

Granger Causality Analysis between Inflation, Debt and Exchange Rate: Evidence from Malaysia

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Abstract Sweeping inflation across the globe and historical high domestic inflation that reached two digits in Malaysia in 1974. Also, warning from Wall Street Journal of growing domestic debt and newly defined external debt starting year 2014 call forth this paper to examine the dynamic relationship between inflation, external debt, domestic debt and exchange rate for Malaysia covering the period of 1960-2014. This article used exploratory data analysis, Johansen cointegration test, and Granger causality test. The exploratory data analysis show that domestic debt and external debt have a strong positive association with inflation, meanwhile a weak positive association between exchange rate and inflation. The cointegration test indicates that there is one long run relationship. In Malaysia, inflation found to granger caused domestic debt, exchange rate granger caused inflation, and domestic debt granger caused exchange rate. A unidirectional relationship found for external debt and exchange rate. In short run, external debt is influencing inflation significantly. Observing the heightening level of external debt by IMF redefinition, external debt caused exchange rate will then lead to inflation. In the long run, the exchange rate is influencing inflation significantly. Hence, policy makers need to formulate appropriate and prudent policy, especially in the high inflation period as the impact of exchange rate during inflation period will be stronger.

Key words Inflation, domestic debt, external debt, exchange rate, Malaysia

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1. Introduction

Inflation that volatile in nature is inevitable during the process of a country development. Inflation also is known as imported inflation, particularly in the developing countries. It is seen to be driving the domestic inflation, leading to the ineffectiveness of domestic government in containing it. Historically due to imported inflation from oil price shock and increased in food prices, Malaysia domestic inflation had reached a double digit in 1974 by 17.3%, 9.7% in 1981 by and 8.5% in 2008 (Bnm.gov.my., 2010). Kameel (2013) warn that Malaysia should stay precaution on the rising inflation that is sweeping across the globe. These historically events implies that policymakers should be heedful towards rising inflation. Especially when Malaysia government is on-going fiscal structural adjustments and consolidation process due to its high level of debt and the newly defined external debt in the year of 2014 by RM744.7 billion or 69.6% of GDP according to Bank Negara data (Khor, 2015). Likewise, the external debt had been the focused in the past research due to resources transfer problem and its vulnerabilities that may lead to the debt crisis.

Since 1988s, the domestic debt has become a critical component of the government debt and continues to increase throughout 1990 to 2012. Throughout the years after the Asian Financial Crisis, Malaysia has been experiencing growing high debt as a result of expansionary fiscal policies. Local media and economists from the Wall Street Journal reported a rise in domestic debt need to be contained as Malaysia's domestic debt has increased to potentially dangerous levels that can, shortly, put the country in a major debt crisis (Kameel, 2013). High leveraging in debt are all the key cause of inflation and bubbles in the economy like the subprime mortgage crisis in the United States and sovereign debt crisis in the euro

region. Sharp increase in the rate of inflation was accompanied by an increase in fiscal deficits (Kumar and Guidotti, 1991).

The exchange rate is a key element in relation to inflation, according to Lin and Chu (2013). Exchange rate and inflation rate are expected to be influencing each other in many theoretical models, particularly in developing countries, during the currency crisis period. When domestic inflation at 5.3% in 1998, ringgit depreciated by 28.3% against U.S. dollar (Bnm.gov.my., 2010). After the currency depreciation, Bank Negara Malaysia pegged the Ringgit to U.S. dollar at RM3.80 for almost seven years and floated the exchange rate till date (MIER, 2016).

This empirical finding intends to fill up the gap of domestic debt that has largely ignored in the vast empirical work on inflation (Reinhart and Rogoff, 2011). Also, studies in developing countries that had been focusing on external debt compared to domestic debt (Panizza, 2008). Also, on the interaction of the exchange rate and domestic prices that varied from one country to another (Ito and Sato, 2008). Hence, this study aims to find the importance of the causal relationships between the inflation, domestic debt, external debt and exchange rate in assisting policy makers in the future in identifying the source of inflation and implementing a suitable fiscal reform.

2. Literature review

Supporting article by Sargent and Wallace (1984), an increase in public debt is typically inflationary in highly indebted countries (Kwon *et al.*, 2009). The relationship between budget deficit and inflation is positive and significant in most countries in the long run, in 15 Economic Community of West African States (ECOWAS) countries during 1980 to 2011 (Pelesai and Oyinpreye, 2013). In Asian countries, Jalil, Tariq, and Bibi (2014) using the autoregressive distributed lag, found positive debt relationship with inflation for Pakistan from 1972 to 2012. Habibullah *et al.*, (2011) with granger causality confirmed existence of a long-run relationship between deficits and inflation, concluded that deficiencies contribute to inflation in developing countries in selected 13 Asian countries. Muhammad *et al.*, (2012) found public debt is one of the causes of the budget deficit in Pakistan and, hence, inflation during 1972-2009. Nouri and Samimi (2011) found the positive and significant impact of debt and inflation during 1990-2008 in Iran. Tan (2006) investigated the short-run and long-run relationship between deficits, inflation and economic growth in Malaysia from 1966 to 2003, found deficits had a short-run inflationary effect on the economy. Catao and Terrones (2005), also found a long run, strong, positive relationship between deficits and inflation over 107 countries over 1960-2001 particular in high-inflation and developing country groups with dynamic panel techniques. Bildirici and Ersin (2007) conclude that inflation fed on the rising costs of domestic public debt. Knowledge on the behavior of domestic debt and inflation is not available as there are few studies on this topic (Reinhart and Rogoff, 2011).

On the other hand, Kannan and Singh (2007) found that deficits and debt have a negative impact on inflation during 1971 to 2006 in India. Khieu (2014) found deficit has no bearing on inflation in Vietnam during 1995 to 2012 with structural vector autoregression. Bassetto and Butters (2009) also found no relationship between surpluses and inflation in 52 countries including Malaysia during 1970-2008. Pekarski (2011) concluded that worsening public finance or rising deficits might not account for the rising inflation in high-inflation economies. Meanwhile, vast of studies in developing countries had been focusing on external debt compared to domestic debt (Panizza, 2008). Due to the belief that historically, domestic government debt played a lesser scope compared to the external debt in the public finances of most developing. Similarly, previously countries had focused on external debt over domestic for two reasons. First, it can increase a country's access to resources as the domestic debt only transferring resources within the country. Second, it is due to the central bank's limitation that could not print constant hard currency to repay external debt.

Sek *et al.*, (2012) show a significant correlation between exchange rate movements and inflation in 1960-2010 in Asian countries. Lin and Chu (2013) found the impact of exchange rate regimes on inflation is stronger in higher inflation episodes than in lower inflation episodes during 1960-2006 in 91 countries. Muhammad, Muhammad, and Khadija (2012) have found that exchange rate has contributed positively to inflationary pressure in Pakistan during 1972-2009. Ito and Sato (2008) conducted studies in East Asian countries during January 1994 to December 2006 found the effect of the exchange rate changes on

domestic price variables called pass-through, while the reverse effect is the determination of the exchange rate in open macroeconomics. Kwon, McFarlane, and Robinson (2009) conducted studies in 71 countries during 1962–2004 with vector autoregression claimed that the relationship between inflation and debt is weak in inflexible exchange rate regimes. Muhammad *et al.*, (2002) examine the exchange rates and stock price relationships for selected East Asia countries with monthly data from 1994 to 2000 found bidirectional long-run causality only in Bangladesh and Sri Lanka. Doong *et al.*, (2005) negative relationship between the stock returns and exchange rates for all countries in six Asian countries except Thailand during 1989-2003 with granger causality test shows bidirectional causality detected in Indonesia, Malaysia, Korea, and Thailand. Ibrahim and Aziz (2003) found exchange rate negatively associated with the stock prices in Malaysia over the period 1977-1998.

However, Kenani *et al.*, (2012) with Johansen procedure found no evidence of a long-run relationship between stock prices and exchange rate in Malawi from 1999 to 2010 and causality results show that stock prices and exchange rates do not cause each other. Amare and Mohsin (2000) in cointegration technique to study the long-run association between stock prices and exchange rates for nine Asian countries including Malaysia during January 1980 to June 1998 found a long-run association between stock prices and exchange rates only in Singapore and Philippines. Also, Franck and Young (1972) found no association between exchange rates and stock prices. Romer (1993) argues that the choice of the exchange-rate regime not an important determinant of inflation.

3. Methodology of research

3.1. Model specification, estimation procedure and data sources

The variables to be explained are the inflation rate. The above discussion shows that all variables mentioned above have a high theoretical relationship with inflation. In sum, we can represent the determinants of inflation by the following expression:

$$CPI = f\left(\underset{+}{DODEB}, \underset{+}{ERATE}, \underset{+}{EXDEB}\right) \quad (1)$$

Inflation derived from CPI due to its subjective measure as supported by Azam and Rashid (2015); DODEB, ERATE, and EXDEB are the determinants of CPI. The sign beneath each variable show the expected direction of CPI in response to the corresponding explanatory variable.

This study used Exploratory Data Analysis (EDA) and Non-Parametric Approach, unit root test, Co-integration, and Granger-causality test. In non-parametric approach, graphical methods that include simple scatter plots, line graph, Confidence Ellipse and scatter with kernel fit also used by Selliah and Applanaidu (2015) to uncover the underlying structure of the dynamic behavior. According to Velleman and Hoaglin (2012), EDA that pioneered by Tukey, J. W. is a quantitative method in understanding the data when little or no statistical hypothesis exist with visual method (Behrens and Yu, 2003).

The properties of the variables was tested for unit root characteristic using Augmented Dickey Fuller test (Dickey and Fuller, 1979). This study employs the Johansen's method as proposed by Johansen (1988, 1991). Johansen (1988) and Johansen and Juselius (1990) has shown that the coefficient matrix contains sufficient information to determine the cointegrating relationships between the variables. In Johansen's procedure, the Gaussian maximum likelihood is used to estimate all parameters of the ECM. Finally, adoption of the Granger causality in identifying the direction of the causal relationship Granger (1969).

Period of 1960-2014 for 55 years, annual data macroeconomic variables includes inflation that derived from consumer price index (CPI), domestic debt (DODEB), exchange rate (ERATE) and external debt (EXDEB) was apply. All variables transformed in natural logarithm. Data for consumer price index (2010=100) and official exchange rate (RM per US\$, period average) were collect from International Financial Statistics, domestic and external debt (RM, million) obtained from Ministry of Finance, Bank Negara Malaysia.

4. Empirical results

EDA and non-parametric analysis with Confidence Ellipse and kernel fit are used to identify the relationship between CPI and variables of interest.

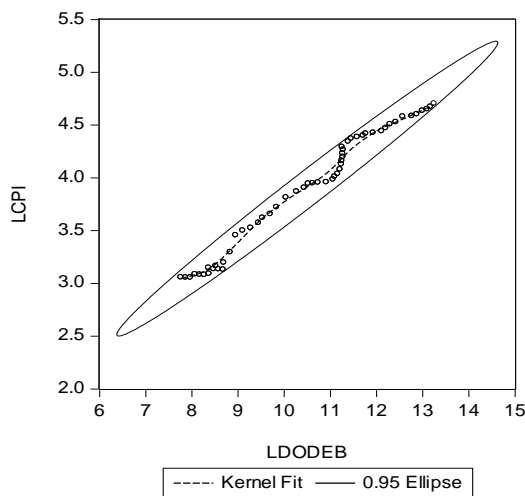


Figure 1. CPI and domestic debt

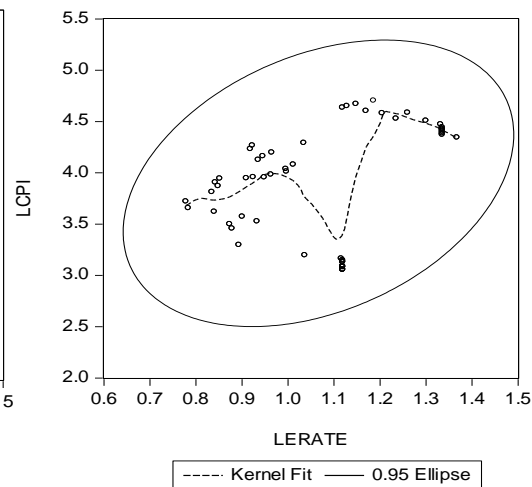


Figure 2. CPI and exchange rate

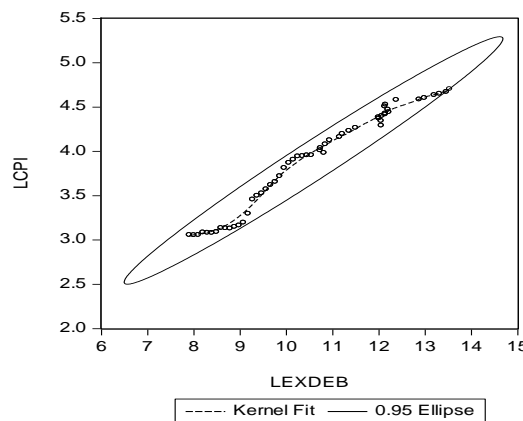


Figure 3. CPI and external debt

Figure 1, Figure 2 and Figure 3 depict the relationship between the CPI, domestic debt, exchange rate and external debt in Malaysia during 1960–2014 with scatter plots. The degree of association was identifying by confidence ellipse, where CPI are found to have a strong association with domestic debt and external debt in Figure 1 and Figure 3. CPI and exchange rate have a weak association in Figure 2. CPI is found to have a positive relationship with domestic debt, exchange rate and external debt with kernel fit.

Table 1. Augmented Dickey-Fuller Unit Root Test results

	Level		First differences	
	Constant without trend	Constant with trend	Constant without trend	Constant with trend
LCPI	-0.7530 (0.8238)	-1.8458 (0.6681)	-4.1862*** (0.0017)	-4.1702*** (0.0093)
LDODEB	-0.2248 (0.9284)	-2.6376 (0.2663)	-5.7517*** (0.0000)	-5.6945*** (0.0001)
LERATE	-1.2685 (0.6378)	-2.0759 (0.5469)	-5.6471*** (0.0000)	-5.6348*** (0.0001)
LEXDEB	0.3523 (0.9790)	-3.1631 (0.1030)	-6.2850*** (0.0000)	-6.2564*** (0.0000)

Notes: ***indicates significance at the 1% level. The optimum lags length for the ADF determined by Schwarz Information Criterion (SIC).

Table 1 shows the ADF test results where all the variables are I(1) series. Hence Johansen method can be employed to identify the cointegration vector.

Table 2. Johansen Cointegration Test

Unrestricted Cointegration Rank Test (Trace)				
Ho	Eigenvalue	Trace Statistic	Critical value 5%	Probability **
r=0*	0.4338	59.1668	54.0790	0.0164
r≤1	0.3019	30.1539	35.1928	0.1580
r≤2	0.1438	11.8285	20.2618	0.4643
r≤3	0.0739	3.9131	9.1645	0.4252
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Ho	Eigenvalue	Max-Eigen Statistic	Critical value 5%	Probability **
r=0*	0.4338	29.0129	28.5881	0.0441
r≤1	0.3019	18.3254	22.2996	0.1639
r≤2	0.1438	7.9154	15.8921	0.5578
r≤3	0.0739	3.9130	9.1645	0.4252

Notes: r indicates the number of cointegrating vectors. * Indicates rejection of the hypothesis at the 5% significance level and ** indicates MacKinnon-Haug-Michelis (1999) p-values.

The cointegration rank test (Trace and Maximum Eigenvalue), there is one cointegration equation between the variables at 5% significance level, and the null hypothesis of no cointegration rejected. The estimated long-run equilibrium given as below:

$$LCPI = 1.492 + 0.181LDODEB - 0.994LERATE + 0.228LEXDEB$$

[0.686]
[1.755]
[0.790]

A 1% of the exchange rate will decrease the LCPI by 0.99%.

Table 3. VECM Test

Variable	DLCPI
D(LCPI(-1))	0.518 [3.549]
D(LCPI(-2))	-0.227 [-1.393]
D(LCPI(-3))	0.163 [1.168]
D(LDODEB(-1))	0.045 [1.094]
D(LDODEB(-2))	-0.013 [-0.284]
D(LDODEB(-3))	-0.118 [-2.691]
D(LERATE(-1))	-0.113 [-1.719]
D(LERATE(-2))	-0.021 [-0.282]
D(LERATE(-3))	-0.018 [-0.309]
D(LEXDEB(-1))	-0.014 [-0.382]
D(LEXDEB(-2))	0.005 [0.131]
D(LEXDEB(-3))	-0.012 [-0.317]

$$\frac{ECT_{t-1}}{-0.034}$$

[-2.637]

Notes: [] denotes t-statistics.

In the short run, external debt is significantly influencing LCPI. Domestic debt and exchange rate are not significant in the near future. The speed of adjustment towards the equilibrium is 3%. Granger causality analysis is given in Table 4.

Table 4. Granger Causality Tests

Null Hypothesis	Obs	F-Statistics	Probability
LCPI does not Granger cause LDODEB	53	2.7532*	0.0738
LERATE does not Granger cause LCPI	53	2.9006*	0.0647
LDODEB does not Granger cause LERATE	53	3.1674**	0.0510
LEXDEB does not Granger cause LERATE	53	5.8064***	0.0055
LERATE does not Granger cause LEXDEB	53	4.0097**	0.0245

Notes: ***, ** and * denotes rejection of null hypothesis at the 1%, 5%, and 10% significance level and using lags 2.

Granger causality test is covered in Table 4. CPI in Malaysia is found to granger caused domestic debt. Exchange rate granger caused CPI, and domestic debt granger caused exchange rate. A unidirectional relationship is found for external debt and exchange rate.

5. Conclusions

With the rising debt level, a stable price environment would provide a mass of flexibility for the Malaysia government particular in carrying out fiscal structural. On the redefinition of external debt by IMF, this study found that Malaysia external debt has a strong positive association with inflation in the short run, significantly. Hence, this study affirmed that Malaysia as developing countries should prioritize adjustment on the external debt compared to domestic debt. This finding is in line with (Panizza, 2008). The empirical finding shows that domestic debt does not cause inflation, though price does cause domestic debt. This might explain why the domestic gap has largely been ignored in the previous empirical studies as a comment by (Reinhart and Rogoff, 2011).

The weak correlation between the price and exchange rate might be due to Malaysia government that pegged the Ringgit to U.S. dollar at RM3.80 for almost seven years. The empirical finding also suggests that exchange rate is a has a significant negative relationship with price in the long run. This negative relationship is possible as explained by Ito and Sato (2008) that the interaction of exchange rate and domestic prices that varied from one country to another. Observing the heightening level of external debt by IMF redefinition, external debt caused exchange rate will then lead to inflation. In the long run, the exchange rate is influencing inflation significantly. Hence, policy makers need to formulate appropriate and prudent policy, especially in the high inflation period as the impact of exchange rate during inflation period will be stronger.

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