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The Interaction between policy mix in Lebanon: Applications of the Nonlinear and linear ARDL models

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Abstract:
This study investigates the interaction between fiscal and monetary policies in Lebanon over the period 2001 to 2019 by using Autoregressive Distributed Lag (ARDL) and the Nonlinear Autoregressive Distributed Lag (NARDL) model introduced by Pesaran et al. (2001) and Shin et al. (2014) respectively in order to examine simultaneously the short- and long-run symmetric and possible asymmetric interactions between fiscal and monetary tools in Lebanon. The fiscal and monetary rules employed in this study are inspired from Leeper (1991, 2016 and 2018). Based on NARDL and ARDL fiscal and monetary reaction functions, Lebanese fiscal authority acts independently indicating a fiscal dominance. This situation obliged the BDL to neglect its main goal of maintaining price stability in order to support fiscal deficit by creating *seigniorage* revenue to balance the government accounts which in turns has led to an acceleration of inflation rates even in case of monetary contraction. The fiscal responsiveness to changes in public debt is extremely weak in Lebanon, and even is negative, and this is due to the high levels of public debt (174.3% of GDP in 2019). The empirical results indicate also that while the linear approach provides evidences of the interaction between the fiscal and monetary policies, the nonlinear approach provides more important evidences to determine in which direction this cooperation or conflict occurs between policy mix. Moreover, this paper provides new evidences of the absence of fiscal and monetary discipline rules followed by the fiscal and monetary authorities, which indicates that the policymakers in Lebanon were managing the financial and monetary policies without any specific plan or program and without any future vision or even a framework that allows these policies to be evaluated.
Key words: monetary policy, fiscal policy, policy mix, policy coordination, policy rules, symmetric Cointegrating Relationships, Asymmetric Cointegration; Asymmetric Dynamic multiplier; linear ARDL ECM-based Estimation; Nonlinear ARDL ECM-based Estimation.

1. Introduction

The autonomy of the central bank means the separation of the monetary actions from the fiscal policy of the government, but this is not a complete separation, as each monetary measure has fiscal consequences. During periods of hyperinflation which is associated with high interest rates or long periods of weak inflation rate (or deflation) and very low interest rates (close to zero), the coordination between policy mix is required (Sims, 2016).

Thus, the effective pursuit of the objectives of prices stability and sustainable economic growth requires close coordination between fiscal and monetary authorities. Fiscal and Monetary policies work over different periods as central bank adjusts periodically its monetary policy and economic agents react faster to its measures, whereas fiscal authority takes time to adjust its tools and economic agents respond with delay to it. In addition, monetary and fiscal measures are designed and implemented by different official institutions, each with its own goals, resources, limits, incentives and strategies (Laurens & Piedra, 1998).

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The private sector expects policy makers to pursue uncoordinated policies. Mainly when the fiscal authority continues to postpone the required fiscal adjustments, while the central bank insists that price level stability must be maintained, and remains committed to increase interest rates to stabilize it. These non-coordinated policies reflect a disharmony between the fiscal and monetary authorities on whether inflation should or should not be used to stabilize debt (Bianchi, F. & Melosi, L., 2017).

For this, it is necessary to attain a close level of coordination between policy mix. Without effective coordination of the policy mix, economic instability can occur causing high volatility and pressures in interest rates and exchange rates associated with rapid inflation, and negative impacts on economic activity (Laurens & Piedra, 1998) as happened recently in many developed countries (Japan and euro zone for example).

In general, Central banks attempt to attain economic growth along with a low and stable price level. Central banks, especially in developed countries, seek for stable inflation rate. For example, the European Central Bank (ECB), the Federal Reserve of the United States of America (fed), and the Bank of Japan (BoJ) aim for inflation target close to 2% (de Haan, J.; et al., 2016).

In addition, macroeconomic policies aim to achieve two main goals: stabilization of the Price-level and the public debt. Monetary and fiscal authorities have many other goals as well, but if they fail to achieve these two minimum tasks, they will not be able to pursue other economic goals. If the policy mix implemented cannot stabilize the public debt, it can grow where it is difficult for the government to repay its obligations.

In this situation, the government will find it difficult to obtain the necessary funding from the financial markets. The lack of ability to borrow makes fiscal authority incapable to pursue counter-cyclical policy through public spending and/or taxes (Leeper, 2016).

For this reason, policy mix must interact within a well-defined framework. Monetary and fiscal authorities cannot operate separately of each other. Understanding the nature of this relationship is essential and crucial to develop effective policy rules (Leeper, 2018).

1.1 Lebanon: Economical Background

As most central banks, the essential mission of the Central Bank of Lebanon (BDL) is to ensure the stability of the price level. To reach this goal, the BDL uses all the measures it considers appropriate to preserve the stability of the exchange rate of the Lebanese lira (LBP) against the US dollar (USD) (Banque Du Liban - Role & Function, n.d.).

The economic crisis and hyperinflation during the 80s and the beginning of 90s have forced the BDL to fix the exchange rate of its national currency in order to attenuate the inflationary pressures resulting from imported inflation. Therefore, the Lebanese Central Bank has conducted a stabilization policy based on the stability of the LBP exchange rate by fixing the exchange rate of the Lebanese lira within a very tight range (± 0.5%), around a rate of 1507.5 pounds per US dollar since November 1998 (DESQUILBET, 2007).

The BDL conducts a monetary policy entirely dedicated to stabilizing the exchange rate of its national currency against the US dollar. For this reason, the BDL uses treasury bonds as main monetary tool in order to stabilize the LBP exchange rate by controlling the money supply in circulation (Mouley, 2012).

Wider fiscal deficits, weak economic growth, and higher interest risk premium due to the Syrian conflict since 2011 have had a severe negative effect on the overall economic situation of Lebanon especially on its debt-to-GDP ratio.

The Lebanese government's budget records a huge and chronic public deficit. Political paralysis sharply worsened decision-making in Lebanon. Budget spending and infrastructure investments have been driven by considerations of confessional quotas and 'electoral geography' rather than real economic needs (Le Borgne, E.; Jacobs, T., 2016).

In addition, Lebanon is considered as a country characterized by internationalization of internal conflicts as the Lebanese economy has been repeatedly affected by major local and regional conflicts (Verne, 2016).

1.2. Lebanon's economic crisis

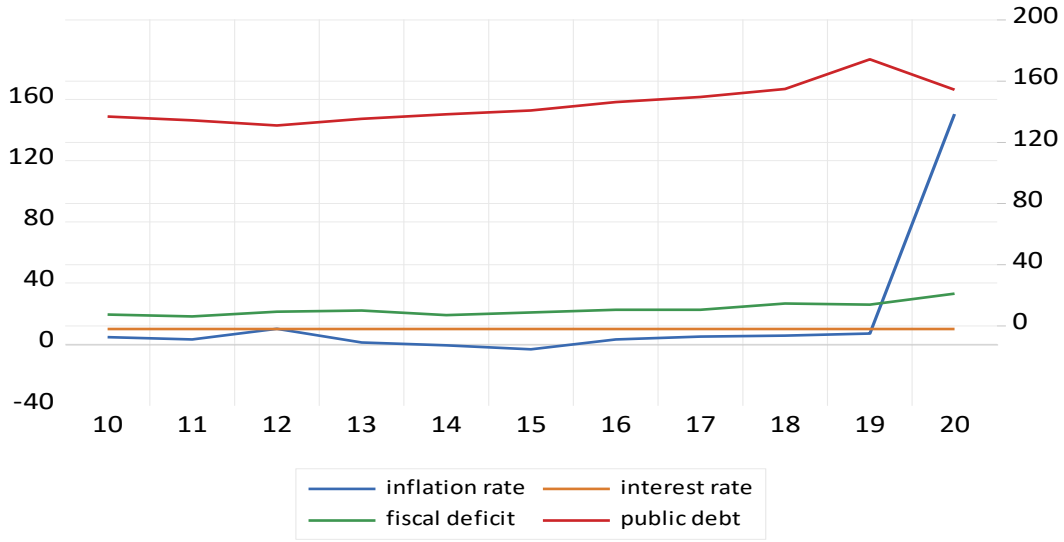
Lebanon has been exposed to successive crises, an economic, financial and monetary crisis, associated with full lockdown of the economy as a result of Covid-19, and finally the blast of the Port of Beirut in August 2020. In addition, Lebanon was due to repay a $1.2 billion Eurobond on March 9, 2020, while another $700 million matured in April 2020 and another $600 million in June 2020.

Because of these severe challenges, Lebanon defaulted on $4.4 billion that was due to be repaid in 2020. Lebanon's public debt burden, one of the largest in the world, is now equals nearly 170% of GDP (Abdo, N.; et al., 2020).

These successive crises have had a severe negative effects on Lebanese economy, as Lebanon suffers from a severe and chronic economic depression where its real GDP growth reached -25% in 2020 and inflation rate reached 150% (according to IMF), while the exchange rate of the national currency continues to lose its value against the US dollar.

Eurobond default has prevented the Lebanese government to access to international financial markets, while the national banking system is severely weakened and has stopped lending, making the economic situation worse. Informal and *ad hoc* capital controls has led to huge popular backlash against banks and central bank. In addition, the economic and financial crisis has led to a severe increase in Lebanon's public debt ratio to GDP, which is on an unsustainable path (World Bank Group, 2020).

Figure 1: Evolution of Public debt (% of GDP), fiscal deficit (% of GDP), inflation rate (% change in CPI) and interest rate 2010-2020



Source: Compiled by the authors, based on IMF database

Analysis of the above graph shows that government debt (displayed on the secondary vertical axis) in Lebanon has essentially increased throughout the sample period following the military conflict in Syria that started in 2011, and reached historically high levels leading to severe sovereign debt sustainability concerns.

The Lebanese economy has been exposed to the growing debt crisis, fiscal deficit and acceleration of inflation rates (see Figure 1).

As seen above, the change in interest rate did not take into account the change in inflation rates. Moreover, the fiscal policy did respond adequately to the changes in public debt.

The interest rate has remained relatively constant, and its changes have clearly not been enough to slow inflation.

Moreover, the government's fiscal policy did not provide sufficient support for BDL's policy to contain inflationary pressures, which gives an indication of the lack of coordination between the financial and monetary authorities in Lebanon.

Besides this introduction, this paper is organized as follows: Section 2 presents the research problem. Section 3 summarizes the monetary and fiscal rules through the theoretical literature review. Section 4 presents the empirical literature. Section 5 outlines the empirical methodology and the source of the data. The empirical results are reported in section 6, and section 7 reports the concluding remarks and the policy path.

2. Research Problem

In order to achieve the main economic goals, the coordination, or at least the absence of conflict, between the central bank's policy and that of the government is crucial. The coordination between these two policies is necessary to achieve sustainable economic growth, low inflation and stabilization of public debt. However, their goals are generally different. Given these different objectives, conflict may arise. These policies are also independent in making their decisions (the Central Bank has its own autonomy established by law) (Janku & Kappel, 2014).

The independence of Central Banks can put the monetary and fiscal authorities in a difficult situation, where each pursues its own goals, without carrying to the consequences on the economy. Thus, the independence of central banks raises problems of coordination between the monetary and the fiscal authorities (DESQUILBET, J.-B., & VILLIEU, P., 1998).

Therefore, monetary policy has to take into account other economic indices as well as the behavior of the fiscal policy. The monetary authority takes the first step and the fiscal policy follows it. Because the central bank can change its instruments quickly, while the government follows a budget that includes its plan every year, in addition to that the government's procedures require the approval of Parliament and may be obstructed by internal political problems (Janku & Kappel, 2014).

Monetary policy actions always have fiscal consequences and how the government responds to those consequences is important for the definitive effects of monetary actions. The rule applied by the fiscal authority to ensure debt stability is essential to the monetary authority's ability to achieve its goals (Leeper, 2018).

For these reasons, it is important to determine whether the policy mix in Lebanon exists in the framework of coordination or in conflict and to analyze and evaluate the performance of the fiscal and monetary authorities regarding the stability of the price level and public debt.

In order to meet this goal, this study aim to answer the following questions: does fiscal policy is responsiveness to changes in public debt? does monetary policy of the BDL tend to react sufficiently to changes in inflation rates? does fiscal and monetary policies in Lebanon work in coordination or in conflict?

3. Literature Review

The debate over the interactions of the policy mix is an old subject and has been the subject of extensive discussion in macroeconomics between monetarist and Keynesian schools (Khalid, Norlin; Marwan, Nur Fakhzan, 2012).

There are numerous theoretical and empirical studies related to the effectiveness and the interaction of the policy mix in achieving main economic goals which will be presented in the following sections.

3.1. Theoretical framework

There are many monetary and fiscal rules which the economic policymakers can follow to reach their goals. In this section, various fiscal and monetary rules will be presented which allow to derive the optimal fiscal and monetary reaction functions which make it possible to guide the fiscal and monetary authorities in order to prevent any conflict between them.

3.1.1. Inflation targeting rule

Since the 90s, several central banks (Bank of Canada, Bank of England, Bank of Sweden, Bank of Poland, Bank of Finland and Bank of Australia) have explicitly adopted target inflation targeting (Siklos, 1999).

A strict inflation targeting rule indicates how the monetary authority modifies its interest rate to achieve the desired inflation goal. This rule has the following form: $i_t = i_{t-1} + \partial(\pi_t - \pi^*)$ (1)

Where i_t and i_{t-1} are the nominal interest rates determined by the central bank in period t and t-1, respectively. ∂ is a feedback term that increases (or decreases) i_t when actual inflation π_t is above (or below) the central bank's goal π^* (McKibbin, W. J. et al., 2017).

3.1.2. McCallum's rule

McCallum prefers the monetary base which seems easier and more direct in its connection to nominal GDP (McCallum, 1988). The central bank can intervene daily in order to influence nominal GDP on a monthly or quarterly basis (Durand & Payelle, 1998). More precisely, McCallum's rule indicates that the central bank affects the growth rate of the monetary base so that nominal output increases at a non-inflationary rate that corresponds to the long-run growth rate of real output (BIKAI, J. L. & MBOHOU M., M., 2016).

Therefore, the central bank adjusts its monetary policy based on the gap between potential GDP and actual GDP, based on the following rule: $\Delta mb = \Delta y^* - \Delta v_t + \varphi(\Delta y^* - \Delta y_t)$ (2)

Where Δmb is the growth rate of the monetary base; Δv_t is the velocity of money; $(\Delta y^* - \Delta y_t)$ is the gap between potential GDP and actual GDP, respectively; φ is the central bank's reaction coefficient to the output gap.

3.1.3. Henderson-McKibbin-Taylor Rules

Henderson-McKibbin Taylor (HMT) rule is a monetary rule that states how a central bank adjust systematically its interest rate to the changes in inflation rate and economic activity growth (McKibbin, W. J. et al., 2017). Thus, the monetary policy provides the nominal anchor to ensure that the inflation rate is at its target level (Chibi, A., Benbouziane, M., & Chekouri, S.M., 2019).

It has the following form: $i_t = i_{t-1} + \alpha(\pi_t - \pi_t^*) + \beta(y_t - y_t^*)$ (3)

Where i_t is the nominal interest rate at time t; $(\pi_t - \pi_t^*)$ is the difference between the current inflation rate π_t and its target level π_t^*; $(y_t - y_t^*)$ is the output gap; α and β are coefficients of the inflation and the output gap, respectively.

According to (Taylor, 1993), if current inflation exceeds its target rate, the nominal interest rate must rise in order to ease inflationary pressures and avoid overheating the economy, which puts downward pressure on wages and prices until inflation returns to its target rate (Levin, 1996).

The taking into account of smoothing interest rate led to a modification of the original Taylor rule into a "backward-looking rule[1]" (Williams, 1999).

It has the following form: $i_t = \rho i_{t-1} + (1-\rho)[\pi_t + r_t^* + \alpha(\pi_t - \pi_t^*) + \beta(y_t - y_t^*)]$ (4)

Where ρ is the degree of interest rate smoothing. r^* is the long-run equilibrium real interest rate. A necessary condition to stabilize the inflation rate is $\alpha > 0$.

This rule allows also for interest-rate smoothing if $\rho \neq 0$ (Muscatelli, A.; Tirelli, P. & Trecroci, C., 2005).

3.1.4. Fiscal rules

The classic fiscal rule is the simple balanced budget rule (Burger, P. & Marina, M., 2012). The developments in the literature concerning the interaction between the policy mix and the rules that must be followed have led to take into account the role of fiscal rules when implementing the monetary policy (Leeper, 1991), (Sims, 1994), and (Woodford, 1995, 2001). The Fiscal Theory of the Price Level (FTPL) is the claim that the price level is determined by fiscal measures instead of monetary measures (Farmer, R. E.A. & Zabczyk, P., 2019).

To maintain the level of real debt over the long term (i.e. fiscal sustainability), the government follows the following tax rule (Bohn, 1998): $pb_t = k.d_t + \varepsilon_t$ (5)[2]

[1] Some authors used monetary rule for the nominal interest rate that follows a "forward-looking Taylor rule" specification by including expected inflation π_{t+n} instead of current inflation π_t (see Clarida, Galí and Gertler, 1998, 2000; Muscatelli, Tirelli and Trecroci, 2002; Galí and Perotti (2003); Giannoni and Woodford, 2003; Muscatelli Anton; et al., 2005).

[2] Where the government debt-to-GDP ratio takes the following form: $d_t = d_{t-1} + i_t d_{t-1} - pb_t$

Where pb is the primary balance[1] to GDP ratio, d is the public debt-to-GDP ratio, k is the coefficient that measures the responsiveness of the primary balance to the changes in debt, *i* is the nominal interest rate on treasury bonds, and ε is the error term that contains the random shocks (Checherita-Westphal, C. & Žďárek, V., 2017).

Knowing that financial sustainability is in general related to the trajectory over the long term of public debt to GDP ratio. Thus, the fiscal reaction function should take into account the reaction of the primary balance/GDP to the changes in public debt/GDP ratio (Burger, P. & Marina, M., 2012).

To determine whether the fiscal authority has responded to maintain its debt-to-GDP stable, the following equation allows us to assess of the government's behavior toward this goal: $pb_t = k.d_{t-1} + \varepsilon_t$ (6)

Equation 6 can be augmented to take into account a one-lag period of the primary balance as in (Boris Hofmann, et al., 2021; Katia Berti, et al., 2016).

In addition, a constant coefficient (α_0) can also be added to equation 6 as in (De Mello, 2005). Then, the fiscal reaction function takes the following form:

$pb_t = \alpha_0 + \alpha_1 pb_{t-1} + \alpha_2 d_{t-1} + \varepsilon_t$ (7)

3.1.5. The optimal policy-mix combination

Fiscal and monetary policies have two main goals: determining the inflation rate and stabilizing the public debt, thus it is necessary to know how an optimal combination of policy-mix allows to achieve them (Leeper, 2016).

To provide a model that allows to determine the reaction of one policy on actions of the other policy, we can rely on Leeper (1991, 2016 and 2018) that reflects the interactions between the main tools of the policy mix. New Keynesian economists categorize the different combinations of the policy-mix as active or passive polices (Roger E.A. Farmer and Pawel Zabczyk, 2019).

Monetary policy is said to be active when the nominal interest rate increases on a more than one-for-one basis (real interest rate rises when inflation rises) in order to reduce the excess demand and prevent an increase in inflation rate above its target.

Whereas, fiscal authority increases taxes when real public debt rises in order to cover real debt service and ensure government solvency. This combination is called "Regime M" which shows an "**Active Monetary and Passive Fiscal Policy".**

The opposite combination overturns the tasks, which makes the fiscal policy determine the price level and monetary policy stabilizes the debt. This combination in known as "Regime F" which shows a "**Passive Monetary and Active Fiscal Policy"** (Leeper, 1991 and 2016).

Under these 2 regimes, the following policy rules are employed by the monetary and fiscal authorities:

Monetary Policy: $i_t = \bar{\imath} + \alpha(\pi_t - \pi^*) + \varepsilon_t^i$ (8)

Fiscal policy: $T_t = \bar{T} + \delta(b_{t-1} - b^*) + \varepsilon_t^\tau$ (9)

Where i is the interest-rate instrument, π_t and π^* are actual and target inflation, T is tax revenues net of transfers as a ratio of GDP, b_{t-1} and b^* are actual and target debt-GDP levels. The ε terms are exogenous changes in policy instruments.

Lack of Coordination occurs when central bank conducts an active monetary policy and that the fiscal authority disregards the level of debt, thus these two policies are in conflict.

Consequently, when the inflation rate rises, an aggressive monetary contraction leads to an increase in the debt service (i_t) and hence to fiscal imbalances.

In this case, the fiscal rule implies that tax authority must adjust taxes in a way that restores the level of public debt to the target level. Otherwise, the failure of the financial authority to respond to the changes of the public debt would call for debt stabilization through inflation (Bianchi, Francesco and Melosi Leonardo, 2017).

[1] The government runs a primary deficit if pb is negative and surplus if pb is positive and primary balance if pb=0.

4. Empirical literature

Muscatelli Anton; et al., (2005) in a study entitled "Fiscal and Monetary Policy Interactions in a New Keynesian Model with Liquidity Constraints" presented a model to analyze the interaction between fiscal and monetary policies in an estimated New Keynesian DGE model. The main result of this study is the following: automatic stabilizers based on taxation policy seem to combine more efficiently with forward-looking inertial monetary policy rules than feedback government spending rules.

Dixit and Lambertini (2000, 2001) examined the interdependence between the fiscal policy and the monetary policy in a model where the central bank has only partial control over the price level, which is directly affected by the fiscal policy measures. They concluded that the two policy rules are complements when fiscal expansions have non-Keynesian effects on output and inflation.

Mélitz (1997, 2000)[1] and Wyplosz (1999)[2] examined the relationship between fiscal and monetary policies over the cycle based on Cross-sectional or panel data techniques and VAR analyses and they concluded that the two policies have acted in opposition (in conflict) over the last 2-3 decades (Loose fiscal policy associated with contractionary monetary policy).

von Hagen Hughes-Hallett and Strauch (2001) found that the interdependence between the two policymakers is asymmetric: looser fiscal measures associated with monetary contractions.

Orphanides Athanasios (2017) studied the reasons for the suboptimal fiscal-monetary policy mix in the euro area in the aftermath of the global financial crisis through a comparison of fiscal and monetary policies and of economic outcomes in the euro area and the United States. He found that the fiscal and monetary policies in the euro area had been inappropriately tight and had been contributing to greater divergence across member states of the euro union. Fiscal policy had been hampered by the institutional framework while the ECB monetary policy had been hampered by the distributional effects of balance sheet policies, which needed to be adopted at the zero lower bound.

Tomislav, Ćorić; et al. (2015) used a structural vector autoregression (VAR) model to analyze the possibilities of monetary and fiscal policy in achieving main economic policy goals, namely price stability and economic growth, in Croatia from 2004 to 2012. The main conclusion of the article is that coordinated measures of monetary and fiscal policies could achieve economic growth with price stability.

Bianchi Francesco; et al. (2020), in a paper entitled "Monetary and Fiscal Policies in Times of Large Debt: Unity is Strength", found that the coordinated fiscal and monetary strategy enhances the effectiveness of the fiscal stimulus and allows the Federal Reserve to correct a prolonged period of below-target inflation.

Bianchi, Francesco and Melosi Leonardo (2017) in a paper entitled "The Dire Effects Of The Lack of Monetary And Fiscal Coordination" studied the implication of the lack of coordination between the monetary and fiscal authorities and found that a coordinated commitment to inflate away the portion of debt resulting from a large recession leads to better macroeconomic outcomes by separating the issue of long-run fiscal sustainability from the need for short-run fiscal stabilization. This strategy can also be used to rule out episodes in which the central bank becomes constrained by the zero lower bound.

Enkhzaya Demid (2018), in a paper entitled "Fiscal and Monetary Policy: Coordination or Conflict?" examined the interaction between monetary and fiscal policies using annual panel data covering the period from 1991 to 2016 for 42 countries and found that central bank independence and inflation targeting are associated with more countercyclical monetary and fiscal policies and an increased degree of coordination between the two.

[1] Mélitz (2000) examined the interaction of fiscal and monetary policies in 19 OECD countries (including 14 EU countries) on annual data from 1959 or 1976 to 1995.
[2] Wyplosz (1999), in contrast to Melitz (2000), focused only on EU countries. He also works with annual data from 1980 to 1997.

Muscatelli Anton; et al. (2003) in a paper entitled "Fiscal and Monetary Policy Interactions: Empirical Evidence and Optimal Policy Using a Structural New Keynesian Model" examined the interaction of monetary and fiscal policies using an estimated New Keynesian dynamic general equilibrium model for the US. They concluded that the nature of the interaction between the two policy instruments should depend on the nature of the shocks hitting the system. In addition, they shown that, for the case of output shocks, fiscal and monetary policies tend to act in harmony, whereas they are used as substitutes following inflation shocks or shocks to one policy instrument.

von Hagen Jürgen and Mundschenk Susanne (2002) in a paper entitled "Fiscal and Monetary Policy Coordination in EMU" examined the interactions and potential conflicts between monetary policy and the national fiscal policies in EMU. The analysis shows that in the long run, monetary policy can achieve price stability without interfering with fiscal policies. But, in the short run, there is a potential conflict between monetary and fiscal policies, as both interact in the determination of aggregate demand in the monetary union.

Combes Jean-Louis; et al. (2017) in a paper entitled "Inflation Targeting, Fiscal Rules and the Policy Mix: Cross-effects and Interactions" examined how inflation targeting and fiscal rules affect inflation and fiscal performance in a large panel of countries during 1990–2009. Their findings suggest that inflation targeting and fiscal rules affect the coordination of the policy mix, and point to potential benefits of reforming macroeconomic frameworks in a comprehensive manner.

Kuncoro Haryo and Sebayang Dianta (2013) in a paper entitled "The dynamic interaction between monetary and fiscal policies in Indonesia" examined the dynamic interaction between monetary and fiscal policies in Indonesia for the period of 1999-2010. They found that in the short term monetary policy reacts as expected to the fiscal policy. On the other hand, fiscal policy marginally reacts to the monetary policy so that fiscal sustainability will be more difficult to attain given the opposite response of governments to public debt shocks.

Marcos Valli and Fabia Carvalho (2010) in a paper entitled "Fiscal and monetary policy interaction: a simulation based analysis of a two-country New Keynesian DSGE model with heterogeneous households", using a DSGE model, found that an important endogenous interaction of monetary policy conditions with fiscal policy responses, although policy rules are not directly responsive to one another. Increasing fiscal commitment to the stationary debt-to-GDP ratio enhances the contraction's impact of a monetary policy shock upon inflation, albeit at the cost of a higher impact on output growth in the medium-run. A higher commitment to the inflation target in the monetary policy rule reduces the variance of inflation and output growth, and their correlation, with the drawback that the fiscal shock gains importance in affecting the variance of inflation.

Çebi Cem (2011) in a paper entitled "The Interaction between Monetary and Fiscal Policies in Turkey: An Estimated New Keynesian DSGE Model" studied the fiscal and monetary policy interactions and their role in stabilization of the economy using a DSGE model and found that the monetary authority reacts to inflation but only weakly reacts to the output gap. The degree of interest rate smoothing is high. Fiscal policy has contributed to the debt stabilization but there is no evidence on active fiscal stabilization of output gap.

Silva Mário (2018) studied monetary and fiscal policies interactions, under different policy regimes using DSGE model for the Brazilian economy and found that under monetary dominance, the central bank should fiercely pursue its targets while the fiscal authority should consider its objectives carefully not to cause instability in the economy's product and prices; and under fiscal dominance, the central bank should accommodate for fiscal policy and public debt trajectory while it carefully chooses its responses to inflation, so that it does not cause higher inflation variances.

Janků Jan and Kappel Stanislav (2014) examined the Interaction of Monetary and Fiscal Policy in the Countries of the Visegrad Group using reaction functions to assess whether the monetary and fiscal policies in these countries are in coordination or in conflict and found that in the case of the Czech Republic, Slovakia and Poland, monetary policy appears to play the dominant role, whereas fiscal policy plays dominant role in Hungary.

Ruoyun Mao and Shu-Chun S. Yang (2020) studied government spending effects under different monetary-fiscal policy regimes in a nonlinear New Keynesian model and found that government spending multipliers under passive monetary policy can be lower because of higher debt levels, longer debt maturity, higher distorting tax rates, more responsive monetary policy to inflation, and the existence of policy regime uncertainty.

Cristina Checherita-Westphal and Václav Žďárek (2017) studied the topic of fiscal sustainability by employing a "fiscal reaction function" (FRF) to euro area economies (EA-18) for the period 1970–2013. They found evidence that euro area sovereigns abide, on average, by (weak) sustainability constraints. The primary balance improves by about 0.03–0.05 for every 1 percentage point increase in the debt-to-GDP ratio after controlling for other relevant factors. The positive reaction of primary surpluses to higher debt strengthened over the crisis.

Boris Hofmann, et al. (2021) studied fiscal and monetary policy with stochastic model simulations and scenario simulations when interest rate policy is hampered by the zero lower bound and found that the systematic use of countercyclical quantitative easing (QE) by the central bank can mitigate the zero lower bound, yielding more stable inflation and output. It also contributed to more stable fiscal deficits and public debt levels, as QE takes some of the burden off fiscal policy.

Tenreyro, Silvana and Thwaites, Gregory (2016) found that monetary policy shocks have more powerful effects on prices during economic expansions than during recessions implying asymmetric effects of monetary policy on price level. Fiscal policy offsets monetary policy more in recessions than in booms.

Katia Berti, et al. (2016) estimated country-specific fiscal reaction functions (FRFs) for selected European countries and tests for a change in fiscal behavior since the beginning of the economic and financial crisis. The estimated country-specific FRFs are used in medium-term projections of the public debt-to-GDP ratio. They found that most EU countries are found to positively adjust their fiscal policy to rising levels of public debt, although to a weak extent in some cases. Since 2009, fiscal responsiveness to public debt appears to have generally increased over the sub-sample of EU countries considered.

Tito Belchior S. Moreira et al. (2021) studied the monetary and fiscal policies implemented in Brazil in the period between November 2002 and December 2015 using Markov-switching model. The empirical results suggest that there are indications of coordination or attempted coordination between fiscal and monetary policies, as well as signs of lack of coordination between them, especially when there is a clear conflict of interest between the two. The results of this conflict of interest between economic policies were recession, fiscal deterioration and high rates of inflation. The results obtained indicate that fiscal dominance occurred in 2010 and between 2013 and 2014, while monetary dominance marked much of 2003 and the period 2005–2007.

António Afonso and Priscilla Toffano (2013) estimated fiscal and monetary reaction functions within a Markov switching framework for the U.K., Germany, and Italy, respectively. Their results showed the existence of fiscal regimes shifts. For instance, in the U.K., active and passive fiscal regimes are clearer cut, notably regarding the periods 1992-1996 and after 2007, when fiscal policy tended to be more active. In Germany fiscal regimes have been overall more passive, supporting more fiscal sustainability.

Previous studies have been shown to be relatively heterogeneous in terms of the empirical approach adopted. This paper therefore contributes to the existing fiscal and monetary reaction functions literature in the context of Lebanon.

In this paper, we make progress on this issue by focusing on the interactions of monetary and fiscal policies and rules taking into account the possibility of a linear and nonlinear interactions between the fiscal and monetary tools.

This study seeks to fill the gap in the literature dealing with the issue of potential presence of asymmetric effects of these two policies (i.e. contractionary and expansionary policies). The revealing of asymmetry in this relationship can provide useful information for economic policymaking and modelling, since fiscal and monetary measures have different impacts in the cases of positive (expansion) and negative (contraction) changes.

5. Empirical Methodology and Data

In order to assess empirically the performance of monetary and fiscal policy and analyze the mutual interaction between these policies in Lebanon, reaction functions based on monetary and fiscal rules were used to assess whether monetary and fiscal policies in Lebanon are in coordination or in conflict.

To analyze the interaction between monetary and fiscal policy in Lebanon, fiscal reaction function (FRF) and monetary reaction function (MRF)[1] were used. These reaction functions aim to identify the behavior of the BDL regarding its main goals and its sensitivity to the financial measures of the Lebanese government.

Accurate estimation of the FRF and MRF is crucial for macroeconomic policy analysis. For at least two issues, the first issue is related to the ability of fiscal policy to adapt to changes in public debt, and the second is its ability to provide adequate support for monetary policy, at least by not engaging in an activity contrary to the policy of the Central Bank.

The second matter is to determine whether the fiscal policy follows the rule of fiscal discipline and the monetary policy follows the rule of monetary discipline and the effectiveness of each of this policy in achieving the desired economic policy objectives.

As we have seen previously, the relevant previous studies did not take into account the possibility of asymmetric changes (i.e. nonlinearity changes) of policy mix. In other words, the empirical studies presented above did not take into account the separate effects of both expansionary and contractionary policies on each other and on determined goals.

Therefore, this study will attempt to fill this gap by taking into account the possibility of asymmetric effects of policy mix, and at the same time studying the commitment of each policy to the rules set for it as indicated by Regime M and Regime F.

For this reason, the Nonlinear Autoregressive Distributed Lag (NARDL) model developed by Shin et al. (2014) and Autoregressive Distributed Lag (ARDL) developed by Pesaran and Shin (1998) which are applied to capture simultaneously asymmetric and symmetric long and short-run effects respectively.

Shin et al. (2014) presented short-and long-run nonlinearities via positive and negative partial sum decompositions of the explanatory variables and provided a dynamic framework that is simple and flexible, and capable of modelling short-run and long-run asymmetries by estimating an Error Correction Model (ECM) without loss of long-term information.

They also derive asymmetric cumulative dynamic multipliers that permit the display of the asymmetric adjustment patterns following positive and negative shocks to the explanatory variables.

Both NARDL and ARDL can be applied even if the variables are not stationary at the same level (i.e. I(0) or I(1)) and are suitable for small samples regardless of the stationarity of the variables[2]. In addition, NARDL permits to derive asymmetric dynamic multipliers that graphically depict the traverse between the short- and the long-run (Shin et al., 2014).

5.1. Empirical Model

The fiscal and monetary rules employed in this study are inspired from Leeper (1991, 2016 and 2018). The model of this study has the following two reaction functions:

$$\text{FRF: } f_t = \alpha_0 + \alpha_1 i_t + \alpha_2 b_t + \varepsilon_t^f \quad (10)$$

Where FRF means fiscal reaction function. f_t is the real fiscal deficit to GDP ratio[3] at time t. i_t is the BDL rate (interest rates) at time t. b_t is the real debt-to-GDP ratio at time t.

[1] Also known as "Central Bank Reaction Function".
[2] The estimation is valid irrespective of whether the underlying regressors are I(0), I(1) or mutually cointegrated (Pesaran and Shin, 1998; Pesaran et al., 2001; Shin et al., 2014).
[3] Primary deficit excludes interest expense. On the other hand, the fiscal deficit takes the interest expense into account, thus we can capture the effects of raising (or lowering) the interest rates by the Central Bank on the public debt and thus on the performance of the government's fiscal policy.

α_0, α_1, and α_2 are the coefficients of the FRF. ε_t^f denotes an error term of the FRF and is assumed an *i.i.d.* exogenous shock with zero means and finite variances.

According to this fiscal rule, the government adjusts fiscal deficit to respond to the changes in public debt and, at the same time, helping central bank's policy to achieve its goals while stabilizing debt. Moreover, it can be seen that a monetary contraction brings fiscal imbalances by increasing the debt service.

From Eq. (10), if the relationship between the variables is assumed to be linear and $\alpha_2 < 0$, then the fiscal policy follows a fiscal rule indicating that fiscal authority is taking the necessary adjustments to contain any increase in public debt by increasing taxes and/or decreasing public expenditures. Also, if $\alpha_1 < 0$, then fiscal policy supports the central bank policy indicating coordination between fiscal and monetary authorities.

The Central bank reaction function takes the following form:

$$\text{MRF: } i_t = \beta_0 + \beta_1 f_t + \beta_2 \pi_t + \varepsilon_t^i \quad (11)$$

Where MRF means monetary reaction function. π_t is the current inflation rate measured by Consumer Price Index (CPI_{2010}=100).

β_0, β_1 and β_2 are the coefficients of MRF. ε_t^i denotes an error term of the MRF and is assumed an *i.i.d.* exogenous shock with zero means and finite variances.

According to this monetary rule, an increase in inflation in Eq. (11) reduces the real burden of government debt in Eq. (10). This link makes monetary policy and fiscal policy interdependent (Bianchi, Francesco and Melosi Leonardo, 2017).

From Eq. (11), if the relationship between the variables is assumed to be linear and $\beta_2 > 0$, then the monetary policy follows a monetary rule. Also, if $\beta_1 < 0$, then monetary policy takes into account the fiscal measures of the government indicating coordination between monetary and fiscal policy.

Having defined the variables in equation (10) and (11), we apply the linear ARDL cointegration approach of Pesaran et al. (2001), which considers both the short-run and long-run symmetric effects of the independent variables on the dependent variable.

Therefore, we transform the model in equation (10) and (11) to the linear ARDL approach of Pesaran et al. (2001) expressed in equation (12) and (13), respectively.

In order to examine the short-run and long-run symmetric (or linear) interactions of the fiscal and monetary policies, the ARDL(p,q) representation for the fiscal reaction function ($ARDL_{FRF}$) takes the following specification:

$$\Delta f_t = \alpha_0 + \alpha_1 f_{t-1} + \alpha_2 i_{t-1} + \alpha_3 b_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta f_{t-j} + \sum_{j=0}^{q} \eta_{1j} \Delta i_{t-j} + \sum_{j=0}^{q} \eta_{2j} \Delta b_{t-j} + \varepsilon_t^f \quad (12)$$

Where α_0 represents the intercept (i.e. the constant term); α_1; α_2 and α_3 are the long-run coefficients; γ_j; η_{1j} and η_{2j} are the short-run coefficients; p and q denote the lag-length; ε_t^f denotes an error term.

To complete our model, the ARDL(p,q) representation for the monetary reaction function ($ARDL_{MRF}$) takes the following specification:

$$\Delta i_t = \beta_0 + \beta_1 i_{t-1} + \beta_2 f_{t-1} + \beta_3 \pi_{t-1} + \sum_{j=1}^{p} \varpi_j \Delta i_{t-j} + \sum_{j=0}^{q} \xi_{1j} \Delta f_{t-j} + \sum_{j=0}^{q} \xi_{2j} \Delta \pi_{t-j} + \varepsilon_t^i \quad (13)$$

Where β_0 represents the intercept (the constant term); β_1; β_2 and β_3 are the long-run coefficients; ϖ_j; ξ_{1j} and ξ_{2j} are the short-run coefficients; p and q denote the lag-length; ε_t^i denotes an error term. The subscript (t) and (t-1) refers to the time dimension.

On the other hand, if the relationship is assumed to be Nonlinear, NARDL representation is used for both fiscal and monetary reaction functions.

To capture possible asymmetries effects between the variables of the model, NARDL decomposes each independent variable into two parts: 1) partial sum of positive changes; 2) partial sum of negative changes; and include both of them as separate repressors in the model.

So, in order to capture possible asymmetric interactions between fiscal and monetary policies. The NARDL representation used in this study for both fiscal and monetary reaction functions takes the following specifications:

$$\text{NARDL}_{\text{FRF}}: f_t = \alpha_0 + \alpha_1 i_t^+ + \alpha_2 i_t^- + \alpha_3 b_t^+ + \alpha_4 b_t^- + \varepsilon_t^f \quad (14)$$

$$\text{NARDL}_{\text{MRF}}: i_t = \beta_0 + \beta_1 f_t^+ + \beta_2 f_t^- + \beta_3 \pi_t^+ + \beta_4 \pi_t^- + \varepsilon_t^i \quad (15)$$

The models shown above are the general form of NARDL for fiscal (FRF) and monetary (MRF) reaction functions, respectively.

The following NARDL for fiscal and monetary reaction functions to be estimated have the following form:

$$\Delta f_t = \alpha_0 + \rho f_{t-1} + \theta^+ i_{t-1}^+ + \theta^- i_{t-1}^- + \varphi^+ b_{t-1}^+ + \varphi^- b_{t-1}^- + \sum_{j=1}^{p-1} \gamma_j \Delta f_{t-j} + \sum_{j=0}^{q-1} \psi_j^+ \Delta i_{t-j}^+ + \sum_{j=0}^{q-1} \psi_j^- \Delta i_{t-j}^- + \sum_{j=0}^{q-1} \omega_j^+ \Delta b_{t-j}^+ + \sum_{j=0}^{q-1} \omega_j^- \Delta b_{t-j}^- + \varepsilon_t^f \quad (16)$$

$$\Delta i_t = \beta_0 + \rho i_{t-1} + \theta^+ f_{t-1}^+ + \theta^- f_{t-1}^- + \varphi^+ \pi_{t-1}^+ + \varphi^- \pi_{t-1}^- + \sum_{j=1}^{p-1} \gamma_j \Delta i_{t-j} + \sum_{j=0}^{q-1} \psi_j^+ \Delta f_{t-j}^+ + \sum_{j=0}^{q-1} \psi_j^- \Delta f_{t-j}^- + \sum_{j=0}^{q-1} \omega_j^+ \Delta \pi_{t-j}^+ + \sum_{j=0}^{q-1} \omega_j^- \Delta \pi_{t-j}^- + \varepsilon_t^i \quad (17)$$

Where α_0 and β_0 are the intercepts. $\rho; \theta^+; \theta^-; \varphi^+; \varphi^-$ are the long-run coefficients. $\gamma;\ \psi^+; \psi^-; \omega^+; \omega^-$ are the short-run coefficients. The Eq. (16) and (17) were derived from the Eq. (12) and (13) respectively by adding the partial sums of positive and negative changes of the independent variables as additional regressors.

The partial sums of positive and negative changes are the following:

$$i_t^+ = \sum_{j=1}^{t} \Delta i_t^+ = \sum_{j=1}^{t} \max(\Delta i_t^+, 0);\ i_t^- = \sum_{j=1}^{t} \Delta i_t^- = \sum_{j=1}^{t} \min(\Delta i_t^-, 0)\,; \quad (18)$$

$$b_t^+ = \sum_{j=1}^{t} \Delta b_t^+ = \sum_{j=1}^{t} \max(\Delta b_t^+, 0);\ b_t^- = \sum_{j=1}^{t} \Delta b_t^- = \sum_{j=1}^{t} \min(\Delta b_t^-, 0); \quad (19)$$

$$f_t^+ = \sum_{j=1}^{t} \Delta f_t^+ = \sum_{j=1}^{t} \max(\Delta f_t^+, 0);\ f_t^- = \sum_{j=1}^{t} \Delta f_t^- = \sum_{j=1}^{t} \min(\Delta f_t^-, 0); \quad (20)$$

$$\pi_t^+ = \sum_{j=1}^{t} \Delta \pi_t^+ = \sum_{j=1}^{t} \max(\Delta \pi_t^+, 0);\ \pi_t^- = \sum_{j=1}^{t} \Delta \pi_t^- = \sum_{j=1}^{t} \min(\Delta \pi_t^-, 0)\,. \quad (21)$$

In order to investigate the presence of a long-run relationship between variables in models (12), (13), (16) and (17), we apply the bounds-testing procedure advanced by Pesaran et al. (2001) for the symmetric long-run relationship, and by Shin et al. (2014) for the asymmetric long-run relationship.

The test statistic of the bounds test is a Wald F-statistic, which tests for joint-significance of all the one-period lagged levels of all variables in a conditional Error Correction Model (ECM). If the estimated F-statistics value is higher than the upper- and lower-bound critical values, then the null hypothesis of no long-run cointegration is rejected. If it lies between the two critical values, the conclusion is indecisive. If the F-statistics value is lower than the critical values, the null hypothesis of no long-run cointegration is accepted (Pesaran & Shin, 1998; Pesaran et al., 2001).

After the bounds test confirms the long-run symmetric cointegration between the variables, the long-run coefficients can be investigated.

Thus, the null hypothesis of no co-integration among the variables in equation (12) is:

H0: $\alpha_1 = \alpha_2 = \alpha_3 = 0$

And, the null hypothesis of no co-integration among the variables in equation (13) is:

H0: $\beta_1 = \beta_2 = \beta_3 = 0$

A long-run asymmetric cointegration is present, if the joint null hypothesis (H0) in equation (16) and (17): $\rho = \theta^+ = \theta^- = \varphi^+ = \varphi^- = 0$ is rejected.

In addition, if the long-run coefficients $\frac{-\theta^+}{\rho} \neq \frac{-\theta^-}{\rho}$ and $\frac{-\varphi^+}{\rho} \neq \frac{-\varphi^-}{\rho}$ then there is possible asymmetry in the long run. So, the null hypothesis (H0) of a symmetric long-run relationship: $\frac{-\theta^+}{\rho} = \frac{-\theta^-}{\rho}$ and $\frac{-\varphi^+}{\rho} = \frac{-\varphi^-}{\rho}$ is tested by using *Wald* statisitc following an asymptotic χ^2distibution.

If H0 is rejected, then there is an evidence of long-run asymmetric effects between the variables of the model. Otherwise, these effects are assumed symmetric (or linear), hence symmetric ARDL model is going to be estimated and analyzed based on the estimation results.

5.2. Data

Data were obtained from the Lebanese Central bank (BDL) database (for the interest rate) and the IMF database (for the other variables of the model). The period of this study is based on annual data from 2001 to 2019. The choice of using annually data is given by the fact that the budget is set annually. Annual discretionary adjustments are common in the implementation of fiscal policy. All data are seasonally adjusted and converted into logarithmic form. The reason behind using data up to 2019, is to study the impacts of the interaction of fiscal and monetary policies on economic situation in Lebanon right after this period, namely the debt default crisis (Eurobonds default) and the failure of the monetary policy adopted by the BDL since Nov. 1998.

6. Empirical Results

In this section of the study, we present first the unit root tests results of the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) for the stationary. In the second section, we present the empirical results of the NARDL and ARDL cointegration tests and the estimation results of the long- and short-run equations along with the diagnostic statistics tests for each model.

6.1. Unit root tests/Stationarity Test

All variables should be stationary at level I(0) or at their first difference I(1) or mutually integrated, but none of them should be integrated at I(2) in order to calculate valid F-statistic (Shin et al., 2014). In order to test this, Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are used in order to determine the order of integration of each variable. ADF and PP tests results are reported in Table 1.

Table 1: The results of the ADF and PP tests

Tests	**ADF**			**PP**		
Variable	**Intercept**	**Intercept and trend**	**None**	**Intercept**	**Intercept and trend**	**None**
$\boldsymbol{f_t}$	-2.544	-2.995	-0.31	-2.572	-5.027**	-
$\Delta\boldsymbol{f_t}$	-4.351*	-	-	-	-	-
$\boldsymbol{i_t}$	-1.985	-2.012	-0.025	-3.606**	-	-
$\Delta\boldsymbol{i_t}$	-3.665**	-	-	-	-	-
$\boldsymbol{b_t}$	-0.459	-2.072	2.921	-0.632	-1.69	2.536
$\Delta\boldsymbol{b_t}$	-2.72***	-	-	-2.727***	-	-
$\boldsymbol{\pi_t}$	-0.058	-2.844	4.647	-0.081	-2.008	4.505
$\Delta\boldsymbol{\pi_t}$	-3.239**	-	-	-3.178**	-	-

The null hypothesis for ADF and PP tests state that the variable has a unit root. *, **, *** represent the significance levels of 1%, 5% and 10% respectively. Δ indicates the first difference of the variable.

ADF test results reveal that all variables are stationary at first difference I(1) and PP test results reveal that the variables are mutually integrated. ADF and PP reveal that none of the variables is integrated at I(2). Hence, the data fit for the long-run cointegration process in ARDL and NARDL framework.

6.2. Cointegration

After confirming that all the variables are not integrated at I(2), which imply that the NARDL and ARDL bounds test for cointegration are valid, NARDL and ARDL bounds-testing procedure proposed by Shin et al. (2014) and Pesaran et al. (2001) are conducted and summarized in the table (2) and (3), respectively.

The F-stat of the $NARDL_{FRF}$ and $NARDL_{MRF}$ is greater than the upper critical bounds values at 10% and 1% respectively, and the F-stat of the $ARDL_{FRF}$ and $ARDL_{MRF}$ is greater than the upper critical bounds values at 5%.

Hence, the null hypotheses of no long-run asymmetric and symmetric cointegration is rejected respectively. Once the cointegration has been confirmed, the estimate of the long-run coefficients of the NARDL and ARDL models can be investigated. The optimal lag order of each model is selected based on Schwarz Information Criteria (SIC)[1].

Table 2: NARDL Estimation Results of long- and short-run FRF and MRF

	$NARDL_{FRF}$ Dependent variable: f_t		**$NARDL_{MRF}$ Dependent variable: i_t**	
	Selected Model	**ARDL(1, 0, 0, 0, 0)**	**Selected Model**	**ARDL(1, 0, 0, 0, 0)**
	Variable	**Coefficients**	**Variable**	**Coefficients**
Long-Run Coefficients	i_t^+	-0.579	f_t^+	0.647**
	i_t^-	0.904**	f_t^-	-0.540
	b_t^+	0.865	π_t^+	-3.253**
	b_t^-	-7.218***	π_t^-	-12.803
	Constant	8.904*	**Constant**	1.752*
	Long-Run Asymmetry Test			
	F-statistic	3.869***	**F-statistic**	9.681*
	Variable	**Coefficients**	**Variable**	**Coefficients**
Short-Run Coefficients	Δi_t^+	-0.416	Δf_t^+	0.313
	Δi_t^-	0.649***	Δf_t^-	-0.262
	Δb_t^+	0.622	$\Delta \pi_t^+$	-1.576*
	Δb_t^-	-5.186***	$\Delta \pi_t^-$	-6.203
	ECT_{t-1}	-0.718*	ECT_{t-1}	-0.484**
	Diagnostic Statistics			
	F-statistic	4.247**	**F-statistic**	18.004*
	R^2	0.638	R^2	0.882
	$\overline{R^2}$	0.488	$\overline{R^2}$	0.833
	JB test	2.842(0.241)	**JB test**	1.616(0.445)
	BG LM test	0.516(0.487)	**BG LM test**	0.086(0.774)
	ARCH test	0.57 (0.461)	**ARCH test**	1.587(0.226)
	Ramsey RESET Test	0.788 (0.393)	**Ramsey RESET Test**	0.929(0.355)
	CUSUM test	Stable	**CUSUM test**	Stable
	CUSUM Squared test	Stable	**CUSUM Squared test**	Stable
	Wald Tests for a null hypothesis of long-run symmetry			
	$W_{i^+=i^-}$	2.326(0.153)	$W_{f^+=f^-}$	3.442(0.088)***
	$W_{b^+=b^-}$	5.07(0.043)**	$W_{\pi^+=\pi^-}$	0.436(0.521)

*, **, *** represent the significance levels of 1%, 5% and 10% respectively. Note: value in parenthesis represents the corresponding p-value. JB, BG LM and ARCH denote Jarque-Bera test for normality, Breusch Godfrey test for higher-order autocorrelation and test for autoregressive conditional heteroskedasticity, respectively. CUSUM and CUSUM Squared are tests of dynamic stability based on cumulative sums of residuals. Ramsey RESET tests the null hypothesis of no functional form misspecification.

[1] It should be noted that the ARDL-AIC and ARDL-SC estimators have very similar performances on small samples, with performances slightly better for ARDL-SC in the majority of the experiments. This may reflect the fact that the Schwartz criterion is a coherent model selection criterion, unlike Akaike (Pesaran M. & Shin Y., 1997).

The results of estimation in table 2 suggest the NARDL model successfully captures asymmetries in the responses of fiscal deficit to changes in public debt and in the responses of interest rates to the changes in fiscal deficit.

The significance is confirmed for coefficients of negative changes in interest rate and in public debt in $NARDL_{FRF}$ indicating that the fiscal policy does not respond to the positive changes in both interest rate and public debt.

While the negative changes in the interest rate implies that the fiscal policy does not take into account the monetary measures of the central bank implying lack of coordination (conflict) between fiscal and monetary policies in Lebanon.

On the other hand, a decrease in the public debt leads to an increase in fiscal deficit, implying that there is no fiscal rule in Lebanon.

For $NARDL_{MRF}$, interest rate responds to the positive changes in fiscal deficit and in inflation rate, while the negative changes in fiscal deficit and inflation rate do not affect the interest rate.

According to the estimated results for MRF, an increase in fiscal deficit leads to an increase in interest rate indicating lack of coordination between these two policies also a partial crowding out effect from the public sector on the economy.

Regarding the inflation rate, an increase in the inflation rate leads to a decrease in the interest rate, indicating that there is no monetary rule in Lebanon.

According to *Wald* test for $NARDL_{FRF}$, the null hypothesis of long-run symmetry between interest rate and fiscal deficit is not rejected implying that positive or negative changes in the interest rates have symmetrical effects on the fiscal deficit.

On the other hand, the null hypothesis of long-run symmetry between debt and fiscal deficit is rejected at 5% level of significance implying that positive or negative changes in the debt have asymmetrical effects on the fiscal deficit.

Regarding the $NARDL_{MRP}$, the null hypothesis of long-run symmetry between fiscal deficit and interest rate is rejected at 10% level of significance implying that positive or negative changes in the fiscal deficit have asymmetrical effects on the interest rate.

On the other hand, the null hypothesis of long-run symmetry between inflation rate and interest rate is not rejected implying that positive or negative changes in the inflation rate have symmetrical effects on the interest rate.

Regarding FRF short-run, the estimated coefficients of positive changes in interest rate and public debt are not statistically significant, whereas the estimated coefficients of negatives changes are statistically significant at 10% level of significance. A decrease in interest rates leads to a decrease in fiscal deficit indicating also a lack of coordination between fiscal and monetary policies in Lebanon.

On the other hand, a decrease in the public debt leads to an increase in fiscal deficit indicating that there is no fiscal rule in Lebanon in the short-run.

Regarding MRF short-run, the estimated coefficients of positive and negative changes in fiscal deficit are not statistically significant, whereas the positive changes in inflation rate is statistically significant at 1% indicating that an increase in inflation rate leads to a decrease in interest rate implying that there is no monetary rule in short-run, while the negative changes of inflation rate is not statistically significant.

Overall, our findings indicate a lack of coordination between fiscal and monetary policies in short- and long-run. Also, neither fiscal nor monetary authority in Lebanon follows the rules of fiscal and monetary discipline.

The adjusted R-squared for the fitted NARDL models is 0.488 and 0.833 for FRF and MRF, respectively, also the F-statistic for $NARDL_{FRF}$ and $NARDL_{MRF}$ is highly significant at 5% and 1%, respectively.

According to Jarque-Bera (JB) tests, the null hypothesis that the residuals conform to a Gaussian distribution cannot be rejected for FRF and MRF. The Lagrange Multiplier (LM) test finds no evidence of serial correlation, while the ARCH test shows no presence of autoregressive conditional heteroscedasticity.

Moreover, CUSUM and CUSUMSQ tests of the residuals reveal the stability of the parameters over the sample period, which confirm that the estimated models are stable.

After confirming that the relation between the interest rate and the fiscal deficit in the FRF and between the inflation rate and interest rate in the MRF is linear, $ARDL_{FRF}$ and $ARDL_{MRF}$ are estimated below in order to determine the linear effects between these variables.

Table 3: ARDL Estimation Results of long- and short-run FRF and MRF

	$ARDL_{FRF}$ Dependent variable: f_t		$ARDL_{MRF}$ Dependent variable: i_t	
	Selected Model	**ARDL(1, 0, 0)**	**Selected Model**	**ARDL(1, 0, 0)**
	Variable	**Coefficients**	**Variable**	**Coefficients**
Long-Run Coefficients	i_t	0.221	f_t	0.278
	b_t	1.204***	π_t	-0.777**
	Constant	-5.388	**Constant**	3.016***
	Long-Run Cointegration Test			
	F-statistic	5.283**	**F-statistic**	5.23**
	Variable	**Coefficients**	**Variable**	**Coefficients**
Short-Run Coefficients	Δi_t	0.129	Δf_t	0.189
	Δb_t	0.704***	$\Delta \pi_t$	-0.527
	ECT_{t-1}	-0.584*	ECT_{t-1}	-0.679**
	Diagnostic Statistics			
	F-statistic	4.583**	**F-statistic**	12.793*
	R^2	0.495	R^2	0.732
	$\overline{R^2}$	0.387	$\overline{R^2}$	0.675
	JB test	0.57(0.751)	**JB test**	0.192(0.908)
	BG LM test	1.006(0.334)	**BG LM test**	2.111(0.169)
	ARCH test	0.096(0.76)	**ARCH test**	0.043(0.838)
	Ramsey RESET Test	0.131(0.722)	**Ramsey RESET Test**	0.077(0.785)
	CUSUM test	Stable	**CUSUM test**	Stable
	CUSUM Squared test	Stable	**CUSUM Squared test**	Stable

*, **, *** represent the significance levels of 1%, 5% and 10% respectively. Note: value in parenthesis represents the corresponding p-value. JB, BG LM and ARCH denote Jarque-Bera test for normality, Breusch Godfrey test for higher-order autocorrelation and test for autoregressive conditional heteroskedasticity, respectively. Cusum and Cusum Squared are tests of dynamic stability based on cumulative sums of residuals. Ramsey RESET tests the null hypothesis of no functional form misspecification.

Regarding the estimated results of the linear ARDL reported in table above, it can be concluded that the fiscal policy does not respond to the changes in interest rate indicating lack of coordination in long- and in short-term. It seems that the Lebanese fiscal authority acts independently indicating a fiscal dominance[1].

Also, it appears that an increase in public debt leads to an increase in fiscal deficit implying also that there is no fiscal rule employed by the fiscal authority in long- and short-term.

On the other hand, the monetary policy does not take into account the changes in fiscal deficit neither in long-term nor in short-term, indicating lack of coordination. Moreover, an increase in inflation rate leads to a decrease in interest rate implying also that there is no monetary rule employed by BDL.

Furthermore, the estimated ECM (error correction model) coefficients of the nonlinear and linear models are negative and statistically significant, which confirms the long-run co-integration between the fiscal deficit and its determinants, and between the interest rate and its determinants in both models NARDL and ARDL, respectively.

The F-statistic for $ARDL_{FRF}$ and $ARDL_{MRF}$ is highly significant at 5% and 1%, respectively. The diagnostic tests reported at the bottom panel of the Table 3, indicate that the ARDL model for fiscal and monetary reaction functions satisfies the statistical properties.

[1] When fiscal policy acts independently, the monetary authority is forced to create *seigniorage* revenue to balance the government accounts indicating a fiscal dominance (Walsh, 2003). In this situation, the central bank neglects its objective of maintaining price stability in order to support government spending (Fiedler, S., K.-J. Gern and U. Stolzenburg, 2020).

To sum up, the results of diagnostic tests, normality distribution of the residuals, homoscedasticity, serial correlation, stability, and functional form confirm that the NARDL and ARDL models of both reaction functions are well-suited.

Figure 1 and 2 present the asymmetric cumulative dynamic multipliers for fiscal and monetary reaction functions that allow to trace out the asymmetric adjustment patterns following positive and negative shocks to the explanatory variables.

The fiscal responsiveness to changes in public debt is extremely weak; this is due to the high levels of public debt. This result is affirmed by Gosh et al (2011, 2013)[1] and Medeiros (2012)[2] who concluded that fiscal responsiveness to debt becomes weak at high levels of debt to GDP ratio.

The results suggest that fiscal and monetary policies do not support each other, reflecting lack of coordination. Moreover, there are no fiscal nor monetary rules employed by fiscal and monetary authorities in Lebanon indicating absence of fiscal and monetary rules.

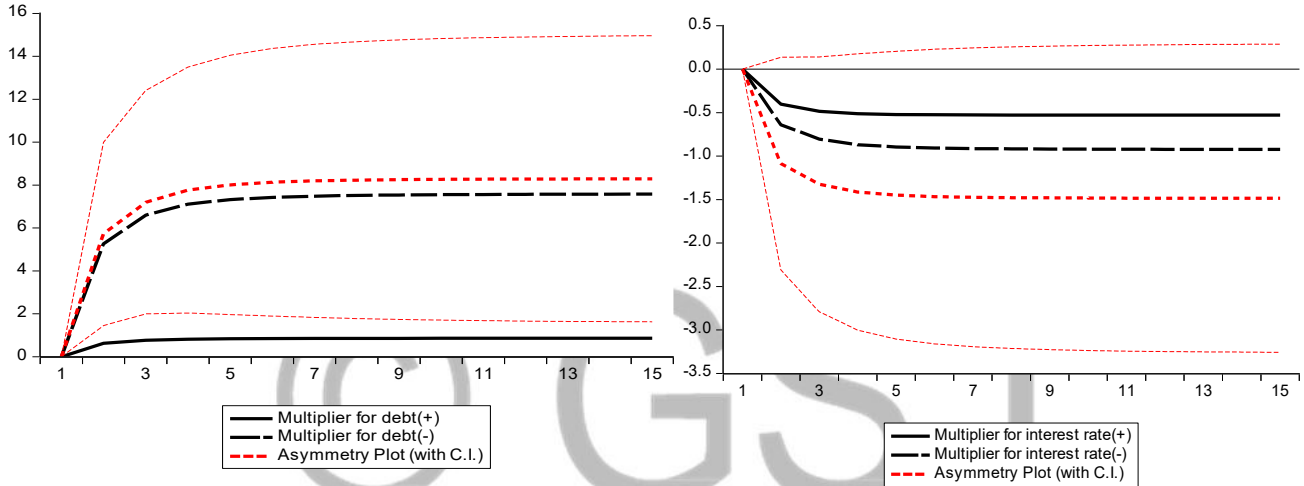


Figure 1: FRF Asymmetric Cumulative Dynamic Multipliers

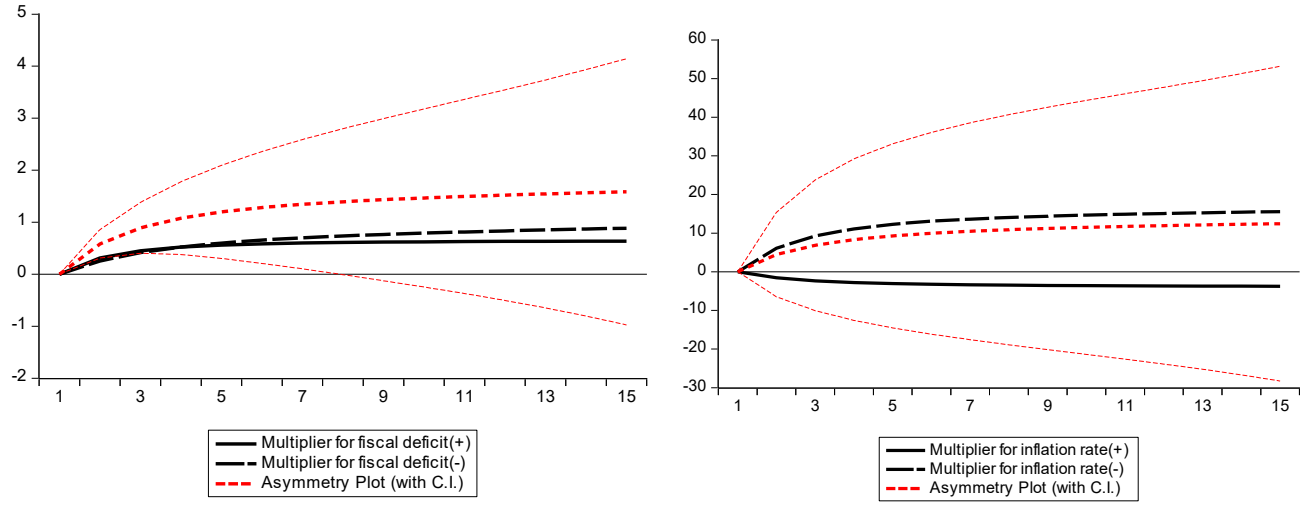


Figure 2: MRF Asymmetric Cumulative Dynamic Multipliers

[1] Debt coefficient turns negative for debt level beyond 150% of GDP.
[2] Debt coefficient is approximately equal zero which indicates the existence of fiscal fatigue above a debt ratio of around 90 to 100% of GDP.

7. Conclusion and policy implication

This study investigates the interaction between fiscal and monetary policies in Lebanon in order to examine simultaneously the short-run and long-run symmetric and possible asymmetric interactions between the fiscal and monetary policies. The fiscal and monetary rules employed in this study are inspired from Leeper (1991, 2016 and 2018). To this aim, both linear and nonlinear Autoregressive Distributed Lag (ARDL) cointegration approaches and error-correction model (ECM) are used.

The empirical results indicate that while the linear approach provides evidences of the interaction between the fiscal and monetary policies, the nonlinear approach provides more important evidences to determine in which direction this cooperation or conflict occurs between policy mix.

Based on NARDL and ARDL fiscal and monetary reaction functions, Lebanese fiscal authority acts independently indicating "fiscal dominance". This situation obliged the BDL to neglect its main objective of maintaining price stability in order to support fiscal deficit by creating *seigniorage* revenue to balance the government accounts which in turns has led to an acceleration of inflation rates even in case of monetary contraction. The fiscal responsiveness to changes in public debt is extremely weak in Lebanon, and even is negative, and this is due to the high levels of public debt (174.3% of GDP in 2019).

Moreover, this paper provides new evidences of lack of coordination between fiscal and monetary policies in short- and long-run and an absence of fiscal and monetary discipline rules followed by the fiscal and monetary authorities, which indicates that the policymakers in Lebanon were managing the financial and monetary policies without any specific plan or program and without any future vision or even a framework that allows these policies to be evaluated.

This paper adds to the existing literature by adding new methodology and technique that can be used to assess the interaction between the policy mix under linearity and nonlinearity impacts assumption. Moreover, this paper provides new framework to determine if the monetary and fiscal authorities follow a specific rule by using ARDL and NARDL models.

This study recommends a coordinated policy strategy which consists of a commitment to stable inflation rate and stable debt-to-output ratio. More precisely, the Lebanon's fiscal policy must be compatible with debt sustainability given that when debt rises it is prudent to increase revenues and/or decrease expenditures in order to ensure a sustainable debt trajectory, thus only public investment should be financed by debt. The monetary measures of the BDL can be seriously compromised if Lebanese government does not act to ensure public debt sustainability.

This means that Lebanese fiscal authority must follow a sustainable path in relation to public debt. At the same time, the BDL must respond adequately to the increases in the inflation rate. In this sense, the monetary authority follows an active monetary policy, and the fiscal authority must employ a passive fiscal policy as indicated in regime M.

In short, the BDL must adopt an inflation-targeting system under a floating exchange rate[1] and perfect capital mobility and the Ministry of Finance must pursue long-term public debt sustainability. The inflation-targeting system in Lebanon has to use the monetary base as an instrument to control money supply, making it exogenous. The BDL can set an inflation target (4% annual rate) with a ±2% inflation band on each side. Thus, the ceiling of the band for annual inflation is 6% and the floor is 2%.

[1] Since the exchange rate adjusts to ensure balance of payments equilibrium, the BDL can choose its monetary policy independent of other countries' policies.

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Appendix A

Figure A.1: Optimal lag selection – $ARDL_{FRF}$ Model

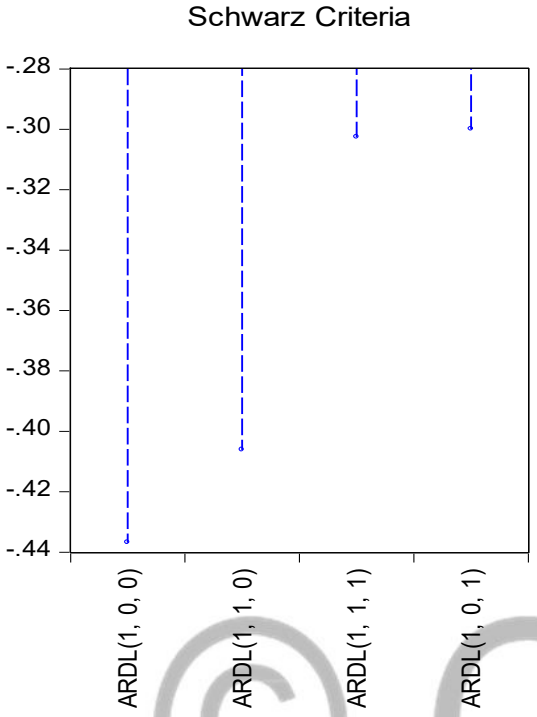

Figure A.2: Optimal lag selection – $ARDL_{MRF}$ Model

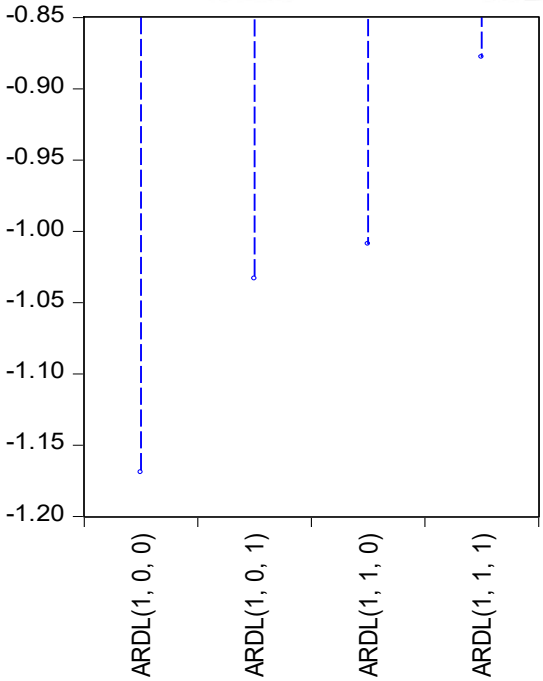

Figure A.3: Structural stability tests – $NARDL_{FRF}$ Model

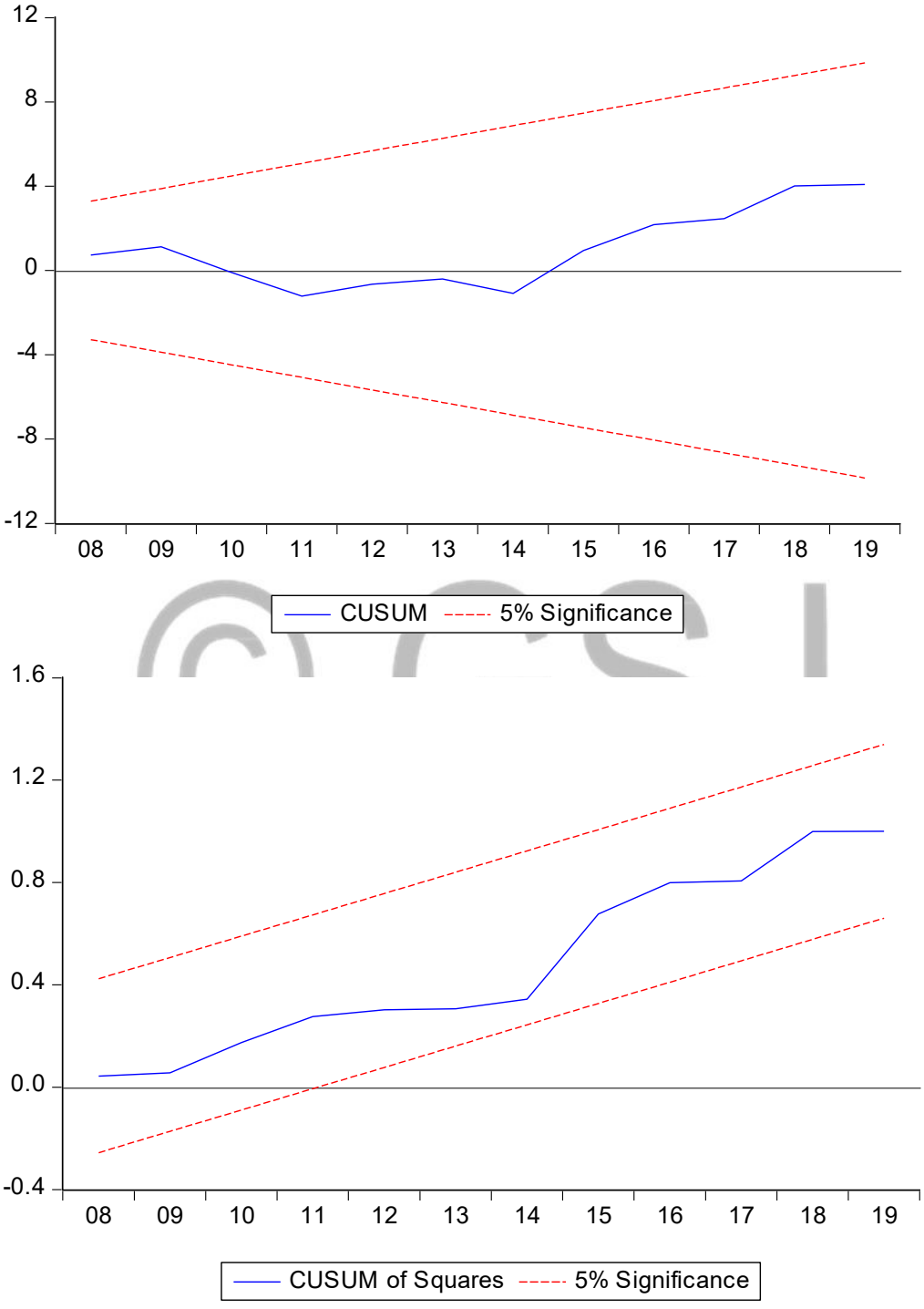

Figure A.4: Structural stability tests – $NARDL_{MRF}$ Model

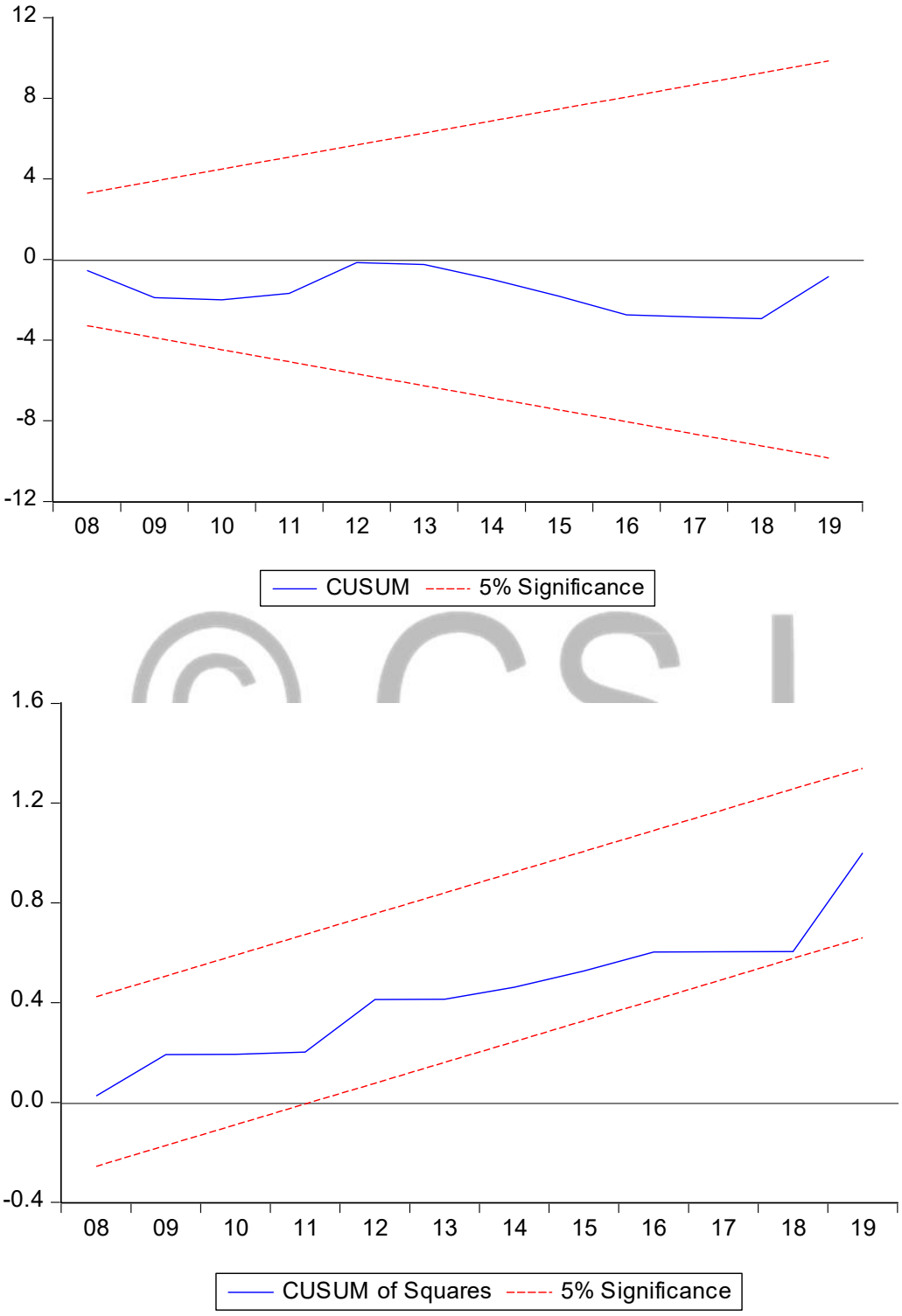

Figure A.5: Structural stability tests –ARDL$_{FRF}$ Model

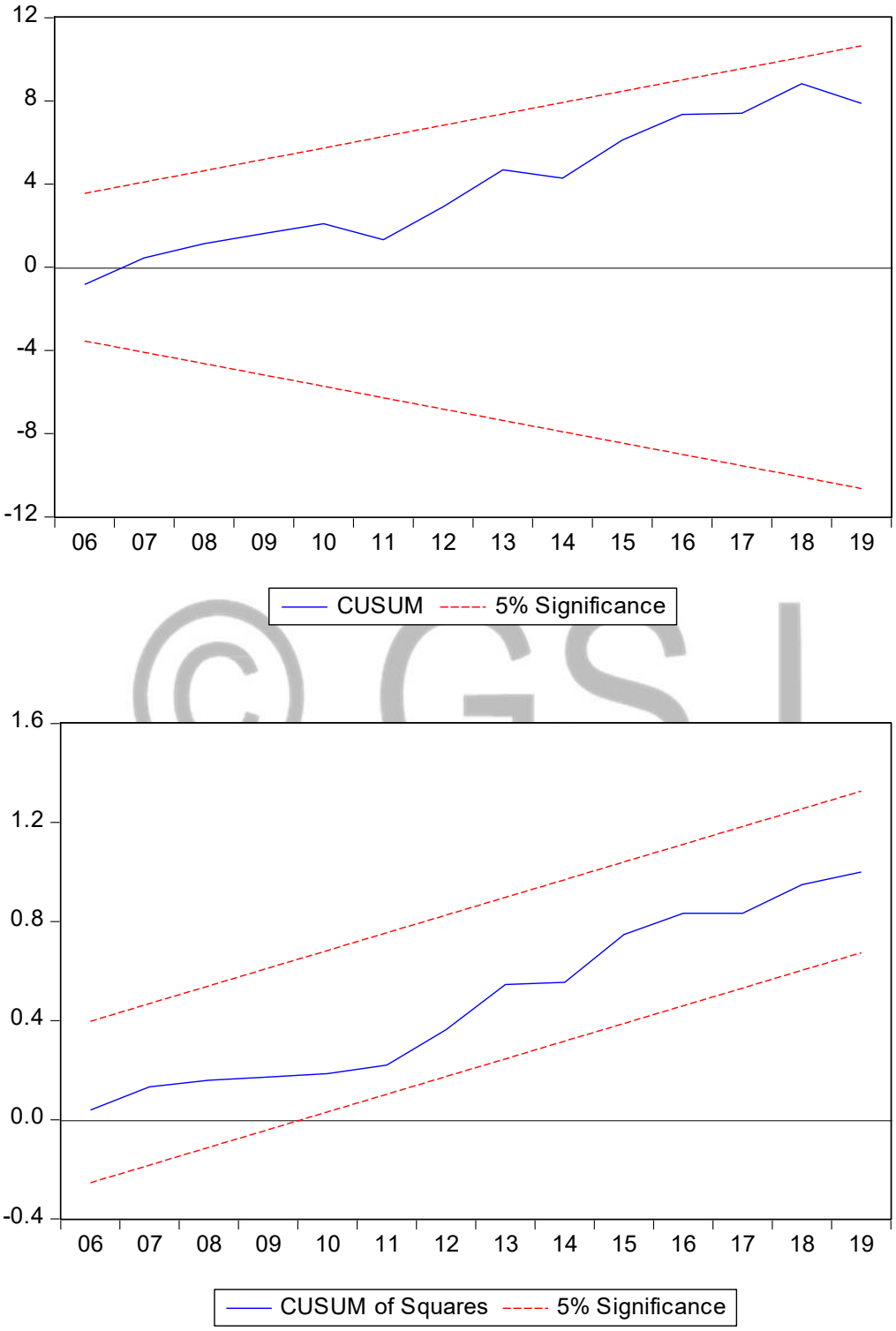

Figure A.6: Structural stability tests –ARDL$_{MRF}$ Model