The consumer price index basket is dominated by imported goods, which account for about two-thirds of the items. The NRBT—which is intensely aware 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 or above of total imports.

The NRBT has had mixed success in pursuing these objectives with instruments of monetary policy, direct and indirect. These include statutory reserve requirement ratio and credit control measures as well as open market operations in the NRBT–issued securities, which were replaced in May 2009 by government treasury bills. Since no studies have so far been undertaken on monetary policy transmission in Tonga, the present paper seeks to fill the gap. As 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 organised as follows. The next section provides a background of Tongan economy and monetary policy instruments employed by NRBT; the third section is a short summary of the various transmission mechanisms as studied in advanced and developing economies and their limitations when applied to island economies; the fourth deals with the methodology adopted for the empirical analysis; the fifth reports the results; and the final section presents conclusions with policy implications.

A background

Tonga (population 102,000), whose selected key indicators are given in Table 1, shares many commonalities with the other PICs. Tonga is heavily subsistence oriented, providing livelihood to 80 per cent of the population. Its manufacturing base is small, being 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)	102
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 per cent (2001–2008)	1.4
Annual Average Inflation in per cent (2001–2008)	9.0
Overall Budget Balance as per cent of GDP (2001–2007)	0.4
Current Account Balance as per cent 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, limited commercial agriculture and a 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, 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, the 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 characterised by relatively favourable macroeconomic conditions, the economic situation in the 1980s and mid-1990s deteriorated. As Australia and New Zealand liberalised their imports of agricultural commodities, including tropical vegetables and fruits, from the rest of the world in the late 1980s, Tonga ceased to enjoy the special treatment accorded to its exports of bananas and copra. However, the emergence of squash exports to Japan as an off-season crop brought a sustained level of export earnings over the next few years. In the 1990s, government announced its strategy of promoting manufacturing through tax holidays and tariff preferences. After an initial rise in domestic production, though, exports did not take off. The second-half of the 1990s and the 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 the country's foreign currency–denominated investments led to depletion of the Tonga Trust Fund, which was built through the country's official reserves, amounting at one time to 20 per cent of GDP (Singh 2006).

In the late 1990s, 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 have slowed down economic growth, while adverse terms of trade shocks as well as rises in fuel and food prices contributed to rising inflation. Ostensibly 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 per cent 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 per cent (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 2008, worldwide increases in food and fuel prices and subsequent volatility in fuel prices exposed the weaknesses in handling the unforeseen impact on the balance of payments. Along with inflation, the decline in reserves was causing concerns. Although real exchange appreciated by 13 per cent during 2003–2007 due to domestic inflation relative to inflation in trading partners, government was not keen to adjust the nominal exchange rate, as there is no visible advantage in devaluing its currency. Already exports of squash to the niche market in Japan had weakened and Tonga's exports were only just 10 per cent of total imports. Thus, containing inflation, rather than promoting competitiveness of limited exports, was a priority. Further, devaluation of the nominal currency would only raise prices of imports of fertilisers, insecticides and other inputs that go into the production of fruits and vegetables including squash, aside from increasing landed prices of all critical imports.

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

Monetary policy formulation and implementation

Structure of the financial system a nd market

As of 2009, 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; and the third was a locally incorporated bank. A small insurance sector completes the financial sector.

Table 2 Tonga: Financial System Structure

	Assets (Millions of pa'anga)	Per cent in Total Assets	Per cent of GDP	Number of Institutions
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 the 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 savings and time deposits for savers to invest in. Table 3 presents the monetary statistics of Tonga.

Following the liberalisation of the economy in general and the financial sector, with discontinuance of controls on lending and deposit rates from the late 1990s, the ratio of broad money to GDP has been on the rise.

Table 3: Tonga: Monetary Statistics

Year	RGDP Growth Rate (%)	M2 (as Ratio of GDP (%)	Inflation (%)	Deposit Rate (%)	Lending Rate (%)	Exchange Rate (index) (US$/ Pa'anga)
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 on the basis of a weighted basket of currencies comprising the Australian dollar, the Japanese yen, the New Zealand dollar and the US. dollar.3 The NRBT manages the exchange rate on a day-to-day basis in response to movements in the basket of currencies. Foreign exchange control regulations in place, in regard to both current and capital accounts in the balance of payments, mean that Tonga preserves some measure of monetary policy independence.

The principal objectives of the NRBT as defined by the National Reserve Bank of Tonga Act4 include regulation of issue of currency, and supply and availability of exchange of money; management of the external reserves; promotion of monetary stability and the soundness of the financial system; and the fostering of 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 recognises that exchange stability is essential for price stability in Tonga given the high pass-through of the exchange rate to the price level, a consequence of the fact that more than two-thirds of the items in 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 that NRBT issue a monetary policy statement every six months.

The NRBT makes currency adjustments on the basis not only of competitive advantage but also on the basis of factors including inflationary impact. Furthermore, NRBT was under frequent strain when it had to pick up the unsold government bonds issued to finance annual budget deficits. Since NRBT has limited monetary policy instruments to mop up surplus funds in the system, inflation has been a recurrent phenomenon.

Monetary policy instruments of a central bank are generally categorised into two: (i) rules-based instruments,5 which are based on the regulatory power of the central bank; and (ii) indirect instruments,6 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 the central bank uses indirect instruments, the objective is to change its own balance sheet. For example, if a 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 instruments will be effective.

The NRBT relied solely on direct instruments until the mid-1990s (Box 1). The Statutory Reserve Deposit (SRD) ratio stands at 5 per cent, having been reduced from 10 per cent 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 the 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 elusive. Excess liquidity caused by frequent monetisation of annual fiscal deficits has been causing problems. IMF (2008) observed that a continued reliance on NRBT Notes would only result in increases in 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 financial position of the central bank. NRBT Notes have now been discontinued since May 2009.

In addition to the excess liquidity created by monetisation 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 with a small number of participants. In such economies as in Tonga and other island countries, IMF (2004, 2005) 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.7

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 were the main monetary policy instruments in Tonga from 2000 until early 2007.

Reserve requirements

Introduced in 1993; they are not remunerated. The ratio was raised from 5 to 10 per cent in 1996, to 12 per cent in 1998, and to 15 per cent 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 per cent per year during the first 10 days, and 19 per cent thereafter, as of August 2002 until 2006. On 29 December 2006, the repo rate was reduced to 12%. The repo rate was set at 2% above the inter-bank rate or 10% per annum whichever is higher. The 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 but 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.

Although expansionary policies, including monetary easing in 2007, were appropriate to facilitate recovery of the economy from the after-effects of riots, inflationary pressures due to volatility in fuel prices and rising food prices in 2008 caused concern 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 growth in bank credit. Simultaneously, imports increased and inflation rose, once again exerting pressures on foreign reserves. 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, both the finance ministry and the central bank had to coordinate their actions to minimise pressures on public finances, as the civil service was pressing the government for increasing the wage bill. Such a move would, of course, have an eventual impact on domestic inflation and foreign reserves.

Monetary policy transmission: a brief literature survey

Monetary policy transmission is described as a process through which decisions on monetary policy change are expected to influence aggregate demand, output and price level in the economy (Meltzer 1995). The impact of monetary policy decisions on the country's GDP domestic product is through its influence on consumption and investment decisions of households, business and financial intermediaries. At least seven channels through which monetary policy affects 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 a 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 the interest rate channel concluded that there was strong empirical evidence for substantial effects on consumer spending on semi-durables and investment spending, making the interest rate monetary transmission mechanisms 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 & 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 money (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 lend 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 2006, 2001, 1995). An expansionary monetary policy raises the price level of equities. Increase in its stock prices enables the firm to raise additional equity capital by issuing fewer stocks. Transmission mechanisms through asset price increases are further strengthened by Modigliani's life cycle model, according to which increase in financial wealth raises consumption by households (Mishkin 2006, 2001, 1995).

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. 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 listed above. One of the constraints faced by PICs, including Tonga, is that in the absence of a well-developed financial sector with an active secondary market, in which financial assets could be traded with considerable ease and speed, the interest rate channel does not operate effectively (Worrell 2000; Fairbairn & 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 PICs and the Caribbean region have not attained such sophistication as to function as an efficient conduit for monetary policy (Baksh & Craigwell 1997). A recent study (Dabla-Norris & Floerkemeir 2006) notes that the inability of banks in developing countries to assess credit risk properly, due to both weak risk management expertise and opaque corporate accounting practices, increases banking spreads and reduces the effectiveness of the balance sheet channel.

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

The exchange rate channel transmission mechanisms 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 the money channel rather than through the interest rate channel.

Variables, data and methodology

In 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 is represented by broad money. Interest rate is proxied by average lending rate, since there is no consistent data series for short-term rate Accordingly, the variables utilised in our empirical study include real gross domestic product (RGDP), either of the two monetary aggregate measures (M1, M2),8 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 the International Monetary Fund (IMF 2008) and output data from Asian Development Bank (2008) and UNESCAP (2008).

Bounds testing approach

The data series for Tonga covers 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.9

Bounds testing with an 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 & 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 1995;10 (iii) Pesaran and Shin (1999) show that estimators of 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.

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

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

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

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

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

where Δ is the first difference operator, and the ε_{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...5

The distribution of the F-statistic 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 might lead to misleading inferences as the computed critical values are generally lower than those generated by Narayan, who used a similar GAUSS code provided by Pesaran et al. (2001). Narayan (2005) has generated a set of critical values for small sample sizes 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 1,000 observations and 2,000 and 40,000 replications respectively, we use the critical values generated by Narayan (2005).11

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. Therefore, 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. With Z_t as the vector of a set of endogenous variables, we can model Z_t as an unrestricted vector autoregression (VAR) model with optimum lag-length:12

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

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

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

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

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 (ADF) (1979, with the null hypothesis of a unit root process. However, one of the problems with the ADF test is that the test has low power. 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 apply the unit root test as proposed by Ng and Perron (2001). The test suggested by Ng and Perron (2001) has a similar null hypothesis as the 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 the cointegration testing are reported in Table 5. The estimated long-run equation is:

$$\begin{array}{llllll} LRGDP_t = 7.681 & - 0.279 LP_t^{**} & + 0.361 LM2_t^{***} & + 0.055 LIR_t & + 0.041 LER_t & \quad (5) \\ t \quad = (4.647) & (-2.669) & (4.205) & (0.666) & (0.523) & \end{array}$$

The estimated coefficients of the long-run parameters have the theoretically expected correct signs. However, the coefficients of interest rate and exchange rate are not significant. The estimated coefficient of price index, which has a negative sign, is found statistically significant. Further, 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 the elasticity of RGDP with respect to M2, suggests that a 1% increase in M2 would lead to about 0.361% increase in real output.

Table 4 The results of unit root tests

Variable	ADF		Ng and Perron		ERS	
	Level	First Difference	Level Difference	First Difference	Level	First
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 s 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)a		Narayan (2005)b	
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

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

b 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 of the bounds test for LRGDP equation, shown in Table 5 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 the 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 (Table 6). 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 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 the linkage runs only from money and other explanatory variables to output.

Table 6 : Granger causality test for Tonga

Dependent Variable	**F-statistics**					**ECT (t-statistics)**
	Δ LRGDP	**Δ LP**	**Δ LM2**	**Δ LIR**	**Δ LER**	
Δ LRGDP	–	7.7306***	9.8009***	9.2368***	12.4039***	–0.1553* (–1.9041)
Δ LP	4.1644*	–	17.9505***	1.5877	6.9994**	–0.0951 (–1.6028)
Δ LM2	0.7631	2.4896	–	1.3208	0.2909	–0.6901 (–0.7336)
Δ LIR	7.6422***	2.2797	3.2806*	–	2.8711	–0.3811 (–0.7474)
Δ 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, causality is seen to exist 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 dominant role of money in stabilising and controlling economic activity.

Table 7 Results of Variance Decomposition Analysis

Period	S.E.	LRGDP	LP	LM2	LIR	LER
Variance Decomposition of LRGDP:						
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
Variance Decomposition of LP:						
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
Variance Decomposition of LM2:						
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
Variance Decomposition of LIR:						
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
Variance Decomposition of LER:						
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 consideration but the findings are robust to changes.

Table 8 Correlation Matrix of the reduced form VAR residuals

	LRGDP	**LP**	**LM2**	**LIR**	**LER**
LRGDP	1	0.0275	0.4636	–0.3961	–0.5252
LP		1	0.2786	0.2530	–0.2469
LM2			1	–0.1237	–0.6829
LIR				1	0.1831
LER					1

Variance decomposition analysis

Table 7 shows the relative importance of shock in each variable in terms of their contribution to the forecast-error variance of variables. It is seen that monetary aggregate is the most important policy variable in explaining both RGDP and price level, in both the short and long run. While money variable explains more than 32 and 28 per cent of total variation in output and price respectively in the short run, it explains more than 50 per cent of total variation in both variables in the long run. Exchange rate shock explains about 27 per cent of forecast-error variance of RGDP variation in the first year. However, it explains about 20 per cent of forecast-error variance of RGDP variation in the remaining time horizon. Price and interest rate shocks explain less than 6 per cent 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 the money variable in the short run, we see that its contribution to price is still relatively high in the medium term, which explains about 20 per cent on price (from the 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 per cent.

Consistent with the Granger causality test results, the money variable emerges as an exogenous variable; over 88 per cent of the forecast-error variance is explained by its own shock at all horizons. Output, money and exchange rate are found to be significant in explaining variation in interest rate in the medium and long terms. On the other hand, the money variable is crucial in explaining exchange rate for the whole horizons. The RGDP, price and interest rate shocks are the least important to explain variation in exchange rate, in either 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 the shock is 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.

Figures 1 and 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 a 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 not statistically 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

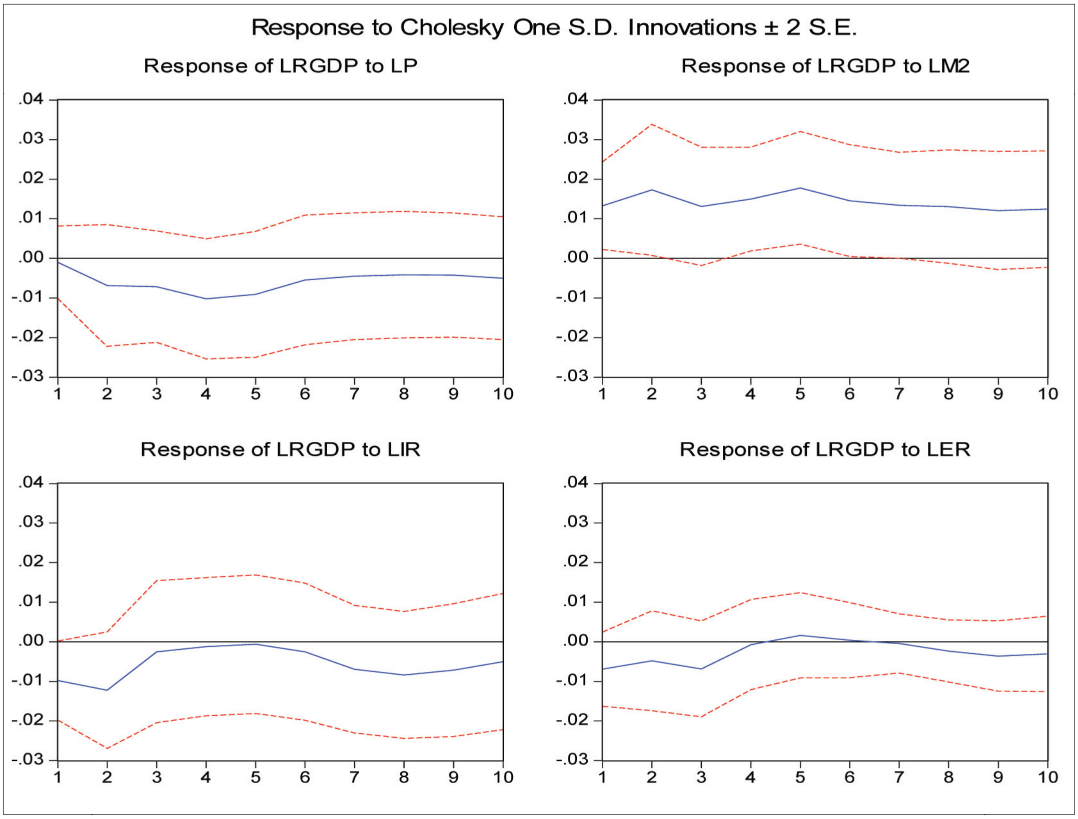
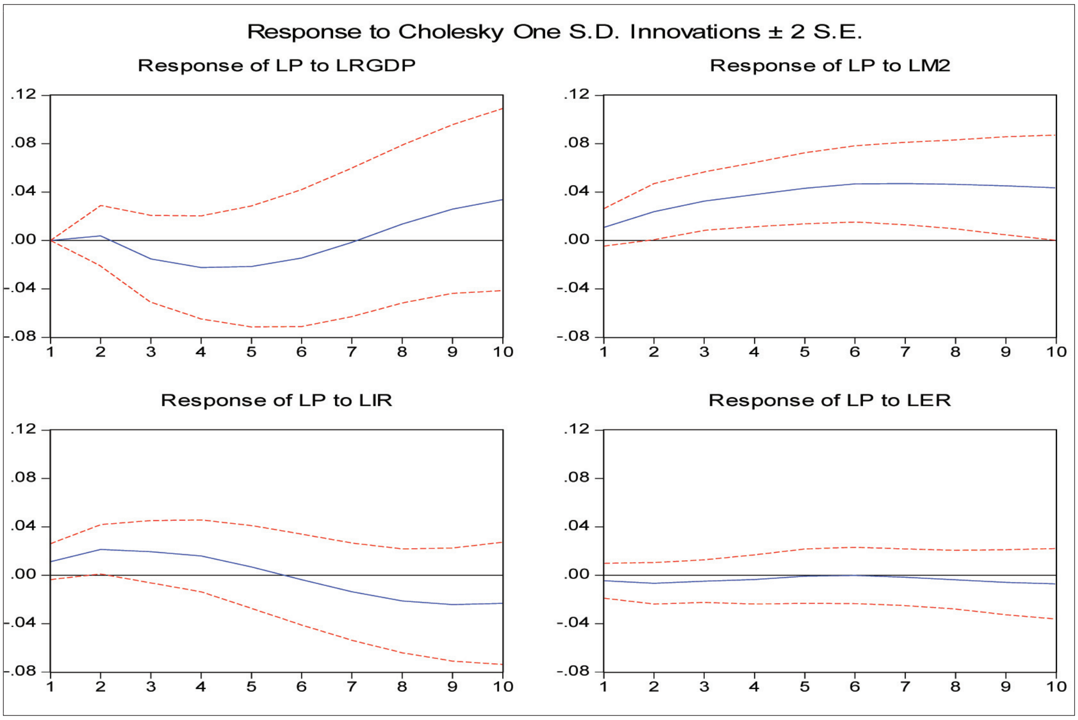


Figure 2 The Results of Impulse Response Function Analysis for Prices



Summary and conclusions

Tonga is one of the six Pacific island countries that have independent currencies of their own. Tonga's financial sector, consisting of five institutions (National Reserve Bank of Tonga (NRBT), three commercial banks and one state-owned development bank) is small. Tonga's money and capital markets are underdeveloped. Further, there are no secondary markets for short- and long-term debt securities.

The principal objectives of NRBT are 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 recognises that exchange stability is essential for the price stability in Tonga given the high pass-through of the exchange rate to the price level, since more than two-thirds of the items in the CPI basket are composed of imported goods.

Tonga's monetary policy aiming at the aforesaid objectives is implemented in the context of a fixed exchange rate arrangement, according to which the value of the pa'anga is determined on the basis of a weighted basket of currencies comprising the Australian dollar, the Japanese yen, the New Zealand dollar and the US dollar. 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, in regard to both current and capital accounts in the balance of payments, Tonga has some measure of monetary policy independence.

There are no studies on monetary policy transmission mechanisms in Tonga, Although monetary policy transmission mechanisms as documented in the growing body of empirical literature is well understood and known, it is not clear how they work in Tonga. This paper seeks to fill the gap by undertaking an empirical study on the monetary policy transmission mechanisms in Tonga.

The study findings reveal that (i) the money variable has a positive and significant effect on output and prices; (ii) interest rate has no significant impact on either output or prices. It is thus confirmed that changes in the short-term interest introduced by NRBT either by open market operations in government securities or in its own securities did not have the intended effects. Only changes in monetary aggregate by direct instruments proved effective. These findings are consistent with the findings of studies in other parts of the developing world, namely 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.

The policy recommendations are clear and direct. Until the financial sector evolves over a period of time, policy makers should continue to target monetary aggregate as a policy instrument for controlling real activity and for price stabilisation in Tonga. With further economic liberalisation and development of the financial sector 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.

Notes

This paper is based on research undertaken as part of a study on monetary policies in the Pacific Island countries under the Commonwealth Secretariat research project.

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The views expressed do not reflect those of the Commonwealth Secretariat or NRBT .

[1] 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 organisation, known as the Pacific Islands Forum (the Forum).

[2] The eight dollarised economies, using one of the three major currencies as legal tender, are: Kiribati, Nauru and Tuvalu (Aus $); Cook Islands and Niue (NZ $), and Marshall Islands, Federated States of Micronesia and Palau (US $).

[3] 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 per cent band in March 1998. In 2000, the band was widened to 5 per cent and the Japanese yen was included in the currency basket since Japan became more important as a trading partner.

[4] Section 4 of National Reserve Bank of Tonga Act 1988.

[5] 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, 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).

[6] 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).

[7] The IMF (2004) reports that soon after the 1998 crisis caused by the run on the Vanuatu National Provident Fund and the subsequent rise in liquidity, the 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 per cent to 6 per cent and imposed credit controls (Jayaraman & Choong 2009). The 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).

[8] 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.

[9] Narayan and Smyth (2006) have extensively discussed the inclusion of time trend variable in the estimation.

[10] Some earlier studies have applied the ARDL model to relatively small sample sizes, with as few as 20 observations, in their research. For example, Pattichis (1999) applies 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).

[11] See Table 2 for these critical values.

[12] The optimum lag length is chosen based on the Akaike's information criterion.

References

Asian Development Bank (ADB), 2008, Asian Development Outlook 2008, ADB, Manila.

AusAID, 2008, *Pacific Economic Survey* 200*8: Connecting the Region,* Commonwealth of Australia, Canberra.

Baksh, S., Craigwell, R.C., 1997, 'The monetary transmission mechanisms in small open economies: a case study of Barbados', Savings and Development, XXI: 179–193.

Bernanke, B.S., 1986, 'Alternative explanations of money–income correlation', Working Paper No. 184, National Bureau of Economic Research, Washington, DC.

Bernanke, B.S., Blinder, A.S., 1988, 'Is it money, or credit or both or neither? Credit, money and aggregate demand', *American Economic Review,* 78: 435–439.

Dabla-Norris, E., Floerkemeir, H., 2006, 'Transmission mechanism s of monetary policy in Armenia', Working Paper WP/06/248, International Monetary Fund, Washington, DC.

Dickey, D.A., Fuller, W.A., 1979, 'Distribution of the estimators for autoregressive time series with a unit root', *Journal of the American Statistical Association,* 74: 427–431.

Fairbairn, T., Worrell, D., 1996, *South Pacific and Caribbean Island Economies: A Comparative Study*, The Foundation for Development Cooperation, Brisbane.

IMF (International Monetary Fund), 2004, *Monetary Policy Implementation at Different Stages of Market Development, Country Cases and Appendices—Supplementary Information*, International Monetary Fund, Washington, DC.

IMF (International Monetary Fund), 2005, *Selected Issues in Solomon Islands*, International Monetary Fund, Washington, DC.

IMF (International Monetary Fund), 2006, *Staff Report of Art IV Mission,* International Monetary Fund, Washington, DC.

IMF (International Monetary Fund), 2008, *International Financial Statistics,* CD ROM, Washington, DC, December 2008.

Jayaraman, T.K., Choong, C.K., 2009, 'Does money matter in Pacific islands?', I, 2/2009, The University of the South Pacific, Suva.

Kashyap, A.K., Stein, J.C., 1994, 'The impact of monetary policy on bank balance sheets', *NBER Working Paper 4821*, National Bureau of Economic Research, Cambridge, Mass.

Kashyap, A.K., Stein, J.C., Wilcox, D.W., 1993, 'Monetary policy and credit conditions: evidence from the composition of external finance', *American Economic Review*, 83(7): 8–98.

King, S., 1986, 'Monetary transmission—through bank loans or bank liabilities', *Journal of Money, Credit and Banking*, 18: 290–333.

Mah, J.S., 1995, 'An analysis of the structural change in the exchange market pressure: Korea, 1980-89', *Applied Economics Letters*, 2: 80–82.

Meltzer, A.H., 1995, 'Monetary, Credit and (Other) Transmission Processes: A Monetarist Perspective', *Journal of Economic Perspectives*, 9: 49–72.

Mishkin, F., 1995, 'Symposium on the monetary transmission mechanism s', *Journal of Economic Perspectives*, 9: 3–10.

Mishkin, F., 1996, 'The channels of monetary policy transmission: lessons for monetary policy', *NBER Working Paper 5464*, National Bureau of Economic Research, Cambridge, Mass.

Mishkin, F., 2001, 'The transmission mechanism and the role of asset prices', *NBER Working Paper 8617*, National Bureau of Economic Research, Cambridge, Mass.

Mishkin, F., 2006, *Economics of Money, Banking and Financial Markets*, Addison-Wesley, New York.

Narayan, P.K., 2005, 'The saving and investment nexus for China: evidence from cointegration tests', *Applied Economics*, 37: 1979–1990.

Narayan, P.K., Narayan, S., 2005, 'Estimating income and price elasticities of imports for Fiji in a cointegration framework', *Economic Modelling*, 22: 423–438.

Narayan, P.K., Smyth, R., 2006, 'The residential demand for electricity in Australia: an application of the bounds testing approach to cointegration', *Energy Policy*, 33: 467–474.

NRBT (National Reserve Bank of Tonga), 2008, *NRBT Quarterly Economic Review*, Various Issues, NRBT, Nuku'alofa, Tongatapu.

Ng, S., Perron, P., 2001, 'Lag length selection and the construction of unit root tests with good size and power', *Econometrica*, 69: 1519–1554.

Pantula, S.G., Gonzalez-Farias, G., Fuller, W.A., 1994, 'A comparison of unit-root test criteria', *Journal of Business and Economic Statistics*, 12: 449–459.

Pattichis, C.A., 1999, 'Price and income elasticities of disaggregated import demands: results from UECMs and an application', *Applied Economics*, 31: 1061–1071.

Pesaran, M.H., Shin, Y., 1999, 'An autoregressive distributed lag modelling approach to cointegration analysis', in S. Strom (ed.), *Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium*, Cambridge University Press, Cambridge: Chapter 11.

Pesaran, M.H., Shin, Y., Smith, R., 2001, 'Bounds testing approaches to the analysis of level relationships', *Journal of Applied Econometrics*, 16: 289–326.

Ramey, V., 1993, 'How important is the credit channel in the transmission of monetary policy?', *Carnegie–Rochester Conference Series on Public Policy*, 39: 1–46.

Romer, C., Romer, D., 1990, 'New evidence on the monetary transmission mechanism', B*rookings Papers on Economic Activity*, 1: 149–198.

Singh, R., 2006, 'Tonga', in C. Browne (ed.), *Pacific Island Economies*, IMF, Washington, DC: Chapter 16, pp. 154–162.

Tang, T.C., 2001, 'Bank lending and inflation in Malaysia: assessment from unrestricted error-correction models', *Asian Economic Journal*, 15: 275–289,

Tang, T.C., Nair, M., 2002, 'A cointegration analysis of Malaysian import demand function: reassessment from the bounds test', *Applied Economics Letters*, 9: 293–296.

Taylor, J.B., 1995, 'The monetary transmission mechanism: an empirical framework', *Journal of Economic Perspectives*, 9: 11–26.

Thornton, D., 1994, 'Financial innovation, deregulation and the credit view of monetary policy', *The Federal Reserve Bank of St. Louis*, 76: 31–49.

UNESCAP (United Nations Economic and Social Commission for Asia and Pacific), 2007, *Economic and Social Survey*, 2007, UNESCAP, Bangkok.

UNESCAP (United Nations Economic and Social Commission for Asia and Pacific), 2008, *Economic and Social Survey 2008*, UNESCAP, Bangkok.

World Bank, 2008, *World Development Indicators 2008*, CD ROM, The World Bank, Washington, DC.

Worrell, D., 2000, 'Monetary and fiscal coordination in small open economies', *Working Paper WP/00/56*, IMF, Washington, DC.