Monetary policy transmission in an undeveloped South Pacific Island country: a case study of Samoa

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Abstract: Amongst the South Pacific's least developed small island countries, Samoa has emerged as a successful economy. Its achievements of low inflation and high growth rates have been due to sustained fiscal adjustment programmes and appropriate monetary policy measures. This paper undertakes an empirical study of transmission mechanism of monetary policy by adopting a VAR approach and using quarterly data over a 17-year period (1990–2006). The study findings are that money and exchange rate channels are important channels in transmitting monetary impulses to Samoa's output.

Keywords: monetary policy; transmission mechanism; monetary aggregate; econometric modelling; cointegration; error-correction model; Granger causality; variance decomposition; impulse response functions; South Pacific; least developed country; Samoa.

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1 Introduction

Located between 13 and 15 degrees S latitude and 168 and 173 degrees W longitude in the South Pacific, Samoa, consisting of two main islands and seven other uninhabited islands, with a total land area of 2800 square kilometres and a population of 180,000, has been designated by the United Nations (UN) as one of the 50 Least Developed Countries (LDC) of the world[1] (United Nations Conference on Trade and Development, 2006). Further, being an island nation, Samoa has also been the focus of attention as one of the 24 Small Island Developing States (SIDS), for which the UN has prepared a Program of Action for Sustainable Development (Encontre, 2006).

Although small states in other parts of the world such as Singapore in Asia, and Malta and Cyprus in Europe, have done well by overcoming the hurdles posed by physical and geographical constraints through exploitation of their highly qualified human resource skills and comparative advantage in certain spheres, such as financial services, the 24 SIDS have been struggling hard due to several weaknesses, including lack of physical and human resources, and inappropriate economic and social policies and inadequacies in governance. Table 1 provides the list of 24 SIDS with their economic vulnerability index (2006) and Table 2 presents a comparative picture of island states in the Pacific region.

Table 1 United Nations Economic Vulnerability Index (2006) and Ranking of 24 small island developing states (least developed countries are shown in bold type)

	Relative influences on economic vulnerability index						
	Score of the five different components of EVI						
Countries	*P*	*D*	*C*	*A*	*E*	*Scores*	*Rank*
Tuvalu	100	49	45	58	100	70.32	**1**
Kiribati	82	42	71	67	62	64.8	**2**
Commoros	64	68	85	10	70	59.11	**3**
Cape Verde	68	43	39	100	28	55.54	**4**
St. Lucia	77	45	61	56	26	52.89	5
Seychelles	82	29	82	51	18	52.47	6
St. Kitts and Nevis	89	39	60	45	24	51.43	7
St. Vincent/Grenadines	80	47	45	59	27	51.39	8
Dominica	84	41	44	42	40	50.08	9
Bahamas	71	45	60	42	29	49.34	10
Tonga	81	36	55	38	32	48.48	11
Solomon Islands	67	51	66	28	21	46.74	**12**
Vanuatu	75	49	35	30	34	44.51	**13**
Grenada	81	41	49	21	30	44.47	14
Sao Tome and Principe	78	31	29	26	45	41.83	**15**
Samoa	77	37	36	27	28	40.93	**16**
Antigua and Barbuda	85	36	18	17	33	37.67	17
Fiji	63	39	35	35	13	37.21	18

Table 1 United Nations Economic Vulnerability Index (2006) and Ranking of 24 small island developing states (least developed countries are shown in bold type) (continued)

	Relative influences on economic vulnerability index						
	Score of the five different components of EVI						
Countries	*P*	*D*	*C*	*A*	*E*	*Scores*	*Rank*
Papua New Guinea	47	58	42	4	30	36.12	19
Mauritius	60	25	24	33	30	34.34	20
Trinidad and Tobago	59	37	29	18	28	34.24	21
Maldives	71	52	36	5	3	33.57	**22**
Barbados	72	45	11	24	14	33.49	23
Jamaica	53	36	50	13	7	31.82	24

P: Population component; D: Economic diversification component;
C: Export Concentration component; A: Agricultural production instability component;
E: Export instability component.

Source: Encontre (2006)

Table 2 Key economic and social indicators of Pacific island countries

Countries	*Population ('000) 2004*	*Area ('000)* (Sq.km)	*Per capita GDP (US$) 2004*	*Human dev. index ranking*
Cook Islands	19	0.2	2651	62
Fiji	841	18.3	2720	92
Micronesia	110	0.7	2300	120
Kiribati	98	0.7	970	129
Palau	20	0.5	6870	NA
Papua New Guinea	5722	462	560	137
Marshall Island	61	0.2	2320	121
Samoa	184	2.8	1840	74
Solomon Islands	468	28.9	560	128
Tonga	102	0.7	1360	54
Tuvalu	11	0.003	345	118
Vanuatu	207	12.2	1390	118

Source: World Bank (2006)

During the second half of the last century, most of the Pacific island countries achieved political independence. Of the 14 Pacific island countries, eight countries are dollar economies, as they have been using the currencies of their former colonial masters, Australia, New Zealand and the USA, as legal tender. The other six Pacific island countries, including Samoa, have their own independent currencies.

From the late 1990s, Samoa has been pursuing reforms in many areas. These included promoting central bank autonomy with powers for independent monetary policy formulation and implementation and use of indirect instruments, doing away with past practices of ceilings on interest rates and quantitative controls on credit. So far, no studies have been undertaken on Samoa's monetary policy transmission mechanism. The present

study has, accordingly, been motivated to fill the gap. The paper is organised on the following lines: Section 2 presents a brief background of Samoa's economy; Section 3 is a short literature survey of channels of transmission of monetary policy; Section 4 outlines the methodology adopted for the study; Section 5 reports the results of the study; and Section 6 is a summary of the findings.

2 Economic background of Samoa

Samoa's economy has a narrowly base. Its main activities are subsistence agriculture and fisheries. Because of the communal land tenure system, which is unique to all Pacific islands in terms of the inalienable nature of communally held land to any private individual for land based activities, the development in the private sector has been seriously hampered. The commercial banks find it difficult to lend, in the absence of land as collateral. Although the country has several attractive tourist locations with beaches, hotel and resort activities have not progressed well mainly because of customary land tenure system.

The country's exports have been copra and copra products, such as coconut milk and cream, and fish. Agricultural activities are mainly subsistence oriented and the surplus is sold in local markets, which provide incomes to families who own the land communally. As the country is prone to frequent cyclones, major cyclones destroy farmlands and uproot coconut trees, the very base of the country's Gross Domestic Product (GDP) to a substantial extent. Samoa depends upon private remittances from its former citizens working in Australia, New Zealand and the USA, which are equivalent to about 25% of GDP. While remittances help families to finance their domestic consumption, generous annual, official transfers from governments of Australia and New Zealand on a regular basis assist the government to financially bridge its annual budget deficits. Most of the investment projects such as roads and jetties and ports, are externally funded.

The financial sector is small. There are four commercial banks, two of which are foreign owned with a market share of about 80% of total banking system assets. The two other banks, which are locally owned, have yet to make their presence felt. The non-banking financial institutions include a few foreign-owned insurance companies and locally owned credit unions, besides the state sponsored pension fund institution, known as Samoa National Provident Fund. Due to inadequate private sector initiatives, mainly hampered by lack of collateral, the pension funds are invested in government's treasury bills and public sector projects. The banking and non-banking institutions are supervised by the monetary authority, known as the Central Bank of Samoa (CBS), set up in 1984. There is no stock market. Further, the only financial securities issued are those of the government, comprising short-term treasury bills and long term bonds of different maturities. There is no secondary market, in which these securities can be traded. So bond holders hold them until their maturity.

During a 25 year period (1970–1995), when some of the newly independent Pacific island countries progressed with sound demand management policies, Samoa presented a contrasting picture. Weak fiscal management and poorly performing state owned enterprises contributed to the decline of the Samoan economy, which was also battered by two cyclones of 1991 and 1992, destroying the country's physical infrastructure. Table 3 presents selected key indicators of Samoa.

Table 3 Samoa: selected key indicators

Land area (Sq.km. '000)	2.8
Population (2004: '000)	184
Per capita GDP (US$) current prices: 2004	1840
Aid per capita in US$ (2004)	167
Aid as percentage of GDP (2004)	8.2
Human development ranking (2004)	75
Annual average growth rate in percent (2001–2005)	4.2
Annual average inflation in percent (2001–2005)	5.3
Overall budget balance as percent of GDP (2000–2005)	–1.3
Current account balance as percent of GDP (2000–2005)	–0.2

Source: ADB (2006) and UNESCAP (2007)

Fiscal adjustment measures including downsizing the public sector and closure of non-viable state enterprises and financial sector reforms, which began in the late 1990s, brought about the much-needed economic transformation. It enabled Samoa to outperform other Pacific island countries during the next five years (2000–2005), with solid economic growth, as well as improvements in public finances, fall in inflation and reduction in debt levels (KVAConsult Ltd., 2007; Leigh, 2006). The financial sector reforms consisted of dismantling all quantitative credit controls and removal of ceilings on interest rates charged by the commercial banks, and encouragement of competition in the banking sector by granting licenses for new banks to enter. Further, the country's monetary authority, the CBS embarked upon new policy initiatives.

Effective January 1998, CBS commenced weekly open market type operations in its own 91-day and 182-day central bank bills through public auction mode, which not only helped liquidity management, but has also now become the primary monetary policy instrument for influencing short term interest rates in the market. Over the last nine years, CBS strived, with notable success, to make the conduct of its monetary policy more transparent with the issue of public information notices and publication of annual monetary policy statements and statistics (KVAConsult Ltd., 2007).

3 Monetary policy transmission: a brief literature survey

The process through which monetary policy decisions affect aggregate demand, GDP in real terms, and price level, is described as monetary transmission (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. There are at least six channels through which monetary policy impacts economic activities:

- interest rate channel
- money supply channel
- credit channel

- the balance sheet channel
- asset price channel
- exchange rate channel
- expectations channel.

One should however recognise that these channels of transmission have varying lags in their functioning (Mishkin, 1995, 1996, 2001, 2006).

3.1 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, would cause rise in investment spending, thereby increasing aggregate demand and rise in output. The key here is that it is the real rather than nominal rate that influences investment. Taylor (1995), in his survey on empirical research studies on interest rate channels, 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.

3.2 Money supply channel

The money supply 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, the short-term interest rate falls (King, 1986; Ramey, 1993; Romer and Romer, 1990; Thornton, 1994). Here, money supply would mean either *M*1, Narrow Money (*M*1) (comprising currency outside the banks and demand deposits) or *M*2, broad (consisting of (*M*1) and savings and time deposits).

3.3 Credit channel

Increase in money supply through rise in bank reserves enhances the ability of banks to expand lending. Banks would make available loans to new borrowers as well, most of who are dependent on bank loans. This will encourage further consumption spending in terms of purchases of semi-durables and business investment. These would lead to increases in GDP. 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).

3.4 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).

3.5 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. The 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).

3.6 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).

3.7 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.

4 Modelling methodology and data

4.1 Limitations in the least developed island economies

In the South Pacific's developing, small and open island economies, there are severe constraints limiting the efficiency of transmission mechanisms acting through various channels. In 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, the interest rate channel does not operate effectively (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 developing island economies in the Caribbean region have not achieved such sophistication in functioning as efficient conduits for monetary

policies (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 the asset price channel mechanism and its variants of Tobin's *q* theory (valuation of equities) and Modigliani's wealth and consumption model, an important pre-condition, namely, the presence of financial assets constituting a key component of borrowers' and wealth holders' portfolios, does not exist in small, island economies. Further, in small economies including Samoa, 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 Samoa has adopted a fixed exchange rate regime, this particular channel may not operate. Furthermore, the scope for exchange rate channel is limited in Samoa, owing to continued existence of controls on capital movements and its financial assets not being considered by overseas investors as perfect and desirable substitutes for other international assets.

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 channels.

4.2 Methodology

For exploring how monetary shocks affect the economy, we employ the VAR methodology, which has been increasingly adopted in recent years (Dabla-Norris and Floerkemeir, 2006; Ramlogan, 2004; Morsink and Bayoumi, 2001). The chief advantage of using standard VAR is that only minimal restrictions need to be imposed. Following Bernanke and Blinder (1992) and Sims (1992), a VAR with k endogenous variables and n lags can be expressed as:

$$\prod_0 y_t = \prod_1 y_{t-1} + \prod_2 y_{t-2} + \cdots + \prod_n y_{t-n} + \varepsilon_t \tag{1}$$

where y_t is a $k \times 1$ vector of endogenous variables, each Π is $k \times k$ matrix of standard parameters of the endogenous variables and ε_t is a $k \times 1$ vector of structural disturbances.

The model uses a recursive, contemporaneous system, whereby it is assumed that the structural shocks ε_t are orthogonal and that each Π is lower triangular. If there is no contemporaneous feedback from the non-policy variable to policy variable, it is theoretically sound to place the policy variable first in the recursively ordered system. If the contemporaneous correlation among the shocks in the reduced–form VAR is high (Ahmed, 2003; Ramlogan, 2004), ordering becomes a matter of concern.

4.3 Data sources

The study covers a 17-year period (1990–2006) and data are drawn from published sources. Table 4 presents selected indicators of annual growth rate and related monetary

statistics. We employ the quarterly data for all variables except real output (RGDP). Since there are no quarterly estimates of real GDP, we resort to the cubic-spline procedure to split annual data series for generating quarterly times series. The monetary variables employed in the study are *M*1 (Haug et al., 2003)[2] and bank credit (CRE), representing loans to private sector. In the absence of a consistent time series covering a 17-year period relating to short-term interest rate, we were constrained to use the average lending rate charged by commercial banks (BR) to represent interest rate representing monetary policy stance.

Besides the monetary variables, we use price level and exchange rate as variables in the study. The price variable employed is the consumer price index (P). The exchange rate (E) refers to the domestic currency (*tala*) units per unit of foreign currency (US dollar). The reason for using the nominal exchange rate is that we can isolate changes in the nominal exchange rate on real economic activity separately from changes in prices, since the real exchange rate is already adjusted for changes in prices and using this variable would make it difficult to isolate price changes (inflation) from exchange rate changes (Dabla-Norris and Floerkemeir, 2006). The data source for monetary variables, price index and exchange rate is *International Financial Statistics CD Rom, July 2007, (*IMF, 2007), whereas the data source for annual real GDP data series is *the Key Indicators of Developing Asian and Pacific Countries 2007* (ADB, 2007).

Table 4 Samoa: growth rate and monetary statistics: 1985–2006

	Annual growth rate (%)	*M1* (*mill Tala*)	*M2* (*mill Tala*)	*CRE* (*mill Tala*)	*CPI* (*index*)	*E* (*Tala/US$*)	*Ave. lending rate (%)*
1985–1989 (Ave)	2.4	26.7	76.9	32.8	55.5	2.2	18.0
1990–1994 (Ave)	–1.1	43.8	123.7	69.9	77.7	2.5	13.0
1995–1999 (Ave)	3.8	68.6	205.8	142.7	94.1	2.7	11.8
2000	6.1	93.3	289.9	233.0	100.0	3.3	11.0
2001	7.0	86.8	307.6	266.6	103.8	3.5	9.93
2002	1.0	95.6	339.0	294.7	112.2	3.4	9.75
2003	3.5	118.2	386.4	318.5	112.3	3.0	9.75
2004	3.7	124.9	418.5	358.7	130.7	2.8	9.75
2005	5.1	160.7	484.0	440.1	133.1	2.7	9.75
2006	3.5	170.1	550.6	538.5	138.1	2.8	9.75

Source: UNESCAP (2007) and IMF (2007)

The six variables, with the exception of interest rate (BR), are duly transformed into logarithmic form, and entered into VAR equation in the following order: *M*1, bank credit to private sector (CRE), interest rate (BR), nominal exchange rate (E), RGDP and consumer price index (P).

5 Empirical results

The empirical study, which employed both E-views and Microfit, begins with an investigation into the time series properties of each variable employed in the study.

The results of the Augmented Dickey Fuller (ADF) tests show that all variables in log levels contain unit root (Table 5). The test statistics, however, reject the null of a unit root in their first difference, indicating that these variables are of I(1) processes.

To test for the existence of a long-run equilibrium cointegration relationship between the economic variables, we employ the system-based method developed by Johansen (1988) and extended by Johansen and Juselius (1990). This is done to check the number of cointegration vectors. The lag length for the cointegration test used is 2. Preliminary results reveal that log CRE is not significant. Further, its inclusion in the analysis has given rise to a serial correlation problem in the model. Therefore, it was considered appropriate to drop log CRE from the analysis. The monetary transmission model to be tested is:

$$Z = (M1, BR, E, RGDP, P). \tag{2}$$

Table 5 Unit root tests: log level and log first difference

	Log level				*Log first difference*			
	Model 1		*Model 2*		*Model 1*		*Model 2*	
Variables	*Lag*	t_{α^*}	*Lag*	t_{α^*}	*Lag*	t_{α^*}	*Lag*	t_{α^*}
log *M*1	3	1.445	4	–3.462	2	–9.237*	2	–9.002*
log CRE	2	0.957	1	–2.831	1	–6.078*	1	–6.156*
BR	2	–3.139*	2	–3.125	4	–3.417*	4	–3.584*
log *E*	1	–1.252	1	–2.491	1	–5.892*	1	–5.921*
log *P*	1	–0.337	1	3.154	1	–7.260*	1	–7.191*
log RGDP	3	0.729	3	–3.421	2	–4.087*	2	–4.171*

*Significant at 5% level.

The optimal lag length for each of autoregressive process of ADF test is determined by Schwarz Bayesian Criterion (SBC).

5.1 Long-term relationship

The results for both λ_{trace} and $\lambda_{\max}$ test statistics for the number of cointegrating vectors are summarised in Table 6. The likelihood ratio test statistics, λ_{trace} are calculated and compared to the 95% quartiles of the appropriate distribution. The null hypothesis of no cointegration ($r = 0$) was rejected in favour of alternative ($r = 1$) suggesting that there is at least one cointegrating vector using trace statistics. Both The λ_{trace} and the $\lambda_{\max}$ statistics identify only one cointegration vector. This indicates the presence of a long run relationship.

The likelihood ratio tests are asymptotically distributed chi-square with one degree of freedom. The results indicate that the variables, money, bank rate, exchange rate and output, contribute to the long-term relationship. Both Lagrange multipliers of lag 1 and lag 2 indicate there is no autocorrelation in the residuals, which confirm the adequacy of the model for cointegration analysis. Normalising the coefficient of log RGDP, the restricted long-run relationship is expressed as:

$$\log \text{RGDP} = \underset{(0.05)}{0.39 \log M1*} \underset{(0.01)}{- 0.02 BR**} \underset{(0.22)}{- 0.39 \log E*} \underset{(0.11)}{- 0.17 \log P} + 6.1$$

The figures in the parentheses are the standard errors.

*indicates significance at 10% level.

**indicates significance at 5% level.

The coefficients of log $M1$, BR, and log E have emerged with correct signs. Further, they are also found to be significant. However, the coefficient of log P has been found to be non-significant.

Table 6 Johansen cointegration analysis

Test of cointegration rank					
Eigenvalue	0.4624	0.2726	0.1647	0.1236	0.0183
Null hypotheses	$r = 0$	$r \leq 1$	$r \leq 2$	$r \leq 3$	$r \leq 4$
λ-Trace	82.51**	42.17	21.47	9.78	1.20
95% C.V.	68.52**	47.21	29.68	15.41	3.76
λ-Max	40.34	20.69	11.69	8.57	1.20
95% C.V.	33.46	27.07	20.97	14.07	3.76
Test of the significance of exclusion of each variable					
Variable	log $M1$	BR	log E	log $RGDP$	log P
Exclusion	16.23**	9.22**	1.67*	13.50**	1.39
Residual analysis: autocorrelation					
		$L(M1)$	$L(M2)$		
LR test: $\chi^2(25)$		21.31	20.92		
p-value		0.67	0.69		

The cointegration model is based on the Vector Autoregressive Model (VAR) with two lags using the Likelihood Ratio (LR) test. Ljung-Box and Lagrange Multiplier tests are performed on the residuals for autocorrelation. No autocorrelation in the residuals are found. The critical values for λ-Trace and λ-Max statistics are tabulated in Table 1 of Osterwald-Lenum (1992). The asterisks, **, * denote significance at the 10% and 5% significance levels, respectively.

5.2 Granger causality

Once the variables have been found cointegrated, the long-and short-run relations among the variables can be investigated by resorting to VECM.

$$\begin{aligned} \Delta Y_t = {} & \mu_1 + \gamma_1 EC_{t-1} + \sum_{i=1}^{p0} \theta_{1i} \Delta LM1_{t-i} + \sum_{i=1}^{p0} \delta_{1i} \Delta R_{t-i} + \sum_{i=1}^{p0} \rho_{1i} \Delta LE_{t-i} \\ & + \sum_{i=1}^{p0} \omega_{1i} \Delta Y_{t-i} + \sum_{i=1}^{p0} \tau_{1i} \Delta P_{t-i} + \varepsilon_t \end{aligned} \tag{3}$$

where EC_{t-1} is the Error Correction Term (ECT), γ, θ, δ, ρ, ω and τ are the estimated parameters, $p0$ is the lag length, and ε_t are assumed to be stationary random processes with mean zero and constant variance.

The VECM is based on a uniform lag of 2, as in the cointegration model. The *t*-statistic of the ECT, and the *F*-statistics relating to the lagged variables are reported in Table 7. Since our interest centres on output and price level, the discussion is focused on the VECM results relating to two equations with output and price as dependent variables, respectively.

In the VECM equation with output as dependent variable, we find that the t-statistic of the ECT is not only negative but also statistically significant at the 5% level. This confirms that in the long-run, all the variables, namely monetary aggregate, exchange rate, interest rate and price influence output. In the short run, however, the Granger causality runs only from monetary aggregate and price to output, as *F* statistics of these two variables are at a significant level. In the equation with price as dependent variable, we find that the ECT has the required negative sign and is significant indicating that all the variables Granger cause RGDP in the long run. However, in the short run, only monetary aggregate and output Granger cause price.

Table 7 Vector Error-Correction Model (VECM)

Dependent variable	*F-statistics*					*t-stat.*
	Δ *log RGDP*	Δ *log P*	Δ *log M1*	Δ *log BR*	Δ *log E*	ECT_{t-1}
Δlog GDP	–	82.33**	2.52*	0.39	1.70	–2.17**
Δ log P	9.22**	–	3.92**	0.06	0.41	–2.11**

All variables except for the lagged error-correction terms (ECT_{t-1}) are in the first difference, denoted by Δ. The ECT is generated from Johansen cointegration with the first cointegrating vector (i.e., the highest eigenvalue) which normalised on the LRGDP. The VECMs are based on 2 lags with constant term.

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

5.3 Variance decomposition

The analysis of dynamic interaction in the post sample period is investigated through variance decomposition and impulse response functions. The variance decomposition analysis decomposes the forecast error variance for a given variable into components accounted for by innovations in all variables in the system. This enables us to identify forecast error attributed to different sources, its own innovation and innovations by other variables, and thus gives quantitative strength to the Granger causality analysis between variables. In addition, impulse response function traces out the effect of an exogenous shock in one variable on the other variables in the system.

On the basis of the estimated VECM equation,[3] we now proceed to obtain the variance decomposition and impulse response functions in our study. It should be noted that we entered the variables in the following order: first, the policy variables, log *M*1, *BR* and log *E*; and then the two goal variables, log RGDP and log *P*. We calculate the variance decomposition at forecast horizons of 2–20 quarters with ten time horizons, in which two and four quarters ahead are the short term. Six, eight and 12 quarters ahead represent medium term while 14, 16, and 20 quarters ahead denote long terms.

The column 'standard error' refers to the square root of the variance of the forecast error of the variable to be forecast at different quarters.

Panel 1 and Panel 2 of Table 8 present the variance decomposition for log RGDP and for log P respectively. Panel 1 shows clearly that the money and exchange rate channels are the most important amongst the three channels in the short, medium and long terms. Next in importance is the interest rate channel. In the short run, shocks in money and exchange rate account for about 14% and 12%, respectively, of the variance in output, while in the long run they account for about 23%.

The interest rate channel's role amongst all the channels is the least important, as it accounted for less than 1% of variance in output in the short run. Similarly, over the medium and long terms the interest rate explains almost 2% of the forecast error variance in output over the medium and long term.

Table 8 Decomposition of variance

Steps ahead	*SE*	*log M1*	*BR*	*log E*	*log RGDP*	*Log P*
Panel 1: Variance decomposition of log RGDP						
2	0.005	6.896	0.101	4.017	87.756	1.228
4	0.017	14.624	0.400	11.815	67.741	5.418
6	0.029	19.677	0.993	17.362	54.743	7.222
8	0.038	21.826	1.495	20.612	48.056	8.009
10	0.042	22.673	1.763	22.089	45.216	8.256
12	0.045	22.886	1.851	22.557	44.425	8.278
14	0.047	22.826	1.844	22.529	44.579	8.219
16	0.050	22.721	1.809	22.367	44.937	8.164
18	0.053	22.735	1.795	22.355	44.946	8.165
20	0.056	22.851	1.815	22.517	44.612	8.203
Panel 2: Variance decomposition of log P						
2	0.037	6.027	2.993	0.548	3.096	87.334
4	0.047	10.041	4.761	6.024	9.664	69.507
6	0.054	10.055	5.515	8.738	10.42	65.267
8	0.061	13.194	6.114	8.489	8.549	63.652
10	0.069	16.660	6.790	7.022	6.796	62.731
12	0.076	19.327	7.379	5.872	5.635	61.784
14	0.082	20.568	7.821	5.282	5.162	61.165
16	0.088	20.998	8.085	5.141	5.081	60.693
18	0.092	21.246	8.245	5.147	4.979	60.381
20	0.097	21.618	8.372	5.062	4.740	60.206

5.4 Variance decomposition of log P

Panel 2 of Table 8 shows the variance decomposition of log *P*. The results indicate that the monetary aggregate channel is the dominant one amongst all the channels throughout the entire time horizon. Shocks in monetary aggregate in the short run

account for about 10% of variability in prices. Its importance grows over the medium term to 19% thereafter two years and remains steady around 21% in the long run. Next to the money channel, shocks in the interest rate (BR) play an important part. Shocks in the interest rate explain the price variability to the extent of nearly 5% in the short run. Over the medium term, the influence of the interest rate grows to over 6% but its influence remains steady over the long-term horizon. Our results show that at 20-quarter ahead horizon, interest rate explains about 8% of the forecast error variance in price.

Innovations in exchange rate are equally important over the time horizon. Initially, shocks in exchange rate account for 6% of variability in prices. However, over the medium term, the influence of exchange rate increases to reach about 8% and but the influence of the exchange rate declines to about 5%. Among all the channels, the exchange rate channel emerges to be the least important.

With a view to evaluating the robustness of the VAR results, which vary according to different orderings of the variables, we examine the correlation of reduced-form VAR residuals. Table 9 shows the correlation matrix of the reduced-form VAR residuals based on the ordering we employed. The elements of the correlation matrix between the policy variable ($\log M1$) and the rest of the variables are very low, indicating that contemporaneous feedback is not a problem. These correlations suggest that the ordering of the variables in Choleski decomposition is not a major concern.

Table 9 Correlation matrix for the reduced form VAR residual

	log M1	*BR*	*Log E*	*Log RGDP*	*log P*
Log *M*1	1.000	–0.041	–0.218	0.151	–0.012
BR		1.000	0.042	0.026	–0.232
Log *E*			1.000	–0.211	0.037
Log *RGDP*				1.000	–0.061
Log *P*					1.000

5.5 Impulse response analysis

The impulse response functions, reported for a horizon of five years (Table 10, and Figures 1 and 2) enable us to trace out the response of output and price to a shock in policy variables. The shock is represented by one standard deviation of the error term in the underlying structural model for the variable. Since all variables are measured in logs, the impulse response functions trace out a growth rate relative to the base period when the shock occurred. The first graph in Figure 1 shows the response of output to shocks in monetary policy represented by one standard deviation of the monetary aggregate. A one-standard deviation shock to the money stock has a positive effect on the level of output, with the peak occurring in the sixth quarter. However, the effect remains substantial and stabilises after about the three years or the 12th quarter. Most of the fluctuations are evident during the first four years.

The shock to interest rate (BR) and exchange rate (LE) lead to permanent (long term) decrease in the output. It is clear from the graphs of Figure 1 and Panel A of Table 10 that shocks to money, amongst all the policy variables, have the largest positive impact on output.

Figure 1 Response of real output (LRGDP) (Response to one SD innovations) (see online version for colours)

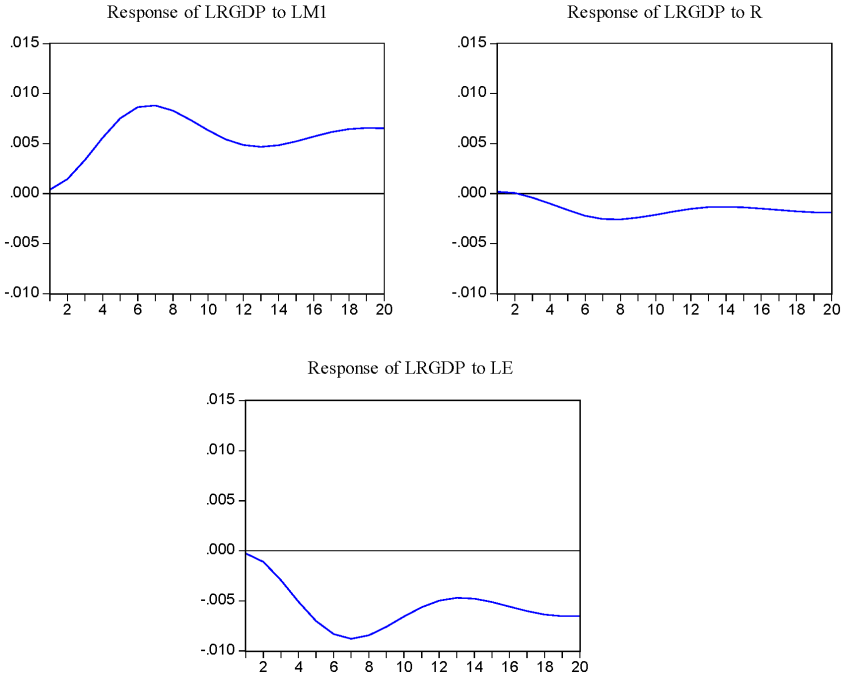

Figure 2 Response of prices (LP) (Response to one SD innovations) (see online version for colours)

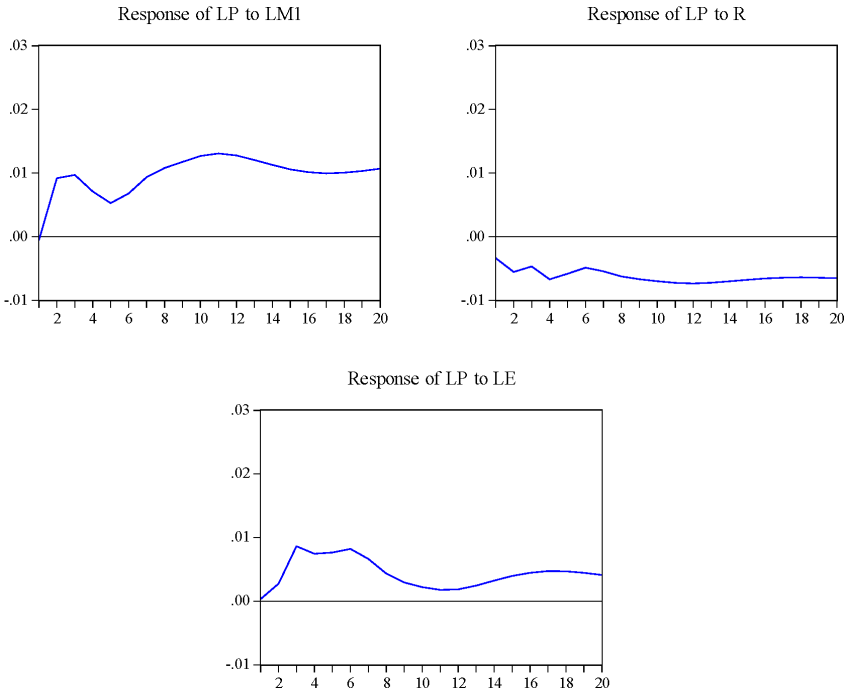

Table 10 Impulse response functions

Period	*LM1*	*R*	*LE*	*LRGDP*	*LP*
Panel A: Response of LRGDP to one SD innovations					
2	0.001	0.000	–0.001	0.005	0.001
4	0.005	–0.001	–0.005	0.011	0.0031
6	0.008	–0.002	–0.008	0.012	0.005
8	0.008	–0.002	–0.008	0.009	0.005
10	0.006	–0.002	–0.007	0.007	0.004
12	0.005	–0.002	–0.005	0.006	0.003
14	0.005	–0.001	–0.005	0.007	0.003
16	0.006	–0.002	–0.006	0.008	0.003
18	0.006	–0.002	–0.006	0.009	0.004
20	0.007	–0.002	–0.007	0.009	0.004
Panel B: Response of LP to one SD innovations					
2	0.009	–0.005	0.003	–0.006	0.019
4	0.007	–0.007	0.007	–0.009	0.014
6	0.007	–0.005	0.008	–0.006	0.014
8	0.011	–0.006	0.004	–0.002	0.016
10	0.013	–0.007	0.002	–0.000	0.017
12	0.013	–0.007	0.002	–0.002	0.017
14	0.011	–0.007	0.003	–0.004	0.016
16	0.010	–0.007	0.004	–0.005	0.016
18	0.010	–0.006	0.005	–0.004	0.016
20	0.011	–0.007	0.004	–0.0034	0.016

With regard to price (Panel B of Table 8 and Figure 2), one-standard deviation shock to the money has a positive effect on the price. The effect gradually increases and reaches a peak in the tenth quarter, after which it stabilises in the long run. The substantial role of money in the impulse response function for Samoa supports the significant role of money in its long-run cointegration relation with Samoa prices. Similarly, a shock to exchange rate also produces a positive impact on prices. At the beginning, price responds in upward direction and reaches the peak by the third quarter. The effect, however, gradually decreases after the sixth quarter and begins to stabilise after the twelfth quarter. This implies that the exchange rate bears a long term impact on Samoa prices. On the other hand, a shock to the interest rate has negative impact on prices. After some fluctuations in the next few quarters, the impact continues to be negative and stabilises in the long run. The findings of our variance decompositions and impulse response functions analysis provide additional support to our Granger causality analysis that the variables, money, interest rate and exchange rate Granger-cause Samoa output and prices.

6 Conclusions

After a sustained period of implementation of reforms in public finances and fiscal adjustment measures, Samoa, one of the 50 (LDC) of the world as designated by the UN, has emerged in recent years to be the best economic performer amongst all similarly placed island countries in the South Pacific. Although there is a growing body of literature on Samoa dealing with its fiscal performance, there has been no study on monetary policy transmission in Samoa. This paper is an attempt to fill the gap. Accordingly, this paper undertook an empirical investigation of monetary policy transmission mechanism in Samoa.

The study, which used quarterly data, covered a period of 17 years (1990–2006) and adopted a VAR approach and decomposition procedure to evaluate the relative strengths of different monetary policy instruments. The results of the VAR analysis show that in Samoa, the money and exchange rate channels are important channels in transmitting monetary impulses to the real sector. With regard to impact on prices, the money channel emerges as the most dominant influence.

As in the output case, interest rate does not play a role in influencing the price level. Interest rate channel has yet to become a principal conduit of monetary policy shocks, whereas money channel is the leading channel of transmission mechanism. These results are not surprising. Samoa's money and capital markets are still at their nascent stages of development. With a limited number of participants and a small number of financial securities, the market is shallow. There is no secondary market for the limited number of bonds and treasury bills issued by government and its agencies. There is no stock market either, as the private sector is yet to take off. Since savers and investors in Samoa have limited portfolio choice and dependence on the banking system is substantial, interest rate has yet to emerge as a significant policy instrument. Therefore, targeting the monetary aggregate is the most appropriate policy instrument for the central bank.

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Notes

[1]The Economic and Social Council of the UN, in 2006, designated 50 countries of the world as LDC. Three criteria were used:

- low income criterion: average (2002–2004) per capita gross national income of US$ 750 and US$ 900 for cases of graduation from LDC status
- human assets criterion, involving a composite index based on the indicators of
  - nutrition (percentage of population undernourished)
  - health (child mortality)
  - school enrolment (gross secondary school enrolment)
  - literacy (adult literacy rate)
- economic vulnerability criterion, involving a composite index of economic vulnerability based on natural shocks affecting agricultural production; share of population affected by natural disasters such as hurricanes; trade shocks; small size of population; and economic remoteness in terms of distance from major markets (United Nations Conference on Trade and Development, 2006).

[2]The monetary aggregate variable chosen is *M*1 rather than broad money. Holding of liquid assets in a developing country plays a much larger role than *M*2 (*M*1 plus quasi-money) in the transmission of monetary policy (Haug *et al.*, 2003).

[3]We are grateful to Professor Gary Koop for guidance on this point (personal correspondence).