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The nonlinear relationship between monetary policy and financial deepening in an oil-exporting economy: Evidence from Saudi Arabia

Sato Ryoji[1]
Awadh Ahmed Mohammed Gamal[2+]
Gan Pei Tha[3]
Joseph David[4]
Norimah Rambeli[5]

[1,2,3,4,5]*Department of Economics, Faculty of Management and Economics, Sultan Idris Education University (UPSI),35900 Tanjong Malim, Perak Darul Ridzuan, Malaysia.*
[1]*Email: post@midori-system.com*
[2]*Email: awadhsham@yahoo.com*
[3]*Email: gan.pt@fpe.upsi.edu.my*
[4]*Email: josephdavid970@gmail.com*
[5]*Email: norimah@fpe.upsi.edu.my*
[4]*Centre for Economic Policy and Development Research (CEPDeR), Covenant University, Nigeria.*

(+ Corresponding author)

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ABSTRACT

This study explores the asymmetric impact of monetary policy on financial deepening in Saudi Arabia from 1992 to 2022. It uses the nonlinear autoregressive distributed lag (NARDL) bounds-testing method to show that there is strong evidence of a long-term link between financial deepening and the sums of monetary policy and control variables. The findings indicate that financial deepening responds nonlinearly to monetary policy shocks. Specifically, both positive and negative shifts in monetary policy encourage financial deepening, but positive shifts have a more significant effect. Additionally, monetary uncertainty and economic activity levels notably influence financial deepening. The study suggests that policymakers should use tools like changing interest rates and managing inflation to help the economy become more diverse, deepen the financial system, and lower short-term monetary risks. This will ensure that the financial sector continues to grow.

Contribution/ Originality: This research exclusively examines the response of financial deepening in Saudi Arabia to monetary policy changes from 1992 to 2022. Despite the significant growth and development of the country's financial sector, empirical studies on this relationship remain limited, rendering this analysis a valuable addition to the existing literature on the topic.

1. INTRODUCTION

The monetary policy is the cornerstone of macroeconomic management, used to stabilize prices, manage inflation, and promote economic growth. It achieves these goals by utilizing instruments such as "interest rate adjustments, open market operations, and changes in reserve requirements, which together influence the cost and availability of money" (Carranza, Galdon-Sanchez, & Gomez-Biscarri, 2010). Typically, central banks modify interest rates to steer aggregate demand and ensure that "the economy operates near its potential output." These adjustments, whether expansionary or contractionary, directly influence borrowing, lending, and investment decisions across the economy. However, the efficacy of these monetary policy tools is "largely determined by the strength and structure of the financial system through which these policies are transmitted" (Ma & Lin, 2016; Sena, Asante, & Brafu-Insaidoo, 2021).

The financial system plays a key role in transmitting monetary policy to the broader economy. As the conduit for monetary policy actions, the capital markets, banking sector, and other financial institutions ensure that "changes in policy rates translate into changes in borrowing costs, savings rates, and investment flows" (Effiong, Esu, & Chuku, 2020; Sena et al., 2021). A well-developed financial system enhances the efficiency and speed of this transmission mechanism by allowing for more accurate pricing of risk, better intermediation of funds, and more stable financial flows. In contrast, underdeveloped financial systems may weaken or distort this transmission, limiting the monetary policy actions' effectiveness. For instance, in a shallow financial system with weak institutions, monetary policy tightening may not curb inflation effectively due to poor credit allocation and a lack of trust in financial instruments (Beck, 2011; Carranza et al., 2010; Islam & Lee, 2020; Seth & Kalyanaraman, 2017).

The connection between monetary policy and the financial sector, therefore, is both bidirectional and complex (Effiong et al., 2020). On one hand, a well-functioning financial system is essential for monetary policy to have its intended effects. In contrast, the stance of monetary policy can "shape the development of the financial sector itself" (Effiong et al., 2020; Seth & Kalyanaraman, 2017). Recent empirical research points to a feedback loop between financial development and monetary policy. Arshad et al. (2021) show that "financial deepening enhances the effectiveness of monetary policy transmission" by improving access to credit and fostering financial innovation. Simultaneously, monetary policy, particularly through interest rate adjustments, can drive financial development by encouraging savings and investment, stimulating competition among financial institutions, and fostering innovations that promote financial inclusion. As financial systems grow more sophisticated, monetary policy's ability to influence economic outcomes strengthens, leading to more robust economic cycles and sustained growth (Arshad et al., 2021; Effiong et al., 2020).

Specifically, interest rate adjustments, as a key monetary policy tool, can directly impact the level of financial deepening—the extent to which financial institutions and markets can mobilize savings and allocate credit efficiently. An increase in interest rates typically raises the return on savings, thereby encouraging higher savings rates, which can, in turn, fuel investment in financial assets and instruments. Stable and predictable monetary policy, particularly in the form of low and controlled inflation, fosters confidence in long-term financial instruments, encouraging both household savings and business investment (Mishkin, 2001; Sakanko & David, 2019). By providing a stable monetary environment, central banks create conditions conducive to the growth and diversification of the financial sector. Moreover, monetary policy decisions can also stimulate financial innovation as financial institutions develop new products and services in response to changing monetary conditions (Effiong et al., 2020; Seth & Kalyanaraman, 2017), further deepening the financial system.

Nevertheless, the association between financial deepening and monetary policy is not always linear (Angelopoulou, Balfoussia, & Gibson, 2014). What monetary policy means for financial deepening depends on the bigger picture of the economy, the strength of the financial system's institutions, and its current stage of development (Effiong et al., 2020; Ma & Lin, 2016; Seth & Kalyanaraman, 2017). Due to structural weaknesses in the financial system, an aggressively expansionary monetary policy may make inflation worse in developing economies with weak financial systems while not doing much to improve credit flows or investment (Islam & Lee, 2020). On the other hand, in economies with more developed financial systems, these kinds of policies might help credit grow and financial deepening because well-regulated institutions are better able to handle the risks that come with more money in the system (Seth & Kalyanaraman, 2017). This shows that the relationship between financial deepening and monetary policy is not a straight line. For example, expansionary policies may have bigger effects in economies with stronger institutions, while contractionary policies may either have little or no effect at all, depending on how mature and deep the financial system is.

While previous studies have extensively examined monetary policy's effectiveness and its implications for financial deepening in developing and emerging economies (e.g., (Abuka, Alinda, Minoiu, Peydró, & Presbitero, 2019; Carranza et al., 2010; Islam & Lee, 2020; Ma & Lin, 2016; Mishra, Montiel, Pedroni, & Spilimbergo, 2014; Ramos-

Tallada, 2015), they have not adequately addressed several key weaknesses. Many of these studies overlook the potential asymmetries in the implications of monetary policy under different economic conditions, such as the unique structural characteristics of economies that are heavily dependent on oil revenues. Such gaps are particularly significant for countries that, despite possessing relatively advanced financial sectors, are still closely tied to resource-based industries.

In the context of the Kingdom of Saudi Arabia, the financial system is relatively well-developed, particularly within the banking sector, yet it remains closely tied to developments in the oil and gas sector. As the country seeks to diversify its economy, monetary policy—especially through interest rate adjustments by the Saudi Arabian Monetary Authority (SAMA)—plays a critical role in fostering financial deepening. While expansionary monetary policies can stimulate the financial sector by encouraging credit growth and financial innovation, contractionary policies aimed at curbing inflation may not lead to an immediate reduction in financial activity due to the cash-based feature of the Saudi economy (Aljassmi, Gamal, Abdul Jalil, David, & Viswanathan, 2024; Mouna & Jarboui, 2022). Still, both expansionary and contractionary monetary policies can affect financial deepening, though in different ways and to different degrees. This is because monetary policy has different effects on the financial sector (Ma & Lin, 2016).

Given these dynamics, it is essential to determine whether the implications of monetary policy for financial deepening in Saudi Arabia exhibit asymmetries across different economic conditions. This study makes many important additions to the literature. First, it is a pioneering effort to explicitly examine how financial deepening responds to adjustments in monetary policy decisions in the Kingdom of Saudi Arabia over the period 1992 to 2022. To "the best of our knowledge," previous research has largely neglected this relationship in Saudi Arabia, despite the significant evolution of its financial sector over time. Second, this study offers a fresh perspective by investigating the possibility of an asymmetric association among financial deepening and monetary policy, thereby addressing a gap in the existing literature where previous studies have failed to fully account for the implications of different economic conditions for this relationship. The selected period (1992-2022) is particularly appropriate as it encompasses key economic phases in Saudi Arabia, including major economic reforms in the early 2000s, the recent Vision 2030 initiatives, and the 2008 global financial crisis. These milestones have had significant "implications for the financial sector," analyzing monetary policy's influence on financial deepening during this period particularly pertinent. Third, to obtain robust results, the study adopts the nonlinear autoregressive distributed lag (NARDL) technique. Lastly, the study wants to help monetary policymakers, researchers, and other important people in Saudi Arabia and other countries with similar economies learn more by looking into the nonlinear effects of monetary policy on financial deepening in Saudi Arabia. Moreover, given the strategic position of Saudi Arabia in the international oil and gas industry, the Middle East, and the global economy, the outcomes from this study are expected to reignite discussions and prompt further actions regarding the deepening of the financial system and the monetary policy.

The rest of this study is organized as follows. The next section focuses on the reviews of the literature. Section 3 describes the method and data. The results are presented and discussed in section 4. The conclusion and policy implications are provided in section 5.

2. LITERATURE REVIEW

The relationship between monetary policy and financial deepening has been extensively explored in both theoretical and empirical research, particularly in developed and emerging economies. Early theoretical work by Gurley and Shaw (1955) and Gurley and Shaw (1967) laid the foundation, which was further expanded by Taylor (1987), Hendry and Ericsson (1991), and Philip Arestis, Hadjimatheou, and Zis (1992). In recent years, much attention has been given to the credit channel theory introduced by Bernanke and Gertler (1995), which posits that "monetary policy affects the economy through its impact on credit supply (the bank lending channel) and borrowers' balance sheets (the balance sheet channel)." The conventional view holds that monetary policy, particularly through interest rate adjustments, influences financial deepening by impacting borrowing costs and the returns on savings. A stable

and predictable monetary environment is believed to foster financial sector development, as low and stable inflation enhances confidence in long-term financial instruments, promotes savings, and supports investment in financial markets (Mishkin, 2001). Within this framework, an accommodative monetary policy, characterized by lower interest rates, stimulates credit growth, expands demand for financial services, and deepens financial markets. In contrast, a restrictive monetary policy may limit financial deepening by increasing borrowing costs and discouraging investment.

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On the empirical front, research examining the association between monetary policy and financial deepening (or financial development) has often focused on the effectiveness of monetary policy rather than on its direct influence on financial deepening. A substantial number of studies, predominantly centred on advanced economies (e.g., (Carranza et al., 2010; Islam & Lee, 2020; Ma & Lin, 2016), underscore that "the effectiveness of monetary policy is contingent upon the structure and development level of the financial system." For instance, most of the studies concluded that "monetary policy tends to have a more pronounced effect on economies where the level of financial development is relatively low" (see, for instance, (Boivin & Giannoni, 2006; Carranza et al., 2010; Ma & Lin, 2016)). However, these studies have limitations. For instance, the fact that they mostly look at advanced economies makes it harder to understand how things work in developing countries. Also, a lot of these studies assume that policies have the same effects in all economic situations, which might make the underlying mechanisms too simple.

Furthermore, while research specifically examining how monetary policy influences the depth and development of financial systems in both developed and developing nations remains limited, the studies generally conclude that while monetary policy can indeed affect financial development, the direction and extent of the influence vary with the level of economic development. For instance, Mishra et al. (2014) utilized a heterogeneous structural panel vector autoregressive (VAR) approach to assess the implication of monetary policy across 132 high-income, emerging, and low-income economies between 1978 and 2013. Their research shows that the way financial systems react to changes in monetary policy is very different depending on the country. In high-income and emerging economies, the response is stronger because of stronger institutional frameworks and "less concentrated banking systems," while in low-income countries, the effects are not as strong. A noted weakness in this strand of research is its limited consideration of country-specific institutional characteristics, which can significantly influence the outcomes.

Similarly, Islam and Lee (2020) investigated the response of financial development to adjustments in monetary policy across both advanced and developing economies from 1960 to 2013 using fixed effects regressions. As a whole, their results show that monetary policy has a "significant positive influence on financial development." However, when the sample is broken down, the evidence shows that monetary policy significantly stimulates financial development in developing countries, but its effect on advanced economies weakens after 1985. This divergence points to a potential weakness in earlier research, namely the assumption of temporal homogeneity in policy effectiveness.

In developing economies, further studies have highlighted that monetary policy can stimulate financial depth and development, although the effects are not uniform. Mishra, Montiel, and Spilimbergo (2012) observed that in low-income countries, the impact of monetary policy on financial development is generally weak and statistically insignificant. In contrast, Ramos-Tallada (2015) found that in Brazil, credit supply was negatively affected by monetary policy shocks over the long run. Furthermore, Abuka et al. (2019) looked at Uganda's bank credit supply between 2010 and 2014 and discovered that contractionary monetary policy decreased the amount of credit available, led to more loan rejections, and made lending conditions stricter. This was especially true for banks with more debt

and exposure to sovereign debt. While these studies provide valuable insights, they often fall short by not fully addressing the structural weaknesses inherent in their respective financial systems, thereby limiting the broader applicability of their findings.

Despite the extensive research on monetary policy and financial deepening in both developed and developing economies, there has been limited exploration of this relationship within the Kingdom of Saudi Arabia. Although it is well recognized that monetary policy's effectiveness through credit transmission channels depends on the development and structure of the financial system, this aspect has not been thoroughly investigated in Saudi Arabia. Considering the considerable size of Saudi Arabia's financial sector and the ongoing efforts to diversify its economy, this represents a significant gap in the literature. Therefore, this study adds to the existing body of knowledge by studying the asymmetric influence of monetary policy on financial deepening in Saudi Arabia over the period from 1992 to 2022 and critically engaging with the limitations of previous research in this field.

3. METHODOLOGY

3.1. Model Specification

To look into the complicated relationship between monetary policy and financial deepening, we created an econometric model that shows how changes in monetary policy, both up and down, have different effects on financial deepening. Here are the details of the model:

$$fd_t = a_0 + b_1 mpr_t^+ + b_2 mpr_t^- + \varphi' Z_t + \mu_t \qquad (1)$$

Where $t = 1,2,\dots,T$ denotes time. fd is financial deepening. mpr^+ and mpr^- represents the "positive and negative changes"[1] in the monetary policy regulation, respectively. Z represents the of control variables (inflation rate, size of economic activities, foreign direct investment inflow, and monetary uncertainty). The selection of these control variables is guided by previous studies on financial deepening (see, for example, (Abuka et al., 2019; Islam & Lee, 2020; Mishra et al., 2012; Ramos-Tallada, 2015)). a_0 is the intercept, and b_i and φ are the slope coefficients. μ_t represent the error term. Monetary uncertainty and the size of economic activities are log transformed to reduce skewness.

3.2. Estimation Techniques

This study employs Shin, Yu, and Greenwood-Nimmo (2014) nonlinear autoregressive distributed lag (NARDL) bounds-testing method to examine the "asymmetric" interplay between monetary policy and financial deepening. This approach builds upon Pesaran, Shin, and Smith (2001) conventional ARDL bounds-testing method by incorporating a nonlinear perspective. Several considerations support the choice of this technique. In the first place, the NARDL method is better because it can find nonlinearity and asymmetry in the relationship (Abu, David, Sakanko, & Amaechi, 2022a; Abu et al., 2022b; David, Sakanko, & Obilikwu, 2020; Gamal, David, Noor, Hussin, & Viswanathan, 2024). The NARDL method has all the benefits of the traditional ARDL method, such as being able to handle cointegrating relationships in finite samples, regardless of the order of integration. It also lets you model different short- and long-term asymmetric changes in a fairly simple way (Abu et al., 2022b; Gamal, Salem, David, & Gan, 2025; Maashani, Gamal, Shaarani, AbdulJalil, & Abd. Hadi, 2025).

A bivariate NARDL(p,q) model is typically expressed as:

$$y_t = c + \beta^+ x_t^+ + \beta^- x_t^- + \chi' Z + \upsilon_t \qquad (2)$$

Where β^+ and β^- are the "parameters of the partial sums" of x_t, the asymmetric variable. Z is the vector of the symmetric explanatory variables, and υ_t is the error term.

[1] The process of decomposing or generating the "positive and negative components" of the monetary policy regulation is presented in Equations 4 and 5 in sub-section 3.2.

x_t is a $k \times 1$ vector of explanatory variables decomposed as:

$$x = x_0 + x_t^+ + x_t^- \quad (3)$$

Where x_t^+ and x_t^- are the "partial sum process of positive and negative changes" in x_t. The partial sums of x_t, a proxy of the monetary policy regulation are generated by computing:

$$x_t^+ = \sum_{i=1}^{t} \Delta x_i^+ = \sum_{i=1}^{t} \max(\Delta x_i, 0) \quad (4)$$

$$x_t^- = \sum_{i=1}^{t} \Delta x_i^- = \sum_{i=1}^{t} \min(\Delta x_i, 0) \quad (5)$$

In line with Shin et al. (2014) Equation 2 re-written as an unrestricted $NARDL(p,q)$ model to illustrate an asymmetric relationship between series x_i and y_i can be expressed as follows:

$$y_t = c + \rho y_{t-1} + \theta^+ x_{t-1}^+ + \theta^- x_{t-1}^- + \gamma' Z + \sum_{i=1}^{p-1} \delta_i \Delta y_{t-i} + \sum_{i=0}^{q} (\pi_i^+ \Delta x_{t-i}^+ + \pi_i^- \Delta x_{t-i}^- + \vartheta' \Delta Z_{t-1}) + \upsilon_t \quad (6)$$

Where Δ denotes the first difference operator. The coefficients θ^+ and θ^- are defined as $-\rho\beta^+$ and $-\rho\beta^-$, respectively, with ρ representing the coefficient for the lagged dependent variable. The parameters π_i^+ and π_i^- capture the corresponding short-run effects. Meanwhile, the lagged covariates that enter the model symmetrically are associated with the vector parameter γ, and the differenced symmetric variables are linked to the vector parameter ϑ. The optimal lag orders (p, q) are based on the Akaike Information Criterion.

In line with Shin et al. (2014) the asymmetric cointegrating relationship among variables is established using the traditional bounds-testing procedure of Pesaran et al. (2001). The presence or absence of a nonlinear cointegrating relationship between y_t and x_t is evaluated by testing the null hypothesis of no cointegration ($H_0: \rho = \theta^+ = \theta^- = \gamma = 0$), against the alternative hypothesis that cointegration exists ($H_1: \rho \neq \theta^+ \neq \theta^- \neq \gamma \neq 0$). If the null hypothesis is rejected, it indicates the presence of cointegration. To determine this, the F-statistic from the Wald test is compared with the critical bounds provided by Pesaran et al. (2001). Cointegration is confirmed only if the F-statistic exceeds the upper critical bound. If it falls between the lower and upper bounds, the result is inconclusive. Once cointegration is established, both long-run and short-run models can be estimated (Gamal et al., 2025; Maashani et al., 2025). Additionally, long-run and short-run symmetry are tested using the Wald test. For long-run asymmetry, the null hypothesis tested is $-\theta^+/\rho = -\theta^-/\rho$, while $\sum_{i=0}^{q} \pi_i^+ = \sum_{i=0}^{q} \pi_i^-$ is the null hypothesis tested for short-run asymmetry (Abu et al., 2022b).

3.3. Data

This paper uses annual time series data spanning from 1992 to 2022, selected based on data availability and the occurrence of key economic events. This period captures major monetary policy adjustments and macroeconomic developments, including the global financial crisis and the COVID-19 pandemic, all of which have significantly impacted financial markets and monetary policy decisions. The monetary policy rate data are sourced from the Bank for International Settlements (BIS). We assess financial deepening using indicators like private sector credit as a percentage of gross domestic product (GDP). The study also looks at inflation (calculated as the percentage change yearly in the consumer price index), GDP (which shows how active the economy is), and foreign direct investment (FDI) inflows (calculated as the ratio of FDI to GDP). All of these variables came from the World Development Indicators database. Furthermore, the Saudi Central Bank provides data on monetary uncertainty, represented by the money supply in millions of Saudi Riyals.

4. RESULTS AND DISCUSSION

This section presents and discusses the empirical results from the various analyses conducted in this study.

4.1. Preliminary Data Analysis

Prior to determining the nonlinear association between monetary policy and financial deepening, the descriptive statistics, alongside the correlation analysis and the stationarity properties of the series, were calculated. The summary statistics and correlation analysis are reported in Table 1. As shown, the average Saudi Arabian monetary policy rate between 1992 and 2022 was 3.399 percent, with values ranging from 1 percent to 7 percent. The standard deviation indicates that the monetary policy rate remained relatively stable during this period. However, the kurtosis (which measures the flatness or peakedness) and skewness (which indicates the asymmetry of the distribution) reveal that the distribution of the monetary policy rate is positively skewed (with a long right tail) and platykurtic (flatter than normal), suggesting that it is not normally distributed.

Furthermore, Table 1 reveals that the average values of financial deepening (credit to the private sector relative to the national output), FDI relative to GDP, and money supply were 40.124 percent, 1.725 percent, and 1.005 trillion Saudi Arabian Riyals (SAR), respectively. The skewness and kurtosis for these variables also suggest non-normality. The standard deviations indicate strong volatility for both credit to the private sector and monetary uncertainty, while FDI exhibited relatively stable variation over time.

Table 1. Descriptive statistics and correlation matrix.

	fd	mpr	y	p	fd	fdi	mu
Mean	40.124	3.399	419.524	1.964	40.124	1.725	1,004.59
SD	19.295	1.758	261.712	2.631	19.295	2.473	741.95
Min.	16.759	1	132.223	-2.093	16.759	-1.308	219.396
Max.	92.1	7	833.541	9.87	92.1	8.496	2,410
mpr	-0.129	1.000					
y	0.827^{***}	-0.636^{***}	1.000				
p	0.039	-0.274	0.329^{*}	1.000			
fdi	0.146	-0.129	0.318^{*}	0.539^{***}	0.146	1.000	
mu	0.852^{***}	-0.642^{***}	0.993^{***}	0.290^{*}	0.852^{***}	0.289^{*}	1.000

Note: Asterisks (***) and (*) denote statistical significance at 1% and 10% levels, respectively. mpr = Monetary policy rate; y = Nominal GDP (In billions of US dollars); p is inflation rate; fd is financial deepening; fdi is foreign direct investment; mu is monetary uncertainty (Measured by money supply in millions of Saudi Riyal).

In addition, the average GDP over the period was US$419.524 billion, with values ranging between US$132.223 billion and US$833.541 billion. A standard deviation of 261.712 billion indicates significant variation over time, and the skewness and kurtosis properties reveal that the GDP series is not distributed normally. The inflation rate, which averaged 1.964 percent with a standard deviation of 2.631 percent, reflects relative stability despite ranging from -2.093 percent to 9.870 percent over the period. The skewness indicates that the inflation rate is positively skewed.

The pairwise correlation analysis in the lower panel of Table 1 shows that there is a weak, statistically insignificant link between the monetary policy rate and financial deepening (r = -0.129). The data also show that financial deepening is strongly and positively linked to both the size of economic activities (r = 0.827) and monetary uncertainty (r = 0.852). Both of these correlations are significant at the 1% level. Conversely, the relationships between financial deepening and the inflation rate (r = 0.039) as well as foreign direct investment (r = 0.146) are both weak, positive, and lack statistical significance. Remember that these correlations do not imply causality or state the series' relationship direction.

We use the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and Zivot-Andrews (ZA) tests in this study to look at "the stationarity characteristics of the data series." Table 2 shows the results. The ADF test results allow us to reject the null hypothesis of a unit root for the inflation rate at the 5 percent level, indicating stationarity at the level. In contrast, the monetary policy rate, economic activity size, financial deepening, foreign direct investment, and money supply are non-stationary in levels but become stationary upon first differencing. The PP test corroborates these findings, showing that while the inflation rate is stationary at its level, the remaining series are integrated in order I(1). The ZA test, which examines possible structural breaks, also shows that all variables except the monetary

policy rate become stationary after first differencing at the 5% significance level. There are some small differences between the tests regarding the order in which monetary uncertainty is integrated, but overall, the evidence suggests that the dataset includes both I(0) and I(1) variables. This mixed integration order supports the application of the NARDL bounds-testing approach, which is suitable for models with variables integrated at different orders.

Table 2. Results of unit root tests.

		fd	mpr	$l.y$	p	fdi	$l.mu$
ADF	Level	2.022	-2.565	-0.493	-3.226**	-2.428	-0.833
	1st diff.	-8.065***	-4.109***	-4.915***	–	-3.924***	-2.451*
PP	Level	1.232	-2.153	-0.501	-3.298**	-1.789	-0.292
	1st diff.	-8.623***	-3.484**	-4.915***	–	-3.751***	-2.363*
ZA	Level	-2.363	-4.593*	-3.540	-3.203	-4.268	-3.071
	T_b	2015	2001	2006	2007	2005	2006
	1st diff.	-6.549***	–	-5.929***	-10.945**	-6.755***	-4.967**
	T_b	2014	–	2014	2010	2010	2002

Note: $l.$ represent log transformation. T_b is the structural break-date. ADF represents the Augmented Dickey and Fuller (1979) test, PP denotes Philips-Peron test, and ZA is the Zivot and Andrews (1992) test with one break. The ADF and PP unit root test tests the null hypothesis of unit root against the alternative hypothesis of a stationary process. ZA and Perron tests the null of unit root against the alternative hypothesis of a trend-stationary process with one-time structural break occurring at an unknown point in time. ZA unit root test is conducted based on model A which represent structural change in the level shift or intercept. The optimal lag length selection in ADF and ZA tests are based on the Schwarz Information Criteria (SIC) of Schwarz (1978) while the maximum lag-length is set to 8. For PP test, the bandwidth is automatically determined based on the Newey-West method using the Bartlett kernel spectra estimation method. MacKinnon (1996) critical values (CV) for ADF and PP tests (intercept only) are given as: -3.670, -2.964, and -2.621, at 1%, 5% and 10% levels, respectively. ZA's CV for structural change in the level shift are: -5.34 (1%), -4.93 (5%) and -4.58 (10%). Asterisks (***), (**) and (*) indicate significance at 1%, 5% and 10% level, respectively.

4.2. NARDL Bounds-Testing Cointegration Test

The NARDL bounds-testing approach is employed to determine whether an asymmetric cointegrating association exists among monetary policy regulation and financial deepening in Saudi Arabia. Table 3 details the results using an NARDL model with a lag structure of (1, 0, 1, 0, 2, 1), as selected by the Akaike Information Criterion (AIC). The analysis reveals an F-statistic of 4.397, which exceeds the upper critical bound of 4.148 at the 5% significance level. The null hypothesis of no cointegration is rejected due to this strong evidence, which confirms the presence of a significant long-run asymmetric cointegrating relationship among financial deepening, monetary policy regulation, GDP, inflation rate, foreign direct investment, and monetary uncertainty.

Table 3. NARDL bounds-testing result.

Model	**Lag length**		***F*-statistic**
$fd = f(mpr^+, mpr^-, l.y, p, fdi, l.mu)$	1,0,1,0,2,1		4.397**
	$K = 6$		$N = 29$
Critical values for case II: Restricted constant and no trend	10%	5%	1%
I(0)	2.334	2.794	3.976
I(1)	3.515	4.148	5.691

Note: K is the number of explanatory variables, and N represents the sample size. Asterisk (**) denotes significance at 1% level based on critical values provided by Pesaran et al. (2001). The optimal lag-length is suggested by AIC.

4.3. Estimation Results of the NARDL Model

Based on evidence of a long-run cointegrating relationship among the variables, we estimated an NARDL model to capture both long- and short-term dynamics, using the optimal lag structure (1, 0, 1, 0, 2, 1) suggested by the AIC. Panels A, B, and C in Table 4 summarise the long-run and short-run estimates, along with diagnostic tests for stability, normality, heteroscedasticity, and autocorrelation. In line with the methodology of Shin, Yu, and Greenwood-Nimmo (2011), we applied Wald restriction tests to evaluate asymmetry in both the long and short run. The long-run symmetric test statistic (W_{LR}) provides "sufficient evidence to reject the null hypothesis of additive symmetry between the positive and negative components" of monetary policy regulation at the 5 percent level, whereas the short-run test (W_{SR}) is statistically insignificant. This indicates that the long-run impacts of the positive and negative changes in monetary policy on financial deepening in Saudi Arabia are significantly different.

Table 4. Results of NARDL Model.

Panel A: NARDL (1,0,1,0,2,1) long-run estimates – dependent variable: fd						
C	mpr^+	mpr^-	$l.y$	p	fdi	$l.mu$
397.487	7.013 (2.555)**	1.868 (1.634)*	-82.605 (-4.059)***	1.359 (1.422)	-0.182 (-0.233)	65.954 (3.541)***

Panel B: NARDL (1,0,1,0,2,1) Short-run estimates – Dependent variable: Δfd		
Regressors	Lag order	
	0	1
Δmpr^+	3.689 (1.979)**	
Δmpr^-	-2.235 (-1.299)	
Δp	-1.030 (-1.443)	
$\Delta l.mu$	-12.924 (-0.338)	15.058 (0.394)
W_{LR}	5.7342 [0.029]**	
W_{SR}	0.3088 [0.586]	

Panel C: Diagnostic statistics tests					
ECT_{t-1}	$\chi^2_{SC}(3)$	$\chi^2_{FF}(1)$	χ^2_{HET}	χ^2_{NORM}	$Adj.R^2$
0.4167***(5.844)	3.31 [0.176]	0.609 [0.458]	20.581 [0.301]	0.183 [0.912]	0.95

Note: Δ represent first difference operator. Asterisk (***), (**) and (*) denotes significance at 1%, 5% and 10% level, respectively. The superscripts "+" and "−" represents positive and negative partial sums, respectively. Values in parenthesis (.) in panel A and B are the t-ratio, and values in square parenthesis [.] in panel B and C are the probability values of test statistics. W_{LR} refers to the Wald test of long-run symmetry, defined by $-\hat{\theta}^+/\hat{\rho} = -\hat{\theta}^-/\hat{\rho}$, and W_{SR} is the short-run symmetry, defined by $\sum_{i=0}^{q}\pi_i^+ = \sum_{i=0}^{q}\pi_i^-$. ECT_{t-1} represent the error correction term. χ^2_{SC}, χ^2_{HET}, χ^2_N, and χ^2_{FF} denotes BG LM tests for serial correlation, BPG LM test heteroscedasticity, JB normality test and Ramsey RESET f-statistic, respectively. The model is estimated by setting the maximum lag to 4, while the optimal lag-length is suggested by AIC.

The estimation results in Table 4 reveal that both positive and negative monetary policy shifts have a statistically significant increasing influence on financial deepening in the long term (Panel A) and the short run (Panel B). In the first place, the results show that a unit change in the positive and negative parts of monetary policy is linked to a 7.013 percentage point and 1.868 percentage point rise in the level of financial deepening in Saudi Arabia. On the other hand, a one percent adjustment in the positive component of monetary policy stimulates short-term financial deepening by 3.689 percentage points. The association between financial deepening and the short-term negative component of monetary policy is statistically insignificant. This result supports the outcome of previous research that indicates that "monetary policy adjustment has strong and positive implications for financial deepening in developing and emerging economies" such as the UAE (see, for instance, (Abuka et al., 2019; Islam & Lee, 2020)). However, it contradicts the findings of Ma and Lin (2016), which reveal "that the effectiveness of monetary policy tends to decline as the financial system matures."

While the results demonstrate that both the long- and short-term influence of monetary policy on financial deepening is positive, the implications of positive adjustments in monetary policy regulation are significantly larger over both periods. The presence of an asymmetric relationship implies that upward adjustments in the policy rate may lead to more pronounced effects on financial deepening than decreases. This effect may stem from the perception of stability and growth associated with rate increases, prompting stronger responses from financial institutions and markets. Positive adjustments in the monetary policy rate may signal economic growth prospects, thereby enhancing market confidence. In contrast, negative changes may not elicit the same level of confidence, leading to more subdued responses in lending and investment, which is reflected in the degree of financial deepening. For instance, when the monetary authority increases interest rates, it may result in higher returns on savings and investments, encouraging financial institutions to expand their services. Conversely, when rates decrease, the immediate impact may be weaker, resulting in a less pronounced effect on financial deepening.

Even though there were differences in how financial deepening responded to changes in monetary policy, whether increasing or decreasing, the results show that monetary policy regulation has a significant impact on the performance of the Saudi Arabian financial sector. By fostering stable macroeconomic conditions, encouraging credit expansion, controlling inflation, promoting financial innovation, and effectively regulating financial institutions, monetary policy and its regulation are critical for stimulating financial deepening. However, evidence suggests that the influence may

depend on the extent of the financial sector's development. For instance, Ma and Lin (2016) reveal that "the effectiveness of monetary policy tends to decline as the financial system matures." Additionally, Islam and Lee (2020) demonstrate that "while monetary policy has an insignificant impact on financial deepening in developed economies—due to their well-developed financial sectors—it is effective in stimulating financial deepening in developing economies, given the underdeveloped nature of their banking sectors, stock markets, and secondary bond markets."

Although Saudi Arabia has one of the more developed financial sectors, particularly in banking, the fact that the nation's financial system remains closely tied to developments in the oil and gas sector, alongside the cash-based nature of its economy, makes these findings particularly interesting and relevant. Therefore, despite the current level of financial sector development, "monetary policy plays a critical role in ensuring macroeconomic stability," fostering innovation, expanding access to financial services, and regulating financial institutions, all of which can stimulate further financial deepening. Through stable inflation, prudent regulation, and proactive policy adjustments, SAMA has historically utilized the monetary policy rate to create an environment that is conducive to the growth and diversification of the financial system. By promoting the growth of "non-bank financial institutions—such as pension funds, venture capital firms, insurance companies, and fintech"—Saudi Arabia has sought to develop a more diversified and inclusive financial landscape that caters to various sectors of the economy. Moreover, the development of capital markets, including equity and bond markets, plays a critical role in diversification by providing alternative financing channels for businesses beyond traditional bank loans. This diversification enables firms, particularly small and medium enterprises (SMEs), to access much-needed capital, thereby promoting broader economic growth.

A statistically significant negative relationship exists between aggregate economic activity and financial deepening, while a statistically significant positive relationship exists between monetary uncertainty and financial deepening at the 1% level. Specifically, a 1 percent increase in aggregate economic activity is linked to an 82.61 percentage point reduction in financial deepening, whereas a unit increase in monetary uncertainty is associated with a 65.95 percentage point improvement. In contrast, the long-run effect of inflation on financial deepening is positive but not statistically significant, and the long-run impact of foreign direct investment, as well as the short-run effects of monetary uncertainty and inflation, are negative and statistically insignificant.

The statistically insignificant positive long-term impact of the inflation rate on financial deepening is inconsistent with previous findings, which suggest that inflation typically reduces the degree of financial deepening in a country (see (Batayneh, Al Salamat, & Momani, 2021; Bittencourt, 2011; Moore, 1985)). However, the moderate inflation rate in Saudi Arabia provides a framework to understand this relationship. While higher inflation typically hinders the "development of the financial sector," moderate inflation can positively influence financial deepening by encouraging financial innovation, increasing demand for financial services, and fostering market expansion. Yet, if inflation becomes excessively high or volatile, it can disrupt financial markets, leading to the opposite effect. Thus, the net impact depends on the prevailing economic and policy environment, as well as the specific level of inflation experienced.

Moreover, the negative relationship between aggregate economic activities and financial deepening contradicts previous findings (see (Acaravci, Ozturk, & Acaravci, 2009; Apergis, Filippidis, & Economidou, 2007; Arestis, Chortareas, & Magkonis, 2015)). In Saudi Arabia, this relationship may be linked to the heavy reliance of the economy on the oil and gas sector and the limited participation of the private sector in other segments of the economy. Beck (2011) has argued that resource dependence in countries like Saudi Arabia and Nigeria can hinder financial sector development even when economic growth is strong. When growth is largely tied to commodity exports—as is the case with oil in Saudi Arabia—the financial sector may not develop in parallel, with investments and financial services concentrated in a few sectors rather than being spread across a broad economic base. This concentration can lead to shallow financial markets and limited financial deepening.

Furthermore, while monetary uncertainty generally harms financial deepening by eroding trust in financial institutions, encouraging capital flight, and fostering short-term speculative behaviour, it can also stimulate financial

development by promoting financial innovation, diversifying financial products, and increasing demand for hedging instruments. These responses are typically aimed at mitigating risk rather than directly driving financial deepening. Rajan (2006) also highlights that period characterised by instabilities, including monetary uncertainty, can lead to the "development of financial instruments designed to mitigate risk, thereby deepening financial markets."

Finally, the coefficient of the error correction term, which is less than one, correctly signed, and statistically significant at the 1 percent level, indicates that approximately 41.67 percent of deviations from the long-run equilibrium in financial deepening are corrected in a year.

4.4. Post-Estimation Diagnostics and Model Stability Test Results

To evaluate the appropriateness of the NARDL model for policy analysis, a series of diagnostic tests were conducted. These tests included the Ramsey RESET test for detecting any specification errors in the model, the Jarque-Bera test for normality of the residuals, the Breusch-Pagan-Godfrey test for heteroscedasticity, and the Breusch-Godfrey test to check for serial correlation. The purpose of these assessments was to ensure that the model met key assumptions of classical regression analysis, namely that the model is properly specified, normally distributed, and the errors are homoscedastic and serially uncorrelated. The outcomes of these tests, presented in Panel C of Table 4, confirm that the model does not suffer from misspecification issues, heteroscedasticity, or serial correlation, and that the residuals follow a normal distribution. Moreover, stability over time is supported by the CUSUM and CUSUMSQ plots depicted in Figures 1 and 2, which illustrate that the model parameters have remained consistent throughout the period analysed.

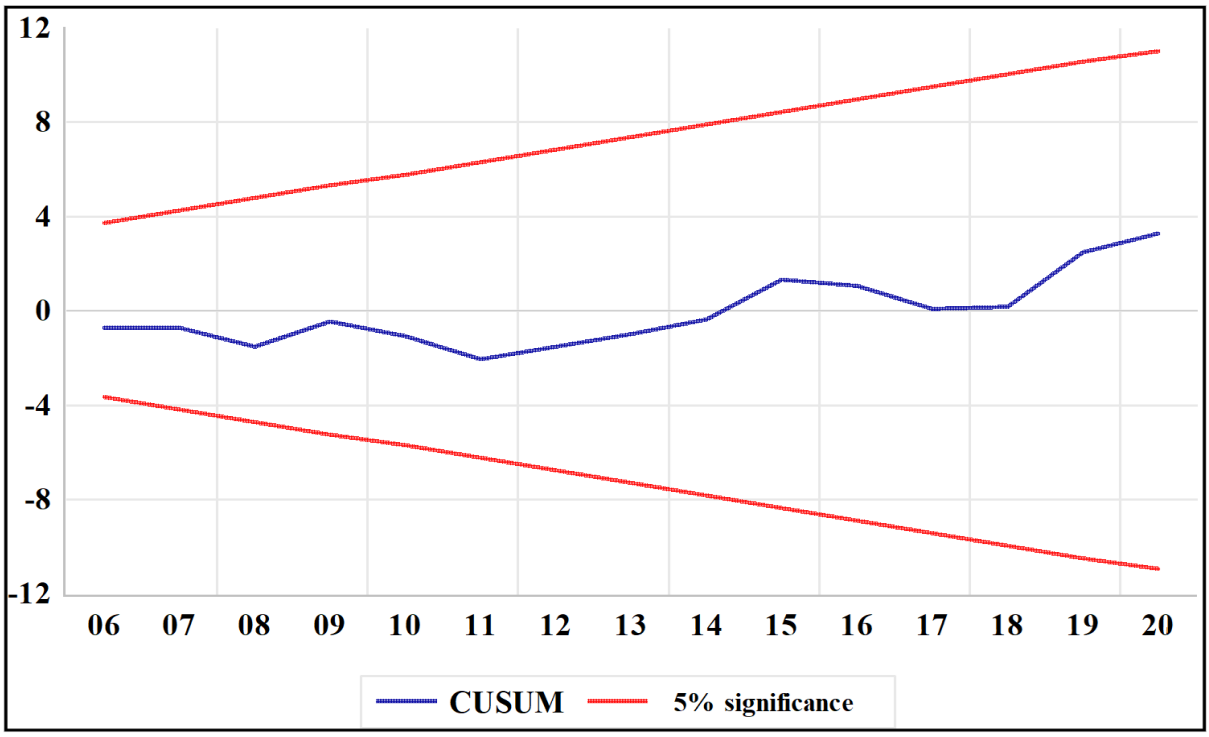

Figure 1. Graph of CUSUM statistics for the Saudi financial deepening model.

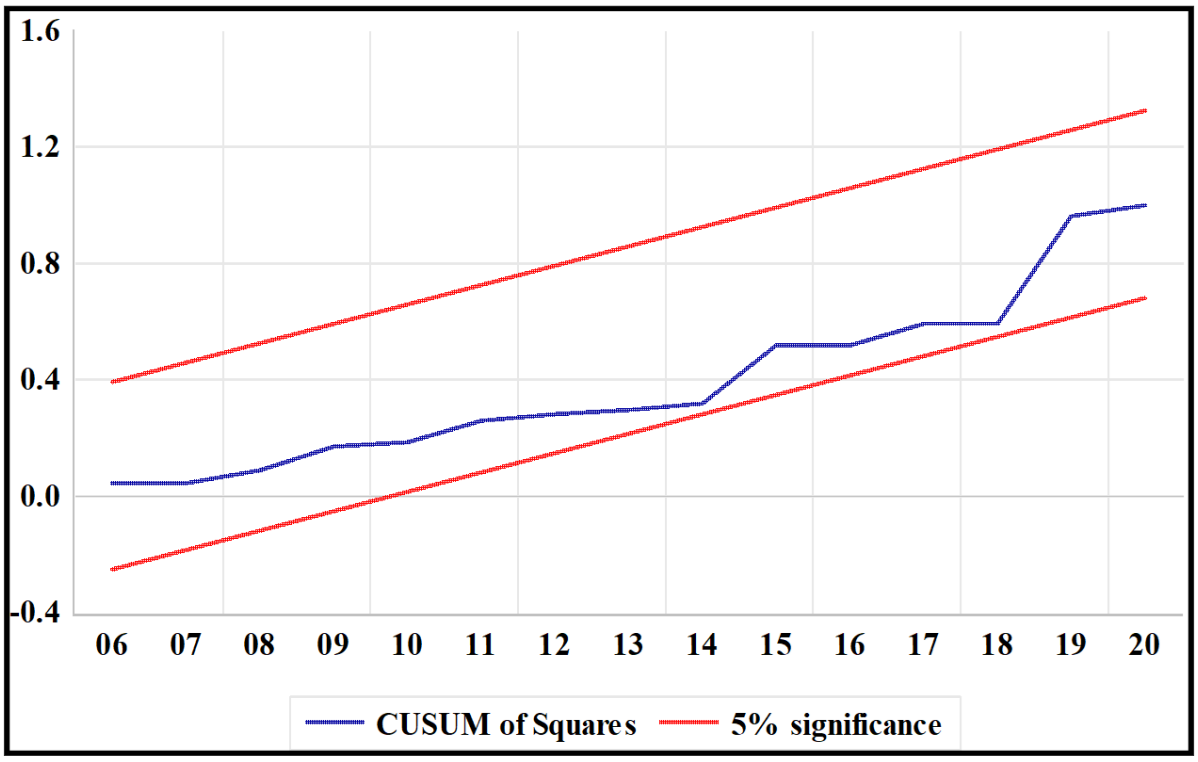

Figure 2. Graph of CUSUMSQ statistics for the Saudi financial deepening model.

5. CONCLUSION AND RECOMMENDATIONS

This research investigates the asymmetrical influence of monetary policy on financial deepening in the Kingdom of Saudi Arabia from 1992 to 2022, employing the NARDL bounds-testing estimation technique. The analysis reveals a robust long-term cointegration relationship among financial deepening and the partial sums of monetary policy regulation, along with the incorporated control variables. Overall, the evidence shows that monetary policy regulation affects financial deepening differently in the long and short run. Specifically, while both positive and negative changes in monetary policy regulation stimulate financial deepening, positive changes have a larger impact. This suggests that enhanced financial sector regulation improves performance rather than impeding growth, likely due to increased public confidence in the sector. Additionally, monetary uncertainty and the scale of economic activities significantly influence the degree of financial deepening in the Kingdom.

We propose several recommendations in light of these findings. First, given the positive relationship between both components of monetary policy and financial deepening, monetary authorities should continue to use monetary policy tools to promote sectoral development. For example, adjusting interest rates directly affects credit availability: lowering costs can encourage borrowing, stimulate business activities, and boost investments in financial markets. This, in turn, deepens the financial sector by increasing demand for financial products and services. Moreover, maintaining low and stable inflation through prudent monetary policy preserves the currency's purchasing power, thereby encouraging savings and investment. A stable inflation environment builds confidence among investors and consumers, paving the way for the growth of long-term financial instruments such as bonds and equities.

Second, considering the observed negative association between financial deepening and economic performance, the government should intensify efforts to reduce the economy's heavy reliance on the oil and gas sector. Diversification across both the financial system and the broader economy is crucial for ensuring balanced and sustainable growth. Policies aimed at promoting non-oil sectors will not only enhance the resilience of the financial system but also contribute to overall economic stability and development. Third, although monetary uncertainty appears to have a short-term positive influence on financial deepening, its effects are primarily risk-mitigating and may not contribute to sustained development. Therefore, monetary authorities should strive to minimize uncertainty

by implementing transparent and consistent policy measures. Reducing uncertainty will help create a stable environment that supports long-term financial deepening and overall economic performance. Lastly, the policy implications of these findings extend beyond monetary adjustments. In light of ongoing economic reforms and changing global conditions, it is crucial for policymakers to implement an all-inclusive approach that integrates monetary, fiscal, and structural policies. By coordinating efforts across these areas, Saudi Arabia can build a more resilient financial system and stimulate comprehensive economic growth. In practice, this means aligning monetary policy with fiscal initiatives and structural reforms aimed at enhancing competitiveness, boosting investor confidence, and ultimately ensuring the sustainable development of the financial sector.

While this study makes a novel contribution by exploring the asymmetric association among financial deepening and monetary policy adjustments in Saudi Arabia, it is not without limitations. The primary limitations of the study include the focus on a single country, the specific timeframe, and the empirical strategy adopted. Nevertheless, these limitations do not detract from the study's policy relevance or its unique contributions. Future research could address these limitations by extending the analysis to other GCC countries, which share similar social, economic, and policy environments, to boost the generalizability of the outcomes. Researchers might also want to look at other macroeconomic factors, such as fiscal policy measures, external economic shocks, or the state of the world's financial markets, and see what effects different monetary policy regimes have, especially since Saudi Arabia is currently undergoing economic reforms and global conditions are changing. Such studies would add to a robust understanding of the dynamics among monetary policy and financial deepening, thereby informing more effective policy interventions.

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