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Existence of the money multiplier in a developing economy: a case of Saudi Arabia

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Abstract: In this study, cointegration methods are used to test the existence of the money multiplier model in Saudi Arabia for 1997m1–2020m4 and subperiods before and after the 2008 global financial crisis. Residual-based tests support broad (M2 and M3) multipliers over the full sample and pre-crisis period, albeit the M3 multiplier performs better than the M2 multiplier. Johansen's vector autoregression (VAR) and Pesaran et al. (2001) autoregressive distributed lags (ARDL) cointegration and coefficient restriction tests reveal that broad multipliers perform well. Narrow and broad multipliers are mean-reverting in the pre-crisis period, and the M3 multiplier is mean-reverting over the full sample. These multipliers are stable in a dynamic framework. Therefore, the Saudi Arabian Monetary Authority (SAMA) can control money stock and inflation by controlling base money. Narrow and broad multipliers are also predictable and broad monetary aggregates can influence monetary policy.

Keywords: monetary policy; money multiplier; bank credit channel; co integration; Saudi Arabia.

JEL codes: E51, E52, C32.

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1 Introduction

In this study, we examine whether the money multiplier relationship between the money stock and the monetary base exists in the long run for the small open economy of Saudi Arabia. The money multiplier that measures the banking system's ability and willingness to convert reserves into money suggests that there is a stable relationship between the money stock and the monetary base and that a country's central bank can influence the monetary base closely, thereby controlling the money stock and the provision of bank credit to the private sector to stabilise the economy. In essence, the multiplier posits that in a fractional reserve system, banks hold reserves only to the extent they are required to satisfy regulatory and withdrawal requirements, and if they find themselves with excess reserves, they will try to lend them to creditworthy borrowers. Consequently, this will increase the availability of bank credit, reduce the borrowing rates, and hence, stimulate the economy, thereby affecting aggregate spending [Williams (2012), p.3].

Since the global financial crisis of 2008, both narrow and broad money multipliers have collapsed dramatically despite massive expansions in the monetary base by central banks to improve credit conditions, and the monetary policy transmission mechanism has ceased to operate in systemically important major countries: the USA, the UK, and Eurozone members. Central banks in these and other major countries had to rely on 'quantitative easing' (QE) policies–ranging from large-scale purchases of public and private debt securities to direct lending to banks–to repair the transmission mechanism, improve the liquidity conditions, and provide monetary accommodation at the zero lower bound interest rate policy (Korniyenko and Loukoianova, 2015). Notwithstanding the measures force-feeding banks with a massive expansion in the monetary base to offset the huge decrease in the money supply (and bank lending), the multiplier relationship between the monetary base and monetary aggregates (and bank lending) failed to be reinstated to stimulate aggregate demand. Abrams (2011) demonstrated that what matters in terms of the IS-LM model for aggregate demand is only the aggregate money supply and not the specific values of the multiplier and monetary base. He argued that an increase in the monetary base offsets a decrease in the money supply, and hence, the multiplier is insufficient to prevent a negative financial-sector shock to aggregate demand.

Figure 1 Money stock series and the monetary base (see online version for colours)

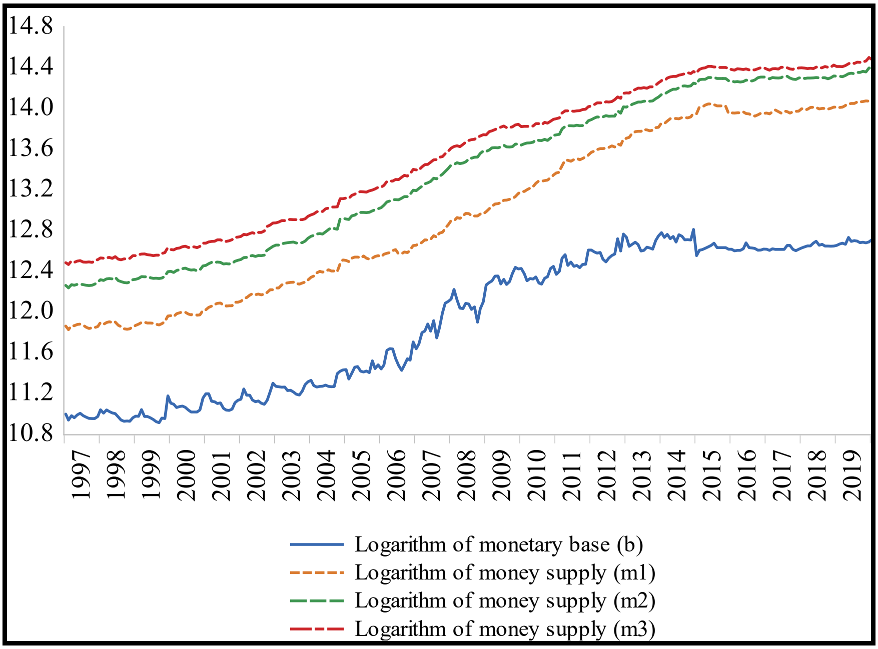
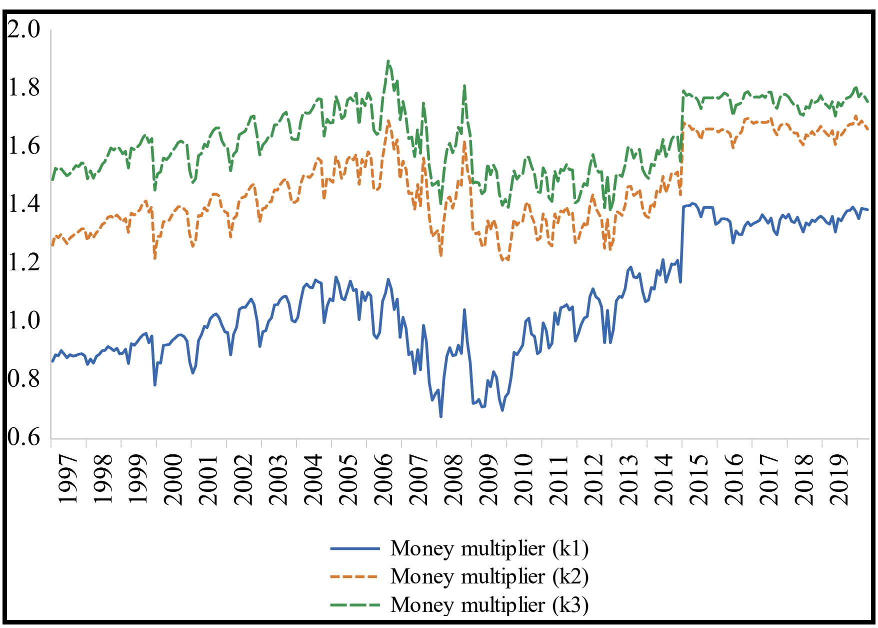


Figure 2 M1, M2, and M3 multipliers (see online version for colours)



The monetary history in Saudi Arabia provides abundant evidence on the role that monetary policy plays in stabilising prices and exchange rates. As Saudi Arabia is a fiscally dominant open economy[1] with its national currency effectively pegged to the

USA dollar since 1986, the role of monetary policy is to support fiscal policy by ensuring stability in prices and exchange rates. The Saudi monetary policy mainly works through the bank credit channel and is primarily based on three instruments: a policy of interest rate corridor (tracking the USA Federal funds rate) made up of an upper report rate and a lower (reserve) report rate, statutory reserve requirements requiring banks to hold reserves with the Saudi Arabian Monetary Authority (SAMA) equivalent to 7% of demand deposits and 4% of time and saving deposits, and the issuance of SAMA bills to bank and non-bank financial institutions to manage liquidity[2]. though it has forgone monetary independence, SAMA retains flexibility in deploying prudential guidelines, adjusting reserve requirements, and issuing SAMA bills to manage liquidity and control inflation.

This study contributes to the empirical literature on the money multiplier by testing its validity for Saudi Arabia using monthly data over the period 1997m1–2020m4. The sample is split into two sub periods (1997m1–2008m1 and 2009m1–2020m4) to assess if the multiplier performs well during both the pre-crisis and the post-crisis periods. The reasons motivating this empirical exercise are as follows. First, the initial observation of monetary aggregates and the monetary base (Figure 1) supports the existence of the money multiplier, since the underlying series appear to move together over time. Unlike major countries, monetary aggregates seem not to have dropped sharply in Saudi Arabia, even after the global financial crisis of 2008. Moreover, unlike major countries, narrow and broad money multipliers in Saudi Arabia (Figure 2) appear not to have collapsed dramatically. In fact, while the global financial crisis of 2008 severely affected many countries around the world, especially developed countries, the Saudi economy continued to show resilience and strong growth[3] Saudi Arabia has remained largely unsusceptible to the volatility of global financial markets due to several reasons.

1 Saudi banks are well-capitalised, profitable, liquid, and subject to limited external shocks; there is limited inflow of portfolio investment in the stock market, and external and fiscal buffers have been all-time strong in Saudi Arabia (Al Kholifey, 2015).

2 Evidence supports a stable money demand function (see, e.g., Al Rasasi and Qualls, 2019; Hassanov, Al Rasasi et al., 2017; Mahmood and Alkhateeb, 2018), implying that monetary aggregates can be used as targets of monetary policy.

3 Al-Bazai (1998) found unidirectional causality that runs from M1 to consumer prices.

4 The monetary approach to balance of payment holds, and SAMA has (weak) control on the money stock (Akikina and Al-Hoshan, 2003).

5 Bank lending is the most effective channel of monetary policy, mainly due to the constraints on the interest rate under a fixed exchange rate regime (SAMA, 2015). Ben Amar et al. (2015) found that the lending channel was effective in affecting non-oil private output, albeit less effective in affecting consumer prices.

6 Similar to other emerging market countries, the Saudi banks dominate the provision of credit to the private sector, accounting for 96.6% of the total bank credit in February 2015[4].

Finally, the exchange rate anchor provides a long-term framework for monetary policy to maintain price stability. In reality, monetary policy is focused on targeting exchange rate stability rather than targeting inflation. In summary, the institutional structure and financial market conditions in Saudi Arabia are conducive to the money multiplier. Therefore, it is necessary to undertake a formal empirical exercise to address the issue of whether the multiplier exists in the long run and impacts the controllability of money supply in Saudi Arabia.

The remainder of the paper is structured as follows. While Section 2 deals with the theoretical background and literature review on the money multiplier model, Section 3 discusses data sources and methodology. Section 4 presents empirical results and analysis. The final section concludes results and discusses implications.

2 Theoretical background and literature review

2.1 Money multiplier model

Friedman and Schwartz (1963) introduced the mechanistic formulation of the money multiplier model to demonstrate (when examining successive episodes of the monetary history in the United States from 1867 to 1960) that changes in the monetary base were the dominant determinant of long-term and major cyclical movements in broad money. Brunner (1961) and Brunner and Meltzer (1964) developed the model more formally by assigning behavioural content to it and formulating the theory of money to demonstrate how monetary policy actions influence economic activity by affecting the quantity of the money stock. Since its inception in the early 1960s, this model has been used as the basic framework in empirical analyses of the money stock control and the impact of monetary policy on other economic variables. In a reduced form, the multiplier relationship can be represented as follows[5].

$$M = \frac{1+c}{c+r} B = kB \tag{1}$$

where M (B) is the money stock (monetary base), c (r) is the ratio of currency holdings (reserves) to bank demand deposits, and k is the money multiplier defined as the ratio of M to B. Equation (1) implies that M can be decomposed into B, which is controllable directly by monetary policy and k, which is affected by changes in technology and the tastes and preferences of the banking system and public. The money multiplier model predicts that M can be determined exogenously (via the money multiplier) by actively regulating B, and inflation can be controlled by controlling changes in M (via the quantity theory of money, $Py = MV$). Combining $MV = Y$ and $M = kB$ yields $Y = kVB$. Under the twin assumption that k and V are 'predictable' (stable stochastic processes), and that they are orthogonal to B, this implies that nominal income (Y) is determined by the monetary base, that is $Y = f(B)$. Although the variations in bank lending and currency holdings may weaken the link between monetary policy and monetary growth in the short run, central banks are able to affect monetary growth significantly and, hence, economic activity in the long run. Monetarists argue that the multiplier is predictable and, therefore, the impact of changes in B on M can be estimated fairly accurately in the long run. Other economists argue that the multiplier is unstable due to the instability of its components.

The money multiplier underlies two broad channels, the ‘money (interest rate) channel’ and the ‘credit (bank lending) channel,’ through which monetary policy affects the money stock and bank lending, thereby affecting aggregate spending in the economy. The money channel operates through two assets (money and bonds), where the volume of deposits that banks issue helps determine the overall interest rate that eventually clears the money market by affecting the borrowing and lending behaviour and hence real variables in the economy. Proponents of the money view argue that policy makers set the short-term interest rate to affect the cost of capital, which affects the demand for investment and consumer durables of business firms and households and, hence, the level of production (Bernanke and Blinder, 1992). In contrast, the credit channel works through three assets (money, bonds, and bank loans), where the volume of bank loans helps determine how close the interest rate on bank loans is to the interest rate on bonds.

In an empirically testable stochastic logarithmic form, (1) can be rewritten as:

$$m_t = \gamma + \theta b_t + \varepsilon_t \tag{2}$$

where m, γ, and b represent the natural logarithms of M, k, and B, respectively. The necessary conditions for the multiplier to be valid in the long run require that the underlying variables m and b be integrated of the same order of unity ($m_t \sim I(1)$ and $b_t \sim I(1)$) and the restrictions $\gamma > 0$ and $\theta = 1$ not be rejected. Conversely, the sufficient condition requires the multiplier to be stationary (stable) over time, which is $m_t – b_t \sim I(0)$.

2.2 Literature review

A large body of empirical work has accumulated on the money multiplier since its inception in the early 1960s. Much of the work investigating the relevance of the multiplier during the pre-crisis period can be divided into several strands. The first strand began with the seminal work of Friedman and Schwartz (1963) that offered monetary interpretation of the Great Depression of 1929–1933 by arguing that the monetary contraction and errors by the federal reserve (Fed) caused the great depression. The work concluded that changes in the money supply profoundly influenced the USA economy, especially the behaviour of economic fluctuations, and emphasised that money leads output, implying that the causation runs from money to output, and not vice versa. In a subsequent work, Sims (1972) documented evidence supporting this contention on the basis of post-war US data. However, Kydland and Prescott (1990) questioned the business cycle leading function of the multiplier and provided evidence that the monetary base lags the cycle, and M1 money is pro-cyclical. There is some evidence that the money-output relationship has weakened in the post-war period (Backus and Kehoe, 1992, p.865).

The second strand that investigated the relevance of the multiplier concerns the studies undertaken, *inter alia*, by Burger (1972), Chu (2006), Hafer et al. (1983), and Hafer and Hein (1984), which employed alternative models to forecast the multiplier.

The third strand deals with the studies conducted, by Beenstock (1989), Burger (1988), Garfinkel and Thornton (1991), Gauger and Black (1991), and Gauger (1998), among others, which explored whether the multiplier is stable and identified the factors explaining the multiplier if it is structurally unstable. Burger (1988) argued that the multiplier was fairly stable in the United States before the early 1980s on an annual basis in terms of the growth rates of the monetary base and broad measures of money supply.

Nevertheless, the money stock underwent a dramatic change during the 1980s, mainly due to the introduction of new financial assets and changes in inflation, interest rates, and the fundamental characteristics of the most traditional monetary assets. Beenstock (1989) showed that the multiplier was relatively stable in the UK until 1970, but it has more than doubled since then.

The final strand covers a number of studies undertaken, *inter alia*, by Al-Loughani and Moosa (1996), Baghestani and Mott (1997), Darbha (2002), Ford and Morris (1996), and Sen and Vaidya (1997), which employed cointegration analysis to examine whether a stable money multiplier exists. Ford and Morris (1996) used the Johansen cointegration technique to test the multiplier for the United Kingdom and found the monetary base to have a strong predictive effect on inflation and output through interest rates with a substantial lead time. Using monthly data over the period 1983:01–1990:06, Baghestani and Mott (1997) found results supporting the long-run relationship between M1, the monetary base, and the bank deposit rate. Baghestani and Mott (1997, p.279) demonstrated that 'deregulating bank deposit interest rates makes the relation between the monetary base and M1 more predictable'. Al-Loughani and Moosa (1996) employed a battery of co integration tests to investigate the multiplier for Kuwait and found the results to be supportive when M1 is used rather than when M2 is used, though the M1 multiplier appears to be structurally unstable. Applying the co integration and stability tests proposed by Gregory and Hansen (1996), Darbha (2002) found a stable but time-varying long-run relation between money supply and reserve money for India.

The empirical work focusing on the post-crisis period has pronounced the collapse of the multiplier that assigns reserves a causal role in determining the supply of broad money and bank lending and, thus, the transmission mechanism of monetary policy. This led many researchers to study the reasons for the money multiplier not showing any clear, persistent signs to conform to its theoretical value and for its invalidity to explain macroeconomic fluctuations during the post-crisis period. Walter and Courtois (2009) observed that the massive increase in the monetary base (liquidity injections) during August 2008 and October 2009 did not result in a proportional increase in the overall money supply. They attributed the failure of the multiplier to an undesirable lending environment, in which banks found it more desirable to hold excess reserves in accounts at the Fed to earn interest on reserves (IOR) with zero risk and the increased demand of banks to hold liquid reserves (as opposed to individually lending those excess reserves) in the wake of the financial crisis. Similar observations were made by Cukierman (2017), Fawley and Neely (2013), and Xiong and Wang (2018).

Fawley and Neely (2013) observed a remarkable consistency among no conventional monetary policy measures in the systemically important countries that while all measures resulted in sharp increases in the monetary bases, none led to sharp increases in broader monetary aggregates. The sharp increase in reserves contributed to the collapse of the multiplier and did not translate the monetary base expansion into growth of credit and money supply. Cukierman (2017, p.111) attributed the dramatic fall in the US multiplier, since the collapse of Lehman Brothers to the large-scale QE operations in conjunction with stagnation in the total banking credits and concluded that 'an important implication of this observation is that the transmission of expansionary monetary policy through the banking credit channel has weakened considerably since of the outbreak of the crisis'. Xiong and Wang (2018) argued that while there has been a commensurate increase in the monetary base, these measures have had much less impact on bank lending and broad monetary aggregates.

Van Den End (2014) argued that the limited effect of an expansion in the monetary base on broader monetary aggregates implies that M2 and M3 multipliers have broken down. Such massive expansions in the monetary base with interest rates at their zero lower bound lead to market conditions typical of a liquidity trap. Cline (2015) argued that since the interest rate was already near the zero bound, QE measures were primarily designed not to work through expansion in bank lending and the money supply but to reduce the term premium aimed at reducing the cost of long-term capital and spur investment to boost the demand for riskier assets including equities, and (in the case of mortgage-backed assets purchased) to stimulate a depressed part of the economy. He noted that, following QE measures, the velocity of broad money did not fall much; instead, it continued to exhibit a long-term gradual decline. In fact, the velocity of broad money fell only by 10% from 1.26 in 2007 to 1.13 in 2013. Cline (2015, pp.1–2) concluded:

> "Correspondingly, it turns out that the lack of inflationary pressure reflects a collapse not in the so-called 'velocity' in the quantity theory of money, but instead in the so-called 'money multiplier' relating the effective money supply in the economy to the base of currency plus bank reserves at the Federal Reserve."

Carpenter and Demiralp (2012) argued that both the institutional structure in the United States and the empirical evidence based on data since 1990 strongly suggest that the transmission mechanism is inconsistent with the multiplier from reserves to money and bank loans, and that the money multiplier, at least since the 1990s, does not explain the USA macroeconomic fluctuations. Using the monthly data for January 1990–June 2007, Carpenter and Demiralp (2012) investigated the effect of the quantity of reserves on the money supply and bank lending by employing a vector auto regression analysis. They found that the transmission mechanism works neither through the money channel nor the bank-lending channel. Benati and Ireland (2017) showed that the post-war shocks to the M1 multiplier have had insignificant effects on the output fluctuations, while the component of M2 different from M1 had effects on nominal aggregates, in particular during the phase of the Great Inflation. Williams (2012) obtained similar findings for 2008–2011. He showed that despite a 200% increase in the monetary base over four years, broad money (M2) increased only by 28% and nominal spending merely by 8%. He noted that the ratio of nominal GDP to the monetary base fell even more precipitously over the same period, and it has never recovered since then, thereby profoundly breaking the linkage between the monetary base and the economy. Thus, notwithstanding an alarm sounded by some commentators that the massive expansion in the monetary base will inexorably lead to high inflation, "inflation in the United States has been a dog that didn't bark [Williams, (2012), p.1]". The average rate of inflation remained at less than 2% over the period 2008–2011. Seghezza and Morelli (2020) argued that the main reason for the USA multiplier collapse in the post-crisis period is that, while banks' reserves increased significantly, there was only a modest increase in deposits. Using quarterly data for 1991–2017, they estimated the demand for loans by firms and households and found that the weak demand for loans by the private sector led to the modest increase in deposits and the persistence of low levels of the US money multiplier.

However, the evidence regarding the collapse of the money multiplier since the global crisis of 2008 may not be generalised for all countries. The money multiplier model and the underlying transmission mechanism may remain operative in some countries, especially in emerging market economies. Bhatti and Khawaja (2018) found that the money multiplier exists in Kazakhstan and that the broad money multiplier is stable over the sample period in question.

3 Method

The money multiplier model was tested for Saudi Arabia based on equation (2) using a battery of co integration methods. An unrestricted error-correction model, allowing for structural breaks, was also estimated based on the autoregressive distributed lags (ARDL) approach to measure the short-term dynamics of the multiplier relationship and the long-run multiplier. Subsequently, the estimated unrestricted error-correction model was used to compute the long-run coefficients of the multiplier model and to assess, based on CUSUM and CUSUM of squares tests, whether the underlying estimated coefficients are stable over the full sample period. Monthly observations were used on the monetary base and narrow (M1) and broad money (M2 and M3) over the period 1997:01–2020:04. Data were collected from the SAMA.

4 Results

4.1 Conventional unit root tests

Prior to testing the multiplier model for co integration, Dickey and Fuller (1979) and Phillips and Perron (1988) unit root tests were used to determine the order of integration of the money stock (m_{1t}, m_{2t} and m_{3t}), and monetary base (b_t). The results (Table 1) indicate that all the series are I (1) in level and I(0) in the first difference for the full sample and the pre- and post-crisis periods, except for m1t, which is I(0) in level in the post-crisis period.

4.2 Unit root tests with one and two structural break(s)

If the multiplier is valid, then a country's central bank can stabilise the economy by using changes in the monetary base to forecast changes in the money supply. However, it is impossible to accurately forecast necessary changes in the money stock to stimulate the economy unless the coefficients of the multiplier are structurally stable. In fact, some global economic and financial shocks (e.g., the rise in oil prices between 2000–2008, the global financial crisis of 2008, the collapse in oil prices between 2008–2009 and 2014–2016) or regime and policy changes in the domestic economy (e.g., Saudi vision 2030 in April 2016[8]) occurring over the sample period are likely to have resulted in breaks in the money multiplier relationship or the underlying series, the money stock, and monetary base.

Table 1 Unit root tests

Variable	*ADF*		*PP*	
	Levels	*Diff*	*Levels*	*Diff*
		1997m01–2020m4		
m_{1t}	0.003	–15.049*	–0.051	–15.088*
m_{2t}	–0.640	–16.732*	–0.610	–16.812*
m_{3t}	–0.831	–17.473*	–0.776	–17.556*
b_t	–0.813	–19.530*	–0. 622	–22.960*
		1997m01–2008m12		
m_{1t}	1.68	–11.14*	1.62	–11.15*
m_{2t}	3.44	–11.30*	4.60	–14.24*
m_{3t}	3.43	–12.49*	6.18	–12.47*
b_t	0.12	–13.21*	1.27	–14.24*
		2009m01–2020m4		
m_{1t}	–3.778*		–3.470*	
m_{2t}	–2.016	–12.595*	–1.982	–12.593*
m_{3t}	–2.168	–12.531*	–2.154	–12.496*
b_t	–2.151	–15.431*	–2.313	–18.493*

Notes: ADF = augmented dickey-fuller (1981); PP = philip-perron (1988); all unit root tests are with an intercept only; the lag lengths for the ADF test are based on the Schwarz information criterion (SIC). * denotes significance at the 5% level.

Therefore, the need to employ appropriate tests of unit root and cointegration that account for the possibility of structural breaks in the underlying series arises. The Zivot and Andrews (1992) unit root test with one endogenous break and the Lumsdaine and Papell (1997) test with two endogenous breaks are employed to determine the order of integration of the individual series. Results based on the Zivot and Andrews (1992) and Lumsdaine and Papell (1997) tests (Table 4) consistently fail to reject a in m_{1t}, m_{2t}, and m_{3t}, whereas both tests provide evidence that b_t is break point stationary.

4.3 ARDL test and error correction model

The results based on unit root test with structural break(s) necessitates the use of the Pesaran et al. (2001) ARDL approach to co integration, because it can be applied to testing for co integration irrespective of the underlying series being integrated of the same order of unity. The other advantage of the ARDL approach is that the inclusion of dummy variables does not affect the asymptotic distribution of the ARDL bounds test. Moreover, the dummies can be incorporated in the ARDL modelling to account for structural breaks (see, e.g., Fuinhas and Marques, 2012; Hoque and Yusop, 2010; Marques et al., 2016; Zachariadis, 2007).

Table 2 Estimates of co integrating regressions and co integration tests

	1997m01–2020m04			*1997m01–2008m12*			*2009m01–2020m04*		
	m_{1t}	m_{2t}	m_{3t}	m_{1t}	m_{2t}	m_{3t}	m_{1t}	m_{2t}	m_{3t}
Panel a: residual-based co integration tests									
γ	–0.74	0.44	1.40	1.11	0.04	0.78		–8.24	–5.84
	(–1.97)	(1.49)	(5.20)	(2.05)	(0.08)	(1.62)		(–3.76)	(–3.05)
θ	1.15	1.09	1.02	0.99	1.12	1.08		1.77	1.59
	(36.61)	(43.69)	(45.42)	(20.69)	(26.83)	(25.26)		(10.19)	(10.48)
R2	0.96	0.97	0.97	0.92	0.95	0.94		0.71	0.72
EG_{τ}	–2.10	–3.54*	–3.76*	–3.20**	–4.07*	–3.92*		–2.54	–2.57
EG_{z}	–17.03**	–24.22*	–26.87*	–18.91**	–28.91*	–27.06*		–13.17	–13.55
PO_{τ}	–2.51	–3.17**	–3.42*	–2.98	–3.98*	–3.87*		–3.00**	–3.10**
PO_{z}	–12.80	–19.16**	–21.88*	–16.05	–27.15*	–25.73*		–16.41**	–17.45**
$t_{\theta=1}$	4.85*	3.54*	0.89	–0.26	2.92*	1.77		4.45*	3.91*
Panel b: Johannes likelihood co integration tests									
Max test									
r = 0	35.68*	37.28*	35.73*	25.80*	45.57*	42.40*		27.41*	26.74*
r = 1	4.12	7.07	8.59	6.83	9.86	10.38		6.64	6.61
Trace test									
r = 0	39.80*	44.36*	44.32*	32.63*	55.43*	52.79*		34..06*	33.35*
r ≤ 1	4.12	7.07	8.59	6.83	9.86	10.38		6.69	6.61
γ	–0.96	2.39	4.44	–1.64	5.82	6.06		–8.89	–6.84
θ	1.20	1.00	0.86	1.26	0.57	0.57		1.84	1.68
$\chi^2_{\theta=1}$	5.71*	0.006	0.48	2.62	8.38*	11.00*		7.43*	7.54*

Notes: t-statistics in (). * and ** denote significance at the 5% and 10% levels, respectively.

Table 2 Estimates of co integrating regressions and co integration tests (continued)

	1997m01–2020m04			1997m01–2008m12			2009m01–2020m04		
	m_{1t}	m_{2t}	m_{3t}	m_{1t}	m_{2t}	m_{3t}	m_{1t}	m_{2t}	m_{3t}
Panel C: ARDL bound test for co integration									
γ							−7.75		
							(−2.5)		
θ							1.72		
							(7.13)		
F-statistic							23.25		
$t_{\theta=1}$							3.00*		

Notes: t-statistics in (). * and ** denote significance at the 5% and 10% levels, respectively.

Table 3 Testing mean-reversion in the M1, M2, and M3 multipliers

Variable	*Conventional unit root tests*		*Robust unit root tests*		*Nonlinear unit root tests*		
	ADF	*PP*	*DF-GLS*	*ERS*	*KSS* (t_{NL})	*EG* (ϕ_μ)	*EG* (ϕ_μ^*)
			1997m01–2020m4				
k_{1t}	–1.59	–1.44	–0.77	9.94	–1.57	2.45	1.63
k_{2t}	–2.42	–2.38	–1.16	7.28	–2.35	3.59	2.97
k_{3t}	–3.04*	–3.13*	–1.87**	3.87**	–3.91*	4.85*	4.73**
			1997m01–2008m12				
k_{1t}	–3.23*	–2.93*	–2.54*	2.35*	–3.03*	3.87**	5.89*
k_{2t}	–3.45*	–3.22*	–2.00*	4.32	–3.15*	4.12**	4.63**
k_{3t}	–3.68*	–3.51*	–2.27*	3.39**	–3.07*	4.90*	5.44*
			2009m01–2020m4				
k_{1t}	–1.87	–1.85	0.20	59.91	–1.83	2.62	3.41
k_{2t}	–1.35	–1.30	–0.50	19.01	–2.22	1.63	0.98
k_{3t}	–1.51	–1.62	–0.77	13.23	–2.62	1.96	1.16

Notes: ADF = augmented Dickey-Fuller (1981); PP = philip-perron (1988); DF-GLS = Elliott et al. (1996) Dickey Fuller generalised least squares test; ERS = Elliott et al. (1996) point optimal test; KSS = Kapetanios-Shin-Snell (2003) nonlinear test; EG (ϕ_μ) = Enders-Granger (1998) test based on the threshold autoregressive (TAR) model; EG $\left(\phi_\mu^*\right)$ = Enders-Granger (1998) test based on the momentum threshold autoregressive (M-TAR). All conventional and robust unit root tests are with an intercept only. The lag lengths for the ADF, DF-GLS, and ERS tests are based on the Schwarz information criterion (SIC). The three nonlinear tests are applied on the de-meaned series, and the tests' equations were augmented by lagged dependent terms to eliminate autocorrelation in cases it arose. * and ** denote significance at the 5% and 10 % levels, respectively.

Table 4 Unit root tests with one and two structural break(s)

Variable	*Unit root test with one break*			*Unit root test with two breaks*	
	ZA	*T^*	*LP*	*TB1*	*TB2*
m_{1t}	–3.95	2015:11 (–5.48)	–4.89	2008:12 (2.84)	2015:11 (–5.86)
m_{2t}	–3.41	2015:11 (–4.86)	–4.50	2006:10 (3.38)	2016:11 (–4.36)
m_{3t}	–3.55	2015:06 (–5.55)	–4.59	2006:01 (3.01)	2015:11 (–4.88)
b_t	–4.97*	2006:11 (4.64)	–6.52*	2007:08 (5.08)	2014:12 (–4.90)

Notes: ZA = Zivot-Andrews (1992) unit root test, allowing for one break in the intercept only; LP = Lumsdaine-Papell (1997) unit root test, allowing for two breaks in the intercept only. The lag lengths for both tests are based on the Schwarz Information Criterion (SIC). * denotes significance at the 5% level.

Employing the ARDL approach to co integration, the following unrestricted (conditional) error-correction model is estimated:

$$\Delta m_t = \alpha_0 + \rho_1 m_{t-1} + p_2 b_{t-1} + \sum\nolimits_{i=1}^{p} \beta_i \Delta_{m-i} + \sum\nolimits_{i=0}^{q} \delta_i \Delta b_{t-1} + v_t \tag{3}$$

where α_0 is the drift factor, ρ_1 and ρ_2 are long-run multipliers, p and q are the lag lengths for Δm_{t-i} and Δb_{t-i}, respectively. Two stability dummy variables are included to account for structural break points identified based on the Lumsdaine and Papell (1997) unit root test. Furthermore, the residuals from equation (3) are inspected to detect outliers, and impulse dummy variables are used to control for the presence of outliers. The stability dummy variables are defined as follows: SD_1 = 1, over the period 2007:01 to 2008:12, 0 otherwise; and SD_2 = 1, over the period 2014:12 to 2015:12, 0 otherwise. The impulse dummy variables are denoted as $ID_{year:month}$ = 1 in the month the outlier occurred, 0 otherwise.

Table 5 Unrestricted error-correction model, the bounds test, and the restricted error-correction model

	Δm_{1t}		Δm_{2t}		Δm_{3t}	
	Coeff	*t-Stat*	*Coeff*	*t-Stat*	*Coeff*	*t-Stat*
Panel A: Unrestricted error-correction model						
α_0	–0.03	(–1.73)	0.01	(1.31)	0.03*	(2.62)
ρ_1	–0.03	(–4.27)	–0.02	(–3.97)	–0.02	(–3.17)
ρ_2	0.03	(4.36)	0.02	(3.94)	0.02	(3.07)
β_1	0.05	(0.91)			–0.04	(–0.98)
β_2	–0.04	(–0.82)			–0.01	(–0.17)
β_3	0.09	(1.84)			0.15	(3.31)
β_4	0.06	(1.21)			0.02	(0.49)
β_5	–0.10	(–2.00)				
β_6	–0.01	(–0.27)				
β_7	–0.11	(–2.37)				
δ_0	0.13	(9.07)	0.14	(12.73)	0.12	(10.98)
δ_1	0.01	(0.68)				
δ_2	0.03	(1.85)				
Time dummies						
SD_1			0.01	(3.43)	0.01	(2.39)
SD_2						
$SD_{(98:07)}$	–0.04	(–2.83)	–0.03	(–2.98)	–0.03	(–2.76)
$SD_{(02:10)}$			0.04	(3.77)	0.03	(3.45)
$SD_{(04:10)}$	–0.03	(–2.13)				
$SD_{(04:11)}$	0.07	(5.36)	0.09	(9.26)	0.07	(7.45)

Notes: JB = Jarque–Bera test for normality; B.G.P = Breusch-Pagan-Godfrey test for heteroskedasticity; RESET = Ramsey's regression specification error test; B.G (12) = the Breusch-Godfrey test for higher order serial correlation. All diagnostic tests results are based on F-statistic except the JB, which is based on χ^2 statistic. t-statistics in () and p-values in []. * and ** denote significance at the 5% and 10% levels, respectively.

Table 5 Unrestricted error-correction model, the bounds test, and the restricted error-correction model (continued)

	Δm_{1t}		Δm_{2t}		Δm_{3t}	
	Coeff	*t-Stat*	*Coeff*	*t-Stat*	*Coeff*	*t-Stat*
Time dummies						
$SD_{(09:01)}$			–0.04	(–3.55)	–0.03	(–2.75)
$SD_{(10:01)}$			–0.02	(–1.83)	–0.03	(–3.34)
$SD_{(15:02)}$	–0.07	(–5.64)	0.03	(3.45)	0.03	(3.12)
$SD_{(15:12)}$	0.05	(3.47)	–0.02	(–2.19)		
$SD_{(19:12)}$			0.03	(3.41)	0.03	(3.42)
Diagnostics						
R^2	0.45	0.54	0.47			
JB	1.11	[0.58]	0.54	[0.76]	1.07	[0.58]
B.G.P	1.22	[0.25]	0.96	[0.49]	1.36	[0.17]
RESET	0.74	[0.39]	14.24	[0.00]	5.18	[0.02]
B.G (12)	1.53	[0.11]	1.32	[0.20]	1.29	[0.23]
Panel B: ARDL bound test for co integration and estimated long-run co integrating equations						
F-statistic	13.99*	34.18*	12.38*			
γ	–1.00	(–1.80)	0.73	(1.34)	2.03	(3.24)
θ	1.20	(25.34)	1.09	(23.98)	0.99	(19.48)
$t_{\theta = 1}$	4.21*		1.91**		–0.18	
Panel C: Restricted error correction model and short-run elasticises						
φ_0	0.13	(9.17)	0.14	(13.05)	0.12	(11.29)
ϑ	–0.03	(–6.50)	–0.02	(–10.16)	–0.02	(–6.12)

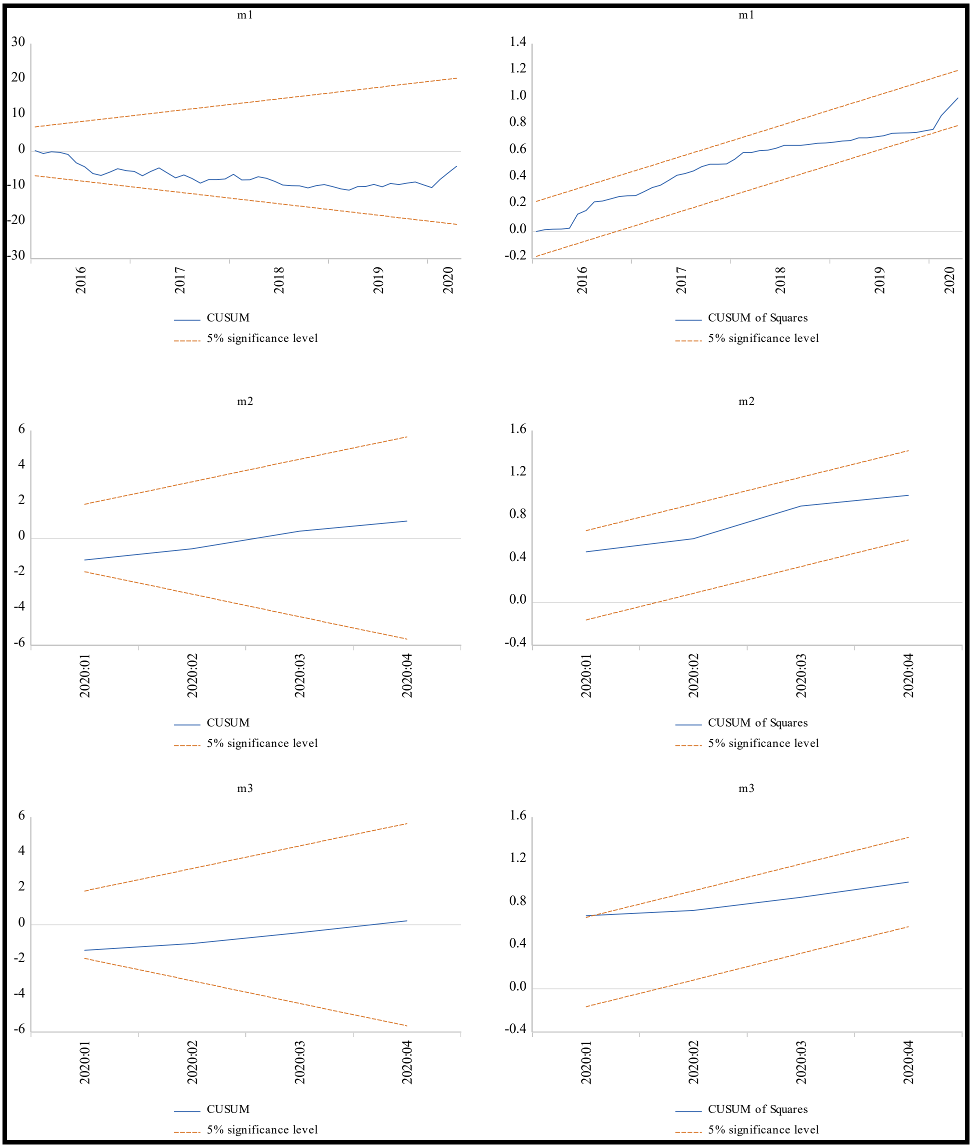
Notes: JB = Jarque–Bera test for normality; B.G.P = Breusch-Pagan-Godfrey test for heteroskedasticity; RESET = Ramsey's regression specification error test; B.G (12) = the Breusch-Godfrey test for higher order serial correlation. All diagnostic tests results are based on F-statistic except the JB, which is based on χ^2 statistic. t-statistics in () and p-values in []. * and ** denote significance at the 5% and 10% levels, respectively.

After the unrestricted error-correction specification is estimated, the ARDL bounds test is performed to determine whether the multiplier holds in the long run. If the bounds test is significant, then the null hypothesis of no co integration is rejected, confirming the long-run multiplier relationship between the money stock and the monetary base. The long-run coefficients of the multiplier relationship, as represented by equation (8), can then be computed as follows: $\gamma = (-\alpha_1)/\rho_1$ and $\theta\ (-\rho_2)/\rho_1$. The estimated long-run coefficients of the multiplier are then used to construct the error correction term, ε_t, to estimate the restricted error-correction model represented by:

$$\Delta m_t = \sum_{i=1}^{p} \phi_i \Delta m_{t-i} + \sum_{i=0}^{q} \varphi_i \Delta b_{t-1} + \varepsilon_{t-1} + v_t \tag{4}$$

Three unrestricted error-correction models are estimated, which normalise on three measures of the money stock, because the results of the Johansen (1988) test for all measures of money, except for M1, and the ARDL test for M1 significantly support the long-run money multiplier. The correlogram of the residuals is used as an indicator of whether enough (but not too many) lags were included to whiten the residuals.

Figure 3 CUSUM and CUSUM of squares tests (see online version for colours)



The results in Table 5[9, 10], are based on unrestricted and restricted error-correction models, as represented by equations (3) and (4) and can be summarised as follows. First, the estimated unrestricted error-correction model based on all measures of money (Panel A) fit the data reasonably well with R^2 ranging from 0.45 for M1 to 0.54 for M2. Second, the estimated error-correction models pass all diagnostic tests (JB, B.G.P, RESET, and B.G (12)), except for the Ramsey's RESET test, [11]which is significant for both M2 and M3 error-correction equations. Third, the short-run dynamics in the M1 unrestricted error-correction model are dominated by the autoregressive process both in the money stock and monetary base, since all the lagged terms in *M* and *B* are statistically significant. Whereas only some lagged terms in M and contemporaneous changes in *B* are significant in the M3 unrestricted error-correction equation and in the M2 unrestricted error-correction equation, only the contemporaneous term in *B* is significant. Fourth, the long-run money multiplier is valid empirically for all measures of money, as the values of the ARDL bounds test (Panel B) are highly significant, rejecting the null hypothesis of no co integration in all cases. Fifth, the money multiplier holds precisely in the long run, as the numerical values of the estimated coefficients are consistent with the model at the 5% significance level over the full sample period when broad money rather than narrow money is used. These results strongly confirm our earlier findings based on the Johansen test of co integration for the full sample period. However, the short-run elasticises are substantially lower than the long-run elasticises in the co integrating relationship. Sixth, the estimated coefficients of the error correction terms in the restricted error-correction equation (Panel C) are correctly signed and statistically significant in all cases. However, the estimated values of the error-correction terms are low, ranging between –0.02 (for M2 and M3) and –0.03 (for M1), indicating a slow speed of adjustment to the long-run multiplier relationship. Only 24% of the deviations are corrected each year in the case of broad money, implying that broad money takes four years and two months to restore the equilibrium relationship with the monetary base, whereas narrow money takes less than three years to correct the deviations from the equilibrium relationship. Seventh, valid error-correction representations of the money multiplier relationship exist for both narrow and broad money.

The stability of the money multiplier model is assessed based on the CUSUM and CUSUM of squares tests in a dynamic framework using a restricted error-correct model. The results (Figure 3) indicate that both narrow and broad money multipliers are stable over the full sample period when structural breaks are considered in the error-correction model. However, the CUSUM of squares graph for the M3 multiplier slightly touches, but never crosses, the upper 5% significance line indicating marginal support for the stability of the M3 multiplier. Our results are strongly consistent with those reported by Bhatti and Khawaja (2018) for the transition economy of Kazakhstan but are in sharp contrast with those of the recent studies pronouncing the collapse of the money multiplier relationship for major advanced countries. This suggests that the multiplier relationship is likely to be still valid for emerging market and transition countries.

5 Conclusions

In this study, the existence of a stable money multiplier is examined in Saudi Arabia over the periods before and after the global financial crisis. Residual-based cointegration tests show that the multiplier performs well over the full sample and during the pre-crisis period when broad money rather than narrow money is used. Although M2 and M3 multipliers exist in the long run, the M3 multiplier performs much better than the M2 multiplier. The Johansen test confirms the multiplier over the full sample and during both the pre-crisis and post-crisis periods for all measures of money, except for M1. While the M2 and M3 money multipliers perform precisely better over the full sampler, only the M1 multiplier performs better in the pre-crisis period as the multiplier restrictions $\gamma > 0$

and θ = 1 are not rejected. The results of the full sample are confirmed by those obtained using the ARDL. Additionally, a valid error-correction representation of the multiplier that accounts for structural breaks exists for all measures of the money stock. Yet the speed of adjustment to the long-run equilibrium is slower. implying that deviations from the M1 multiplier take approximately 33 months to be corrected whereas those from the M2 and M3 multiplier seem to be corrected in about 50 months. In addition, the multiplier is stable for all measures of money when structural breaks are properly considered.

The implications of this study are as follows. First, the multiplier is structurally stable for all measures of the money stock, implying that Saudi Arabia can rely on monetary policy to control the money stock by controlling the monetary base. Second, the M3 multiplier performs better than the M2 multiplier, implying that M3 can serve as a better and effective mechanism for monetary policy to stabilise the economy.

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Notes

1 In Saudi Arabia, about 80% of government spending is financed by oil revenues, unlike other economies where public spending is largely financed by local taxes.

2 See Al Kholifey (2015, pp.40-43).

3 See Al-Hamidy (2011).

4 See SAMA (2015).

5 See, for example, Garfinkel and Thornton (1991) for derivation.

6 For an exposition on DF-GLS and ERS tests, see Elliott et al. (1996).

7 For a discussion on the KSS and EG (ϕ_μ) see Kapetanios et al. (2003) and on EG $\left(\phi_\mu^*\right)$ tests see Enders and Granger (1998).

8 The Saudi Vision 2030 aims to transform the economy from its conventional reliance on oil and natural gas to a more diversified economy based on sustainable economic and social development.

9 The detailed results pertaining to the dynamics and the time dummies are suppressed to reserve space and will be made available upon request.

10 The SD_2 variable is dropped as the impulse dummies sufficiently capture the impact of the drop in oil prices from \$112 to \$47 during June 2014 to January 2015.

11 This suggests the presence of some nonlinear effects or asymmetries in the adjustment of the money stock.