Money Demand and Inflation:

The relationship between money demand, inflation, and the risk premium

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Abstract

In varied economics laws, inflation and interest rates are a standard reference of the economy. to place it merely, once interest rates fall, a lot of people and establishments will borrow extra money from banks and alternative lenders. Rising and rising interest rates push customers into saving mode as a result of the next come on savings. This leaves customers with less financial gain to pay that slows the economy and, as a result, lowers inflation. This relationship shapes up to date financial policies associated is that the most powerful consider the direction of an economy. this suggests that variable interest rates and inflation have a linear combination which will be shapely as economic potency.

Introduction

In various laws of macroeconomics inflation and interest rates are a common reference of the economy. In simplistic terms of relation, when interest rates fall, more individuals and entities are able to borrow more money from banks and other lenders. This results to the end consumers having enough money to go on their businesses (spending), this spending causes an economic growth and as such, so does inflation. The opposite “increased interest rates” is also true. Increased and rising interest rates push consumers into a saving mode since returns on savings are higher (Ireland, 2008). This causes consumers to have less income to spend slowing down the economy and as such, the inflation declines. This relationship drags indicate a certain measure of interdependency between money demand and inflation in close relation to economic performance.

Under a system of reserve banking, () states that inflation rates and interest rates and correlated in an inverse/ negative trend. This relationship forms the contemporary money policies and are the greatest influencers of the direction that an economy takes (Serletis, 2006). This means that the variable interest rates and inflation have linear combinations that

can be modelled into economic performance. This research paper is intended to closely examining various cointegrating relationship between money demand, inflation and interest rates to better understand the relationship they hold and in respect help improve future forecasts where two $I(1)$ time series x_t and y_t can be described by the stationary process $u_t = y_t - \alpha x_t$.

Purpose of the study

Forecasting a time series analysis using various methods require that the assumption that means and variances of the time series are a constant that hold independence of time generally referred to as a process that is stationary. Non-stationary forecasting analysis of the time series do not fulfil this assumption making the results of any hypothesis test incorrect, misleading or biased. With this assumption in mind, this paper will test the relationship between money demand, inflation (Tsay, n.d.), and the (interest) risk premium and test for cointegration to identify whether it is stationary or not and whether it is a stable and a long-run relationship that can improve time series forecasting.

Research question

Is the relationship between money demand, inflation, and the (interest) risk premium cointegrated?

Literature review

Each nation around the globe have set in place various monetary policies. These monetary policies are subject to a review of the economic and financial conditions that the nation has been experiencing. Monetary policies are the actions that are set in place to regulate the

availability and cost of money and lending. To set these policies, various economic indicators such as inflation and interest rates are used as a benchmark to develop more sustainable policies that will keep the economic performance in shape and balanced (Zhang, Warner & Homsy, 2017).

In other literatures, observing and keeping an eye on historical performance of the economy, central banks and monetary policy regulators are able to determine the direction and position that interest rates take. By moving the interest rates up and down in respect to the historical performance, regulators are able to achieve target economic indicators such as employment rates, stable prices of consumer commodities and stable economic growth altogether (Gaffard, Napoletano & Battiston, 2018). Furthermore, the regulators will use the interest rates to combat inflation. The regulatory bodies in monetary policies will increase interest rates to try and reduce inflation and will reduce interest rates to achieve economic growth. These regulation processes require that monetary policy makers be able to achieve very accurate forecast from historical performance to enable for setting policies that will at all-times achieve a stable and functional economy. This research is aimed to examine cointegration in these factors; interest rates and inflation in relation to economic performance to help improve forecast accuracy and dependency. (Ireland, 2008)

In the money markets, a watch out for the trends and directions of the monetary policies is crucial in decision making. Traders and investors in the money markets closely monitor the interest rate decision. In anticipation of the interest rates, various money markets move in response to the anticipation. Investors and traders anticipate these announcements by conducting their own forecasts based on historical performance to gain positive leverage in the money market before the actual announcement are made (Gaffard, Napoletano & Battiston, 2018). For instance, a nation's currency rallies in response to an anticipated increase in interest rates, at the same time, the bond market may fall in anticipation of interest rate

increase and hikes. Fore reduce risk of this anticipation, investors and traders have to have very accurate forecast and thus improving forecast parameters by examining cointegrating relationships between inflation is essential to developing stable and reliable financial markets (money markets and capital markets) (Moosa & Vaz, 2016).

Methodology

Data

This research paper utilized a time series of New Zealand macro data to study the relationship between money demand, inflation and interest rates. The data is quarterly data from March 1988 to March 2015. The following variables are available in the dataset;

- Quarter (the last day of the quarter) as a string variable.
- Real M1 money balances from RBNZ (and SNZ for deflator) (this corresponds to m)
- Quarterly inflation rate (year on year changes) from Stats NZ (this corresponds to infl)
- Real GDP (expenditure based) from RBNZ (this corresponds to y)
- SME overdraft rate for business lending from RBNZ (this corresponds to cpr)
- 10 year NZ government bond yields from FRED (this corresponds to tbr)

Method

To test for various tests of cointegration in a multivariate time series forecast a two-step approach has been utilized in this research study. The first step is an examination of temporal

properties of the time series being utilized to check whether the time series was stationary or not. For this test, an augmented Dickey Fuller test was applied (Tsay, n.d.). For this test, the null hypothesis is usually that the variable has a unit root. The Dickey Fuller test is fitted into the model;

$$y_t = \alpha + \rho y_{t-1} + \delta t + u_t$$

By terms of an OLS regression, there might happen to be chances of serial correlation that are rectified and controlled by fitting the Dickey Fuller test into the model;

$$\Delta y_t = \alpha + \beta y_{t-1} + \delta t + \zeta_1 \Delta y_{t-1} + \zeta_2 \Delta y_{t-2} + \dots + \zeta_k \Delta y_{t-k} + e_t$$

Where k is the number of lags specified, thus testing $\beta=0$ as equivalent to testing $\rho=1$ as such that, y_t follows a process of unit root.

The second step is tests for various cointegrating relationship. For this test a Johansen cointegration test in Vector Auto Regression (VAR) were applied (Vella & Verbeek, 1999). A VAR can be modelled as a p-th order, with variables x being exogenous is the form

$$y_t = v + A_1 y_{t-1} + \dots + A_p y_{t-p} + B_0 x_t + B_1 x_{t-1} + \dots + B_s x_{t-s} + u_t$$

Where, y_t is the vector of K variables that are modelled as the function of p lags of the variable in question and a set of exogenous variables x_t . The estimation requirements of the VAR assume that the variable in y_t and x_t are stationary covariance. If the variable on y_t are not covariance stationary and first differences are, a vector error correction model (VECM) will be applied.

Lastly, the Johansen cointegration test, commonly referred to as the Eigen value test will be conducted based on assumptions of findings from the VAR and VECM model. This test is based on the estimate $(r_0+1)^{th}$ largest Eigen value.

Analysis and results

Augmented Dickey Fuller test

An augmented Dickey Fuller tests was used to determine whether the time series was stationary or non-stationary to fit the model described in the methodology. Ate first the logged GDP and GDP were plotted to spot differences as shown below.

The results for Dickey Fuller test were as shown below;

Augmented Dickey-Fuller test for unit root			Number of obs = 105	
----- Interpolated Dickey-Fuller -----				
Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value	
Z(t)	-19.054	-4.038	-3.449	-3.149
MacKinnon approximate p-value for Z(t) = 0.0000				

D.gdp_1	Coef.	Std. Err.	t	P> t [95% Conf. Interval]

gdp_1				
L1.	-3.324029	.1744526	-19.05	0.000 -3.670138 -2.97792
LD.	1.492608	.1320952	11.30	0.000 1.230535 1.754682
L2D.	.7544726	.0697894	10.81	0.000 .6160123 .8929328

_trend		4.514165	3.977856	1.13	0.259	-3.377789
12.40612						
_cons		610.7923	252.4085	2.42	0.017	110.021
1111.564						

From this table, it is accurate to strongly fail to reject the null hypothesis of a unit root at all common significance levels. From the regression output of this test, the estimated β equal to -3.324 implies that p has been reduced less than. When observing the $Z(t)$ which is equal to -19.054 is an absolute value that is smaller than all of the critical values at 1% to 10% thus we still conclude of failing to rejecting the null hypothesis. On the assumptions of the Ducky Fuller test, this time series does have a unit root and thus this time series can be considered to be stationary. With this observation, this time series can be used for analysis.

Determining number of lags for the tests

To test number of lags for cointegration relationship, a VAR model was run in Stata software package. Having achieved that the time series satisfies the order of integration by being stationary, this model will determine the number of lags for this cointegration test. The results for the test were;

*test for cointegration-Johansen cointegration test in Vector Auto Regression (VAR)

Selection-order criteria

Sample: 1990q1 - 2015q1

Number of obs = 101

	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-2334.4				9.0e+13	46.3248	46.3772	46.4543
1	-1843.18	982.45	25	0.000	8.9e+09	37.0927	37.4071	37.8694*
2	-1791.21	103.94	25	0.000	5.2e+09	36.5586	37.1351	37.9826
3	-1760.94	60.538	25	0.000	4.7e+09	36.4542	37.2928	38.5256
4	-1699.76	122.35	25	0.000	2.4e+09*	35.7379*	36.8385*	38.4566
5	-1675.38	48.769	25	0.003	2.5e+09	35.7501	37.1128	39.1161

6	-1655.21	40.337	25	0.027	2.8e+09	35.8458	37.4705	39.8591	
7	-1632.98	44.456	25	0.010	3.2e+09	35.9007	37.7874	40.5613	
8	-1602.61	60.756*	25	0.000	3.1e+09	35.7942	37.943	41.1021	
+-----+									
-----+									
Endogenous: y m infl tbr cpr									
Exogenous: _cons									

From the table above, the optimal lags are Final Prediction Error (FPE), Akaike Information Criterion (AIC), Hannan Quinn Information Parameters (HQIC) and Schwartz Information Parameters (SBIC). From the lags table, the lag according to FPE is 4 and same case applies to AIC and HQIC which is a selection that follows the majority. Therefore we select the number of lags as 4 to continue to the Johansen cointegration test.

Johansen cointegration test

This test also known as the Eigen value test is based on the likelihood ratio test. This test assumes the null hypothesis of no cointegration and the alternative hypothesis of cointegration. The results for this test were as shown below.

Johansen tests for cointegration					
Trend: constant			Number of obs =		
105					
Sample: 1989q1 - 2015q1			Lags =		
4					

maximum			trace	5%	
rank	parms	LL	eigenvalue	statistic	critical value
0	80	-1830.4527	.	88.8047	68.52
1	89	-1808.0149	0.34779	43.9291*	47.21
2	96	-1793.5949	0.24018	15.0890	29.68
3	101	-1789.2143	0.08005	6.3279	15.41
4	104	-1786.1813	0.05613	0.2619	3.76
5	105	-1786.0504	0.00249		

maximum			max	5%	
rank	parms	LL	eigenvalue	statistic	critical value

0	80	-1830.4527	.	44.8756	33.46
1	89	-1808.0149	0.34779	28.8401	27.07
2	96	-1793.5949	0.24018	8.7611	20.97
3	101	-1789.2143	0.08005	6.0660	14.07
4	104	-1786.1813	0.05613	0.2619	3.76
5	105	-1786.0504	0.00249		

From the table above, an observation of the maximum rank zero where the null hypothesis are as follows;

Null Hypothesis: There is no cointegration

Alternative Hypothesis: There is cointegration

The table shows that, at the maximum rank zero, the trace statistic = 88.805 is greater than the critical value at 5% = 68.52. Therefore, the null hypothesis will be rejected suggesting that the money demand, inflation and interest rates are cointegrated. The same can be said for the maximum statistics where the maximum value = 44.876 is greater than the 5% critical value = 33.46 also assuming that the null hypothesis will be rejected. From these results, according to maximum rank zero, money demand, inflation and interest rates are cointegrated.

Vector Auto Regression (VAR)

A VAR model to test for further cointegration was employed. This test will be based on the hypothesis of the log-likelihood and significance. The following results were obtained from the test

Vector auto regression					
Sample: 1988q3 - 2015q1			No. of obs	=	107
Log likelihood = -1909.16			AIC	=	36.71328
FPE = 6.08e+09			HQIC	=	37.27023
Det(Sigma_ml) = 2.17e+09			SBIC	=	38.08716
Equation	Parms	RMSE	R-sq	chi2	P>chi2

y	11	1779.22	0.9648	2933.157	0.0000		
m	11	501.922	0.9899	10468.95	0.0000		
infl	11	.639226	0.8555	633.2881	0.0000		
tbr	11	.418609	0.9713	3627.61	0.0000		
cpr	11	.414094	0.9575	2411.135	0.0000		
		Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
y							
	y						
	L1.	.2646693	.1237418	2.14	0.032	.0221397	.5071988
	L2.	.1984599	.1219306	1.63	0.104	-.0405196	.4374395
	m						
	L1.	.1357731	.4611839	0.29	0.768	-.7681307	1.039677
	L2.	.6424487	.4579441	1.40	0.161	-.2551051	1.540003
	infl						
	L1.	52.38598	233.8843	0.22	0.823	-406.0188	510.7908
	L2.	93.59921	226.0684	0.41	0.679	-349.4866	536.6851
	tbr						
	L1.	-669.7579	434.3574	-1.54	0.123	-1521.083	181.5671
	L2.	-56.38374	463.7601	-0.12	0.903	-965.3369	852.5694
	cpr						
	L1.	377.9254	440.8914	0.86	0.391	-486.2058	1242.057
	L2.	-141.177	400.7005	-0.35	0.725	-926.5355	644.1815
	_cons	14046.37	3387.525	4.15	0.000	7406.945	20685.8

When assuming the model above, the variable inflation, interest rates, governments bonds have been used as to affect the GDP. The model is statistically significant at $p = < 0.005$ with the R square being over 85% indicating the goodness of fit of the model. The log-likelihood - 1909.16 is the highest showing that there is consistency with no lag showing significant effects to the GDP

Discussion

Various assumption of the overall results of this analyses presented in this research papers have been arrived at. The analyses have revealed the following outcomes:

- This time series with the variables utilized has an order of integration that indicates that the time series is stationary and thus can be used favourably for time series analysis and forecasting.
- From these analyses suing the maximum rank zero, all the variables in this time series; GDP, Bond yields, Interest rates, Inflation and money balances are cointegrated properly with results being significant.

From this outcomes, the variables GDP, Bond yields, Interest rates, Inflation and money balances seem to move away and differ from each other in the longer term. This means that their variation would be expected to remain the same over periods of time and as such assume a common average value.

Conclusion

Having identified that the variables GDP, Bond yields, Interest rates, Inflation and money balances as per their relationship seem to be having an order of integration and cointegrated relationship means that they can be used to improve forecast is the field of monetary policy making, setting interest rates, adjusting inflation in respect to the GDP (Zhang, Warner & Homsy, 2017).

Furthermore, this means that these variables can be utilized to accurately forecast the money markets and capital; markets as well as being used for concepts in hedge funding (Gaffard, Napoletano & Battiston, 2018). In summary, these variable can accurately be used in time series forecasting to help stabilize and grow the economy as required without being prone to risks and errors of estimation.

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