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Interaction between Monetary and Fiscal Policy: Empirical Evidence from Algeria

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Abstract:

The aim of this paper is to analyze the dynamic interaction between monetary and fiscal policies in Algeria for the period of 1963-2017. First, we propose the reaction function between monetary and fiscal policies, and examined the nature of fiscal policies in Algeria using a vector Autoregression (VAR) model. The results provide evidence of a non-Ricardian fiscal policy in Algeria (a negative correlation between fiscal balances and government liability). These results suggest the validity of the fiscal theory of the price level determination, which postulates that changes in prices are driven by fiscal policies, and that the price level has to adjust to ensure equilibrium in private sector wealth, and government solvency.

In the second exercise, we try to estimate the policy reaction function of the Central Bank of Algeria (Interest Rates equation) and Algerian government (fiscal balance equation) using ARDL model. The reaction function between fiscal and monetary authorities indicates that fiscal policy is not responsive to monetary policy during this period and monetary policy is responsive to the fiscal policy. Also, we test the deviation of both policies from the intended target (i.e., active or passive polices). The results show that fiscal policy has more deviations smaller than monetary policy (fiscal policy is more dominant for the case of Algeria).

Further, the paper analyzes the interactions between monetary and fiscal policies by applying a State-space model with Markov-switching to estimate the time-varying parameters of the relationship. The evidence indicates that monetary and fiscal policies in Algeria have interacted in a counteractive manner for most of the sample period. With these results we identify a game where the fiscal authority plays first (or it is active) while the monetary authority have a passive behavior determining the debt levels to the prices given by the fiscal policy. This is favorable to the fiscal dominance.

Keywords: Monetary-fiscal policy; Dominant regime, Algeria.

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I. Introduction:

Monetary and fiscal policies are the two most important tools for managing the macroeconomic in order to achieve high employment rates, price stability and overall economic growth. An important issue that has exercised the minds of macroeconomists is the understanding of how the dependence, independence and interdependencies between monetary and fiscal policies could lead the economy closer or further away from set goals and targets. In a poorly coordinated macroeconomic environment, fiscal policies might affect the chances of success of monetary policies in various ways, such as: its eroding impact on the general confidence and efficacy of monetary policy, through its short-run effects on aggregate demand, and by modifying the long-term conditions for economic growth and low inflation. On the other hand, monetary policies may be accommodative or counteractive to fiscal policies, depending on the prevailing political and economic paradigms.

As far as Algeria is concerned, the fiscal and external balances have deteriorated significantly as a result of higher spending and lower hydrocarbon revenue (The impact of the oil price shock since 2014). The fiscal deficit widened significantly during the last five years, as it moved from the 1.2% of GDP in 2011 to 13.5% in 2016 (45.3 % of NHGDP). To meet large financing needs over the medium term with savings in the FRR near the statutory floor of DA 740 billion (see [Figure 1 in Appendix](#)), Algerian authorities launched a domestic debt issue in first April 2016 as it seeks to diversify financing sources and also aimed at mobilizing savings in the informal sector. The debt, with a maturity of 3 to 5 years, will carry an interest rate of 5.0 to 5.75 percent. Despite all the available means, the public authorities have succeeded in attracting only 400 billion dinars, or the equivalent of \$ 3.6 billion (36 per cent of the value must be collected). While this process aimed to recruit financial resources of up to \$ 10 billion (It is the third of budget deficit which estimated at \$ 30 billion). As a result, central government debt has increased significantly to 27 percent of GDP at end-2017.

In 2018, Faced with rising unemployment, concerned with repaying domestic arrears, and reluctant to borrow externally or let the exchange rate depreciate further, the authorities saw their policy options limited to creating fiscal space for higher spending through monetary financing. The banking law was changed in October 2017 to allow for five years Bank of Algeria (BA) to finance directly, among others, the budget deficit, public sector debt buy-back and the National Investment Fund (FNI). The total amount of money printed under this funding amounted to 2185 billion Algerian dinars (19 billion US dollars) in 2017 (equivalent of about 23 percent of 2017 GDP) and 1555 billion Algerian dinars since the beginning of 2018. Broad money growth started accelerating in 2017: Q2, (8.3 percent) partly driven by a higher growth in deposits, it reflected a slower decline in net foreign assets and a rapid growth in credit to the government (see [figure 2 and 3 in Appendix](#)).

In an environment where external risks remain tilted to the downside, this new strategy may further exacerbate macroeconomic imbalances as it risks increasing inflationary pressures. If not adequately sterilized, the increased liquidity would raise perceived or actual nominal wealth and stimulate demand, causing prices to rise in the short term due to insufficient domestic supply or saving opportunities. At the same time, hardened import barriers may fuel inflationary pressure by decreasing supply (or possibly creating product shortages). To mop up part of the liquidity injected through monetary financing, Bank of Algeria (BA) raised the reserve requirement ratio from 4 percent to 8 percent in January 2018 and resumed its absorption operations by taking seven day bank deposits. It is also considering a moderate increase in the policy rate.

In this paper, we will try to explore the interactions between monetary and fiscal policies in order to get fiscal solvency, for the case of Algeria over the period 1970-2017. The Algerian economy, characterized by chronic government deficits, seems to be an interesting case of study to investigate how budget deficits were financed, which will allow us to determine the prevailing policy regime along the period of analysis, i.e., “monetary dominant” (MD) regime or “fiscal dominant” (FD) regime. Also, we will verify whether there are regime shifts in the interactions between monetary and fiscal policies in Algeria.

The plan of study is as follows: after the introduction, section two deals with the theoretical foundation of the interaction between fiscal and monetary policy, whereas a detailed empirical literature is presented in section three. Section four and five focuses on the methodology used as well as the main results. The last section proposes some conclusions.

II. Theoretical Framework:

The coordination between fiscal and monetary policies has been relegated to the bottom of the macroeconomic agenda for too long. Both monetarists, who suggest minor government intervention and who are against discretionary economic policies, and Keynesians, who cling more fondly to interventions and seek to establish optimal rules for monetary and fiscal policies, have tended to dissociate the debate between fiscal and monetary policies.

Sargent and Wallace (1981) blazed a trail in the modern macroeconomic theory by approaching the role of coordination between fiscal and monetary policies for price level determination. To achieve that, they explored the idea that the fiscal authority (government) must stick to an intertemporal budget constraint (IBC). In short, they establish that the value of government debt is equal to the present discounted value of future surpluses. One of the ways to produce surplus is by increasing seigniorage revenues, and for that reason fiscal deficits are related to monetary growth rate and to inflation rate. Fiscal authorities are insensitive and irresponsive to changes in debt, they do not adjust government expenditures or tax revenues to reduce outstanding stock of government debt, and henceforth creation of base money is the only way to finance the fiscal deficit. In this situation, fiscal policy actions dominate monetary policy, leading to what Sargent and Wallace (1981) called “fiscal dominance” (FD) or non-Ricardian regime. From the fiscal standpoint, the fiscal authority wins the “game of chicken”. In this case the monetary authority could only control the timing of inflation. However, if the government adjusts its primary deficit to limit the debt accumulation and the central bank follows a Taylor (1993) rule under which the nominal interest rate increases more than proportionally when inflation increases. Thus, monetary policy provides the nominal anchor to deliver price-level determinacy (inflation target). In this approach, the fiscal authority follows a rule under which (lump-sum) taxes stabilize debt. This approach has been referred to as “monetary dominance” (MD) or Ricardian regime.

In order to describe the two possible ways of achieving fiscal sustainability, we will make use of the government’s IBC, written in terms of GDP shares:

$$b_t = \sum_{j=0}^{\infty} \left(\frac{1+x}{1+r} \right)^{j+1} E_t s_{t+j+1} + \lim_{j \rightarrow \infty} \left(\frac{1+x}{1+r} \right)^{j+1} E_t b_{t+j+1} \dots \dots \dots (1)$$

where b and s denote, respectively, the public debt and primary surplus, both as ratios to GDP; E is the expectations operator; and x and r stand, respectively, for the rate of growth of real GDP and the real interest rate, both assumed to be constant for simplicity. The condition for fiscal sustainability is:

$$\lim_{j \rightarrow \infty} \left(\frac{1+x}{1+r} \right)^{j+1} E_t b_{t+j+1} = 0 \dots \dots \dots (2)$$

i.e., the transversality condition; or, equivalently:

$$b_t = \sum_{j=0}^{\infty} \left(\frac{1+x}{1+r} \right)^{j+1} E_t s_{t+j+1} \dots \dots \dots (3)$$

i.e., solvency requires that the government must run expected future budget surpluses equal, in present-value terms, to the current value of its outstanding debt.

Notice that, in equilibrium, the fiscal solvency condition holds under both the MD and FD regimes; the difference between the two regimes lies in how solvency is achieved. According to the MD regime approach, the price level would be determined in the money market, following the quantity theory of money, and the primary surplus would adjust endogenously to satisfy the IBC. In terms of equation (3), s would be set to meet a given b , independently of the price level.

On the other hand, when the FD regime prevails, the primary surplus is set exogenously by the government, regardless of the level of public debt. In this framework, the price level would adjust in order to assure the fulfillment of the IBC. And the main implication for fiscal policy would be that government solvency turns to be a sufficient condition for price stability.

Later on, [Leeper \(1991\)](#) classified fiscal and monetary policies as active and/or passive according to their behavior and based on effects on debt. An authority that uses an active policy has autonomy to establish her policy without considering the behavior of current and past variables controlled by the passive authority. Conversely, if the authority uses a passive policy, it will be limited to optimization decisions made by consumers and by the active authority's actions. Active monetary policy targets inflation whereas passive monetary policy adjusts interest rates in a way to bring debt within sustainable limits. Active fiscal policy spends ignoring debt levels, whereas passive fiscal policy adjusts taxes and expenditure to keep debt within sustainable limits. Unique equilibrium requires one policy to be active and the other to be passive. Determinate prices require one of the policies to be active and budget solvency condition requires one of the policies to be passive. Other papers along this line are [Sims \(1994\)](#) and [Leith and Wren-Lewis \(2000\)](#).

[Woodford \(1995\)](#) proposed another way whereby fiscal policy can interfere with price level determination, known as the Fiscal Theory of the Price Level (FTPL). The FTPL adds to the theory developed by [Leeper \(1991\)](#) and differs from the theory put forward by [Sargent and Wallace \(1981\)](#) by assuming that the government budget constraint equation represents an equilibrium condition. If the constraint is violated for a given price level, then such level is not consistent with an equilibrium. As a result, [Woodford \(1995\)](#) classified fiscal policy as Ricardian when the fiscal authority acts judiciously and the debt does not prevent the conduct of monetary policy from attaining the inflation target (MD). On the other hand, a non-Ricardian regime occurs when the risk of fiscal insolvency requires that the monetary authority cause inflationary "surprise" to deflate the nominal value of the government debt (FD). This terminology is quite intuitive in view of the fact that in the Ricardian model government bonds do not represent net worth. For example, a bond financed tax cut should not affect the price level under MD, but it may affect it under FD.

[Woodford \(2003\)](#) also shows if fiscal policy is locally Ricardian, or taxes are responsive to debt, equilibrium is determinate if and only if the response of monetary policy to inflation exceeds unity. If fiscal policy is locally non-Ricardian, monetary policy will have to violate the Taylor Principle and moderate its response to inflation in order to prevent government debt from exploding. So unsustainable borrowing requires monetary accommodation.

When the two approaches are considered together, there are four possible combinations of monetary and fiscal policy stances that have been referred to as monetary-fiscal policy interactions. The four combinations are: (i) an M regime; (ii) an F regime; (iii) a regime where no authority provides the nominal anchor and the price level is indeterminate; (iv) a regime where both authorities try to provide the nominal anchor and debt is unbounded.

A substantial empirical literature argues that policy rules have not remained invariant over the past six decades (time-varying). And as [Davig and Leeper \(2007\)](#) emphasize, policymaking is a complicated process of analyzing and interpreting data, receiving advice, and applying judgment. During some periods policymakers may give more attention to inflation or debt stabilization, while in other periods they may give more attention to output stabilization.

In this regard, numerous studies ([Semmler & Zhang \(2004\)](#); [Fialho and Portugal \(2005\)](#); [Chuku \(2010\)](#); [Gonzalez-Astudillo \(2013\)](#); [Gerba and Hauzenberger \(2013\)](#); [Cekin \(2013\)](#); [Kliem et al \(2016\)](#)) formulate and solve a New Keynesian model that incorporates monetary and fiscal policy rules whose coefficients are time-varying and interdependent (regime shifts in the interactions between monetary and fiscal policies). Time variation and interdependence allow for co-movements in monetary and fiscal policymaking, thereby introducing a direct channel of interactions. This channel influences expectations about future monetary and fiscal policymaking, affecting the dynamics of the variables in equilibrium. In particular, when there are co-movements in monetary and fiscal policymaking in the direction of stable and determinate

equilibria -the M and F regimes- the volatilities of output and inflation are reduced, compared to the case where co-movements in that direction are absent.

Despite its popularity and general acceptability⁴, the FTPL has come under intense criticisms on the theoretical and empirical formulations. [Canzoneri et al. \(2000\)](#), [McCallum \(2001\)](#), [Semmler and Zhang \(2003\)](#) and [Buiter \(2002, 2018\)](#), provide some detailed criticism on the FTPL. According to these authors, the original FTPL rests on a fundamental compounded fallacy: confusing the intertemporal budget constraint (IBC) of the State, holding with equality and with sovereign bonds priced at their contractual values, with a misspecified equilibrium nominal bond pricing equation, and the ‘double use’ of this IBC.

III. Empirical Literature:

There are four approaches to evaluate the interaction between monetary and fiscal policy. **The first** is certainly related to the fiscal theory of the price level (monetary versus fiscal dominance), which proves that it can change the conditions of stability of monetary policy.

For example, [Kuncoro and Sebayang \(2013\)](#) analyze the dynamic interaction between monetary and fiscal policies in Indonesia for the period of 1999-2010. First, they propose the reaction function between monetary and fiscal policies. Second, they identify the main determinants of both interaction decisions, i.e. interest rate and primary balance surplus. The results of quarterly data estimation show that in the short term monetary policy reacts as expected to the fiscal policy – in the sense that governments have the ability to run a primary surplus. This action makes fiscal sustainability easier to achieve in the long run. On the other hand, fiscal policy marginally reacts to the monetary policy (interest rate) so that fiscal sustainability will be more difficult to attain given the opposite response of governments to public debt shocks. Furthermore, the interaction matrix indicates that monetary policy is more dominant in Indonesia.

[Javid and Arif \(2014\)](#) examine the relative importance of fiscal and monetary determinants of inflation for Pakistan during 1960-2011. The study finds that the incident of wealth effects of adjustment in nominal public debt may pass through to prices by escalating inflation variability as predicted by the fiscal theory of price determination. The results do not support the perception that monetary authorities acted consistently with monetary dominant regime in Pakistani case to accommodate the fiscal shocks.

[Bajo-Rubio et al \(2014\)](#) try to explore the interactions between monetary and fiscal policies in order to get fiscal solvency, for the case of Spain over the period 1850-2000. They find that the Spanish government deficit would have been sustainable and the whole period can be characterized as one of fiscal dominance. The Spanish case seems to be an example of how an FD regime is compatible with a sustainable fiscal policy; or, from a different point of view, they might conclude that an independent monetary policy (or an MD regime) is not a necessary condition for achieving fiscal sustainability.

In resource-dependent economies, [Elbadawi et al \(2017\)](#) analyze the fiscal foundation of the choice of monetary regimes and the extent of pro-cyclicality of fiscal policy during the post mid-1990s oil boom in the relatively under-research oil-dependent Arab economies. They find preliminary evidence on the existence of a threshold effect for oil rents per capita, below which countries tend to be subject to fiscal dominance and pro-cyclical fiscal policy. This might explain the country experiences of low rents per capita and relatively populous Sudan and Yemen, compared to the GCC member countries of Oman, Saudi Arabia, the UAE as well as Algeria. The latter managed to sustain credible de facto pegged exchange rate regimes and convertible currencies (for the GCC) or graduate to flexible regime (for Algeria). Instead, the former had to abandon their pegged regimes as a result of their unsuccessful exchange rate-based stabilization programs.

To assess the empirical relevance of Sargent and Wallace’s tight-money paradox, [Goncalves \(2017\)](#) apply Rigobon’s identification via heterocedasticity methodology to Brazilian

⁴ [Carlstrom and Fuerst \(2000\)](#), [Canzoneri et al \(2010\)](#) and [Šehović \(2013\)](#) survey the positive and normative aspects of monetary-fiscal policy interactions in the existing literature.

data in the short window surrounding Central Bank's board meetings. He did not find evidence of fiscal dominance; his estimations suggest interest rate tightenings/loosenings have systematically led to lower/higher inflation expectations.

Panjer et al. (2017) empirically determine whether a Ricardian or a non-Ricardian regime is more plausible for the euro area. A Vector Autoregressive (VAR) model for the primary government balance and the government debt is estimated for the period 1980q2-2013q4. Their model uses dummy interaction terms to account for the breaks due to the introduction of the Euro Convergence Criteria (ECC) and the start of the global financial crisis, respectively. No evidence is found in favour of either regime for the pre-ECC period. In the post-ECC period, a Ricardian regime is more plausible. Some evidence points in the direction of a non-Ricardian regime for the period after the start of the financial crisis.

Jevđović and Milenković (2018) empirically ascertain the prevailing policy regime (monetary versus fiscal dominance) in five emerging European economies (Hungary, Romania, Bulgaria, Serbia, and Macedonia). Results overwhelmingly suggest that monetary policy may have been subordinated to fiscal policy over the period of analysis in all economies under scrutiny and that fiscally-led regime prevailed.

Second approach test the hypothesis of time varying regime changes (accommodative and counteractive) and the nature of the interactions (i.e., substitutes or complements) between monetary and fiscal policies.

In order to study monetary and fiscal policy interactions in a more general way, Semmler and Zhang (2004) explore time-varying interactions by estimating a State-Space model with Markov-switching for some Euro-area countries. There appear to be some regime changes in monetary and fiscal policy interactions in France and Germany, but the interactions between the two policies are not strong. Moreover, the two policies have not been accommodative but counteractive to each other. They explore forward-looking behavior in policy interactions and find that expectations do not seem to have played an important role in the policy designs.

Davig and Leeper (2006) estimate Markov-switching models of monetary and fiscal policy rules with U.S. data. Their results show that there have been numerous switches in monetary and fiscal policy rule coefficients. In particular, whenever the interest rate rule pays more (less) attention to inflation deviations, less (more) weight is given to output deviations. Also, when the tax rule pays more (less) attention to debt deviations, more (less) weight is given to output deviations [in line with an automatic stabilizers argument. These switches deliver the four regimes of policy interactions described above.

In Nigeria, Chuku (2010) analyzes the interactions between monetary and fiscal policies by applying a State-space model with Markov-switching to estimate the time-varying parameters of the relationship. The evidence indicates that monetary and fiscal policies in Nigeria have interacted in a counteractive manner for most of the sample period (1980-1994). At other periods, he did not observe any systematic pattern of interaction between the two policy variables, although, between 1998 and 2008, some form of accommodativeness can be inferred. Overall, the results suggest that the two policy regimes (counteractive and accommodative) have been weak strategic substitutes during the post 1970 (Civil War) period. For the policy maker, his results imply the existence of fiscal dominance in the interactions between monetary and fiscal policies in Nigeria, implying that inflation, predominantly results from fiscal problems, and not from lack of monetary control.

Bianchi (2012) conducts a full-information estimation of a Markov-switching model with policy rule coefficients that switch among three states. The results show that an M regime was in place starting in the 1990s, that an F regime was in place during the 1970s and that a no-bounded-solution regime was in place during the 1980s.

Çekin (2013) analyzes the end of the Turkish high inflation period in the context of monetary and fiscal policy interactions within a rational expectations model in which policy rules are allowed to switch between "active" and "passive" regimes (time-varying policy rules). It is shown that after 2001 monetary policy experienced a switch to an "active" regime whereas fiscal

policy experienced a switch to a “passive” regime – the conditions necessary for monetary policy to stabilize prices by preventing deficit shocks from affecting inflation.

[Gonzalez-Astudillo \(2013\)](#) uses Bayesian methods to estimate the policy rules with time-varying coefficients, endogeneity, and stochastic volatility in a limited-information framework. Results show that monetary policy switches regime more frequently than fiscal policy, and that there is a non-negligible degree of interdependence between policies. Policy experiments reveal that contractionary monetary policy lowers inflation in the short run and increases it in the long run. Also, lump-sum taxes affect output and inflation, as the literature on the fiscal theory of the price level suggests, but the effects are attenuated with respect to a pure fiscal regime.

[Piergallini \(2017\)](#) investigates global equilibrium dynamics in a macroeconomic model where both monetary and fiscal policies are nonlinear, consistent with empirical evidence. Nonlinear monetary policy, in which the nominal interest rate features an increasing marginal reaction to inflation, interacting with nonlinear fiscal policy, in which the primary budget surplus features an increasing marginal reaction to debt, gives rise to four steady-state equilibria. Each steady state exhibits in its neighborhood a pair of ‘active’/‘passive’ monetary/fiscal policies *à la* Leeper. It is shown that the steady states are endogenously connected. In particular, the global dynamics reveals the existence of infinite equilibrium paths that originate around the steady states locally displaying either monetary or fiscal ‘dominance’ - and thus locally delivering determinacy- as well as around the steady state with active monetary-fiscal policies, and that converge into an unintended high-debt/low-inflation (possibly deflation) trap. This implies that the dynamic system is indeterminate even around the steady states usually displaying fiscal and monetary dominance. In other words, under nonlinear interest-rate and primary-surplus adjustments of the type empirically documented, neither monetary variables nor fiscal variables are viable to ‘pin down’ the inflation rate.

Third approach analyses the interaction between monetary and fiscal authorities through the dynamic equilibrium models that have become a staple of macroeconomic theory since the real business cycle (RBC) revolution. This approach implicates both fiscal and monetary interactions through a government budget constraint. A considerable number of authors examined the interaction between monetary and fiscal policy using new Keynesian dynamic stochastic general equilibrium model (DSGE), among which there are three types - the Solow model, the Ramsey model and the so called overlapping generations model. Moreover, apart from the conventional dynamic, new Keynesian DSGE models are developed in the literature, the so called new Keynesian structural DSGE models, which take into account a richer range of fiscal channels, and using this models some authors conclude that the automatic stabilizers that are used in the tax system are combined more effectively with monetary policy based on the rules compared to public spending policy based on rules.

[Muscatelli et al \(2004\)](#) examine the interaction of monetary and fiscal policies using an estimated New Keynesian dynamic general equilibrium model for the US. In contrast to earlier work using VAR models, they show that the strategic complementarity or substitutability of fiscal and monetary policy depends crucially on the types of shocks hitting the economy, and on the assumptions made about the underlying structural model. We also demonstrate that countercyclical fiscal policy can be welfare-reducing if fiscal and monetary policy rules are inertial and not co-ordinated.

[Ornellas \(2011\)](#) investigates the interaction between fiscal and monetary authorities in Brazil in order to measure the degree of fiscal dominance in the Brazilian economy. To do that, a dynamic stochastic general equilibrium model is used. The model was developed for an economy with sticky prices and inflationary trend, whose parameters of interest are estimated by Bayesian inference. It is concluded that the degree of fiscal dominance in the Brazilian economy is low *vis-à-vis* the U.S. and Canadian economies. This result has a direct impact on the conduct of policies targeted at reducing inflation, and this probably means having to bring inflation targets down, which would directly influence the agents’ expectation about future inflation.

[Shahid et al \(2016\)](#) investigate fiscal and monetary policy interaction in Pakistan using dynamic stochastic general equilibrium model. Their results show that fiscal and monetary policy

interacts with each other and with other macroeconomic variables. Inflation responds to fiscal policy shocks in the form of government spending, revenue and borrowing shocks. Monetary authority's decisions are also affecting fiscal policy variables. It is also evident that fiscal discipline is critical for the effective formulation and execution of monetary policy.

Fourth approach employs the game-theoretic tools (strategic interaction) and considers fiscal and monetary authorities as playing a “game” against each other⁵. To make the argument more formal: The interaction between the fiscal authority (FA) and monetary authority (MA) is strategic since each optimizes its objective function taking account of the other's action. Strategies available to each are C (cooperate) and NC (do not cooperate). The FA gives more weight to growth and the MA to reducing inflation. C for the FA means improving the supply-side and reducing inflation, and for the MA it means maintaining demand to allow output to grow at potential while restraining the cost of government borrowing. Reducing demand by raising interest rates reduces inflation, but marginally. The passive-active strategies are each NC. An active FA that can get any deficit financed may neglect improving the composition of expenditure. Whoever plays NC when the other plays C gets a relatively higher immediate payoff. This is the crux of the Prisoner's Dilemma game and the reason why the equilibrium would be Nash (NC, NC) where both (and the economy) are worse off. Growth is lower and inflation higher than the optimal. The Nash equilibrium will shift up the AS, and shift AD to the left (Goyal 2018; P: 12).

For example, on a pooled sample of 19 industrial countries with annual information for the period 1970-94, Bennett and Loayza (2000) present a game-theoretic model where the fiscal and monetary authorities interact to stabilize the economy. These authorities are different in that they have dissimilar preferences with respect to output and inflation gaps and control different policy instruments. Modeled as Nash or Stackelberg equilibria, the solution under lack of policy coordination implies that an increase in the preference divergence between the monetary and fiscal authorities leads to, *ceteris paribus*, larger public deficits (the fiscal authority's policy instrument) and higher interest rates (the central bank's instrument).

Goyal (2007) shows under delegation to a more pro-growth MA and less populist FA, the unique credible equilibrium becomes C, C with higher payoffs for both. The delegation credibly changes the Prisoner's Dilemma game to a co-ordination game. Since the pay-offs each get from NC are now relatively lower, both are better off at C, and C, C becomes self-enforcing. The equilibrium is shown to be subgame perfect in the extensive game.

On Russian economy in the period between 2001 -2008, Merzlyakov (2012) show that, in an export-oriented economy, the independence of the central bank does not play a significant role. The effective interaction of fiscal and monetary policies is possible under a cooperative Stackelberg game interaction with the government as leader⁶. Social loss is minimal under both forms of interaction, if fiscal and monetary policies are expansionary and allow output to approach its optimal level. In other words, the efficient interaction of fiscal and monetary policies is possible given either coordination or political differences of opinion between the government and the central bank. Intuitively, this can be explained by the fact that the condition of independence of the central bank does not play a decisive role and is more a political rather than economic issue in a resource-based economy with undeveloped financial markets.

In the Brazilian case, Saulo et al (2013) derived optimal monetary and fiscal policies in context of three coordination schemes: when each institution independently minimizes its welfare loss as a Nash equilibrium of a normal form game; when an institution moves first and the other follows, in a mechanism known as the Stackelberg solution; and, when institutions behave cooperatively, seeking common goals. A numerical exercise shows that the smallest welfare loss is obtained under a Stackelberg solution which has the monetary policy as leader and the fiscal

⁵ In Game Theory parlour, the Treasury plays first and the CB takes its decision as a given before choosing the optimal inflation tax. The policy game approach of the Barro-Gordon (1983) type can be associated with FD, but not with MD which does not allow any “tricks” of this kind (for example, inflation targeting is just the opposite to surprise inflation tactics).

⁶ This is based on the conclusions of Dixit and Lambertini (2003) that leadership in fiscal policy is usually more efficient than leadership in monetary policy.

policy as follower. Under the optimal policy, there is evidence of a strong distaste for inflation by the Brazilian society.

IV. Model Identification and Methodology :

According to theoretical framework explained in the previous section, the reaction function of monetary and fiscal authorities is derived from the utility function of both authorities in which contains their preferences on macroeconomic variables. However, the theoretical framework is not specific enough to serve as an econometric model.

As shown in [Bajo-Rubio et al \(2014\)](#), the empirical literature has usually made use of two approaches to test for the prevalence of monetary dominance versus fiscal dominance:

- The *backward-looking* approach (e.g., [Bohn, 1998](#)), so that, in a Ricardian regime, an increase in the previous level of debt would result in a larger primary surplus today; i.e.,

$$\Delta b_{t-1} \rightarrow \Delta s_t$$
- The *forward-looking* approach (e.g., [Canzoneri et al, 2000](#)), so that, in a Ricardian regime, a larger primary surplus today would lead to a reduction in the future level of debt; i.e.,

$$\Delta s_t \rightarrow \Delta b_{t+1}$$

According to the first approach, one should estimate a cointegration relationship between the primary surplus and the (lagged) level of debt, both as ratios to GDP: $s_t = \alpha + \beta b_{t-1} + \varepsilon_t$

In this equation, a positive and significant estimate of β would be a sufficient condition for solvency, indicating that the government satisfies its present-value budget constraint; that is, in terms of the transversality condition, s would be set to meet a given b , independently of the price level. Furthermore, in accordance with the backward-looking approach, an estimated $\beta > 0$ would indicate the prevalence of an MD (Ricardian) regime, and an estimated $\beta < 0$ the prevalence of an FD (non-Ricardian) regime.

The second approach distinguishes between Ricardian and non-Ricardian regimes. Consider how a positive innovation in surplus influences the next period's liabilities. In a Ricardian regime, the surplus pays off part of the debt and the next period's liabilities fall. In a non-Ricardian regime, there are two possibilities. Consider first that an innovation in surplus is not correlated with future surpluses on the right hand side of. In this case, the next periods' liabilities will not be affected by the innovation in surplus. Next suppose an innovation in surplus is positively correlated with future surpluses. In this case, the next periods' liabilities will rise⁷.

In the other hand, we draw from [Muscatelli et al. \(2002\)](#) ; [Semmler& Zhang \(2004\)](#); [Fialho and Portugal \(2005\)](#); [Chuku \(2010\)](#); [Gonzalez-Astudillo \(2013\)](#); [Gerba and Hauenberger \(2013\)](#); [Cekin \(2013\)](#); [Kliem et al \(2016\)](#) by specifying a State-Space (SS) model with Markov-Switching (MS) characteristics. We prefer introducing regime switches model rather than in a DSGE model, since it is difficult to model slack in the economy and potentially non-clearing markets in a DSGE framework without imposing strong assumptions regarding the behavior of households and firms. In contrast, VAR models require fewer identifying assumptions and thus are tied more easily to empirical reality.

The reason for applying this model is to enable us test the hypothesis of regime changes (accommodative and counteractive) and the nature of the interactions (i.e., substitutes or complements) between monetary and fiscal policies in Algeria, and if yes, to find out how they may have interacted, i.e., as substitutes or complements. The peculiar advantage of the SS-MS model is in the fact that it allows us to take into account multiple structural breaks in a given time series, and to explain non-linearities in the data. Though powerful, the SS-MS model is restrictive, because it only permits the existence of two time-regimes ([Maddala and Kim, 1998](#)).

⁷ Impulse response functions from a VAR in surplus and liabilities would help differentiate between Ricardian and non-Ricardian regimes. If the next period's liabilities fall following a positive innovation surplus, then we have a Ricardian regime. If not, we have a non-Ricardian regime. Note that a negative response can be reconciled with a non-Ricardian regime, supposing there is negative correlation in the surplus process at longer horizons and the correlation is strong enough to lower the present value of surpluses.

This limitation does not undermine the objective of our work, since we hypothesize that monetary-fiscal policies in Algeria can be categorized into accommodative or counteractive regimes.

MS-VAR (Markov Switching Vector Autoregression) models provide a generalized framework of VAR models which take into accounts changes in regimes s_t . The mean adjusted MS-VAR process of order p and M regimes may be written in the general form as:

$$y_t - \mu(s_t) = A_1(s_t)(y_{t-1} - \mu(s_{t-1})) + \dots + A_p(s_t)(y_{t-p} - \mu(s_{t-p})) + u_t \quad (4)$$

Where $u_t \rightarrow NID(0, \Sigma(s_t))$ and $\mu(s_t), A_1(s_t), \dots, A_p(s_t), \Sigma(s_t)$ are the regime-dependent parameters. A different representation (intercept form) of MS-VAR, is the following:

$$y_t = v(s_t) + A_1(s_t)y_{t-1} + \dots + A_p(s_t)y_{t-p} + u_t \quad (5)$$

$$\text{Where } v(s_t) = \mu(s_t) \left(I - \sum_{j=1}^p A_j(s_t) \right)$$

The mean-adjusted form (4) and the intercept form (5) of MS-VAR models are not equivalent because they imply different dynamic reactions of dependent variables to a regime shift. Differently from VAR(p) model where both representations are equivalent. More precisely, while in the model (4) a regime change in the mean $\mu(s_t)$ determines an immediate adjustment of dependent variables to new levels, in the model (5) a regime shift causes a smooth and dynamic change of the intercept. The last model seems to be more preferable because it is more plausible that means approach smoothly new levels after a regime shift. In the general MS-VAR specifications all parameters are regime-dependent. However, in the empirical applications it is preferable to consider only some parameters dependent on the state s_t . The fact that parameter may be (or not) regime-dependent determines a lot of MS-VAR specifications.

By following the [Krolzig \(1998\)](#) notation, we could add to the MS (Markov- Switching) notation, the following letters, to specify the regime-dependent parameters: M for Markov-Switching Mean, I for Markov-Switching Intercept, A for Markov-Switching autoregressive parameters, H for Markov- Switching heteroskedasticity (e.g MSMH-VAR is a Markov-Switching Mean specification with Σ varying).

In all MS-VAR specifications, the unobservable regime s_t is governed by a first order Markov process, which is defined by the transition probabilities:

$$\Pr(S_t = j | S_{t-1} = i) = p_{ij}, \quad \text{whith: } \sum_{j=1}^M p_{ij} = 1 \quad \forall i \quad i, j = 1, \dots, M$$

Where p_{ij} is the probability that event i is followed by event j and an element of the transition matrix:

$$P = \begin{bmatrix} p_{11} & p_{21} & \cdot & \cdot & p_{N1} \\ p_{12} & p_{22} & \cdot & \cdot & p_{N2} \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ p_{1N} & p_{2N} & \cdot & \cdot & p_{NN} \end{bmatrix}$$

A crucial characteristic of MSVAR models is that the states are unobservable and, hence, do not necessarily have an obvious interpretation. Also, a given observation cannot directly be associated with any particular regime. Only conditional probabilistic assignments are possible via statistical inference based on past information.

The estimation technique implemented for MS-VAR models, the EM (Expectation-Maximization) algorithm, is discussed in [Krolzig \(1998\)](#) (and in Hamilton (1990) for the univariate case). The parameters must be estimated by maximizing a log-likelihood function. The problem is that the FOCs are nonlinear and consequently have not a closed solution; it is not possible to solve them analytically. To solve the equations, it can be implemented two steps. Firstly, arbitrary initial values of parameters are defined.

The first step (The Expectation Step) is based on the computation of transition probabilities which depend on the initial values above mentioned. The second step (The Maximization Step) makes use of the previous probabilities to compute the maximum likelihood estimates of parameters. These two steps are repeated until parameters estimates converge.

V. Empirical Results:

Before analyzing the hypothesized regime switching nature of the interactions between monetary and fiscal policies in Algeria, we first undertake some preliminary empirical research on the nature of fiscal policies in Algeria, using a simple VAR framework. The rationale behind our preliminary investigation is to test whether the fiscal regime in Algeria has followed the “Ricardian” or “non-Ricardian” approach, to enable us ascertain whether the assumptions for the fiscal theory of price level determination are valid or invalid for Algeria. The approach we adopt is in the spirit of [Canzoneri et al. \(2000\)](#), [Semmler and Zhang \(2003\)](#), [Fialho and Portugal \(2005\)](#), [Chuku \(2010\)](#) and [Panjer et al. \(2017\)](#).

Thus, we examine the interaction between two fiscal variables: fiscal balance and government liabilities. Government liabilities are measured by the Federal Government’s debt, and the fiscal balance is the overall surplus or deficit of government finances (The use of the overall budget balance is consistent with previous studies of budget deficit sustainability⁸). We scale the two variables by dividing with nominal GDP (see [Figure 1](#)). The data period is from 1963 to 2017. All the data sets are provided by International Financial Statistic (IMF), Central Bank of Algeria, and Ministry of Finance.

Before undertaking the VAR estimation, we test for stationarity of the variables, using the Augmented Dickey-Fuller (ADF) unit root test. The results indicate that the variables are stationary at their first-differences (see [Table 1](#)). Hence, we use the first differences of the fiscal balance and government liability series in the VAR estimation. With two lags of the variables (see [Table 2](#)), the results obtained from the estimation are thus:

$$\begin{aligned} \Delta FB &= -0.0043 + 1.67*\Delta FB (-1) - 0.92*\Delta FB (-2) - 0.008**\Delta DEBT(-1) - 0.002**\Delta DEBT(-2) \\ &\quad [-0.21339] \quad [63.8047] \quad [-35.2238] \quad [2.61633] \quad [-2.15184] \\ \Delta DEBT &= -0.0031 + 0.02 \Delta FB (-1) - 0.006**\Delta FB (-2) - 1.74*\Delta DEBT(-1) - 0.89*\Delta DEBT(-2) \\ &\quad [-0.06927] \quad [1.34462] \quad [-2.10363] \quad [54.1944] \quad [-27.6204] \end{aligned}$$

Where ΔFB and $\Delta DEBT$ denote the first difference of fiscal balance/GDP and government liability/GDP respectively, and the values in parenthesis are the t -values. The results from the VAR estimation lend credence to the negative relationship (negative correlation with the correlation coefficient being -0.2584). Following this estimation, we simulate the impulse responses for the two variables, and present them in [Figure 2](#). The impulse response graphs indicate that one-standard deviation innovation in DDEF causes a negative response, and similarly, one S.D innovation in DDEBT also induces negative some kind of negative response. This suggests that net borrowing does not decrease when the fiscal balance decreases. Rather, it increases when the fiscal balance decreases. This observed relationship suggests the existence of non-Ricardian fiscal regime in Algeria.

⁸ [Trehan and Walsh \(1988\)](#) argue that the assessment of budget sustainability should be based on the time series properties of the value of the overall budget balance, inclusive of interest payments and seigniorage revenue.

Figure 1: Government debt and the fiscal balance in Algeria (1963-2017) (% GDP)

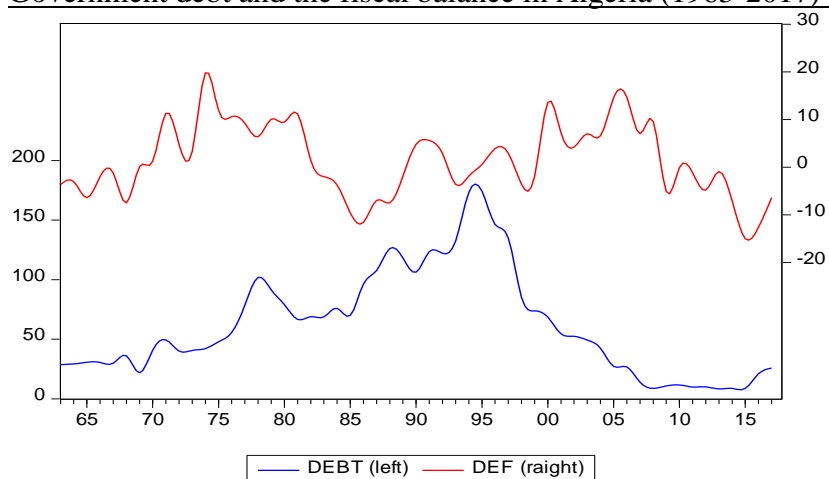


Table 1: unit root test

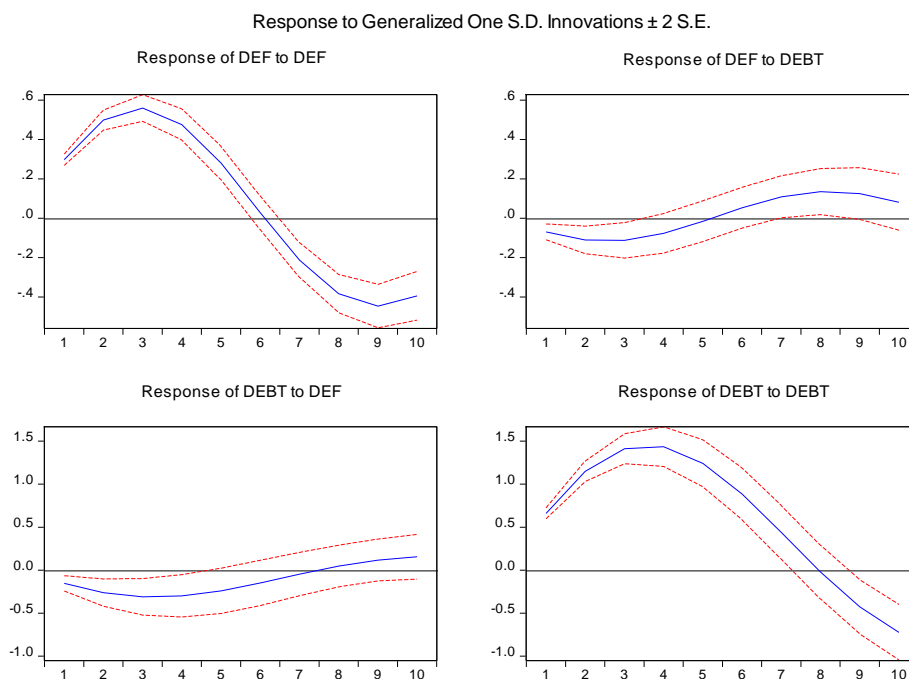
	level	1st Difference	
<i>int</i>	-1.228552	-4.428774	I(1)
<i>inf</i>	-1.475286	-5.725974	I(1)
<i>Gap</i>	-4.131765	-	I(0)
<i>M</i>	-1.580822	-7.861109	I(1)
<i>Dep</i>	-1.783413	-10.13766	I(1)
<i>oil</i>	-0.427755	-5.507839	I(1)
<i>FB</i>	-1.438981	-6.603414	I(1)
<i>debt</i>	-0.859340	-5.357582	I(1)

Critical values are: -2.610192, -1.947248 and -1.612797 at the 1%, 5% and 10% levels.

Table 2: Lag order selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-977.3306	NA	35.27639	9.238968	9.270634	9.251767
1	-621.5453	701.5012	1.276968	5.920239	6.015237	5.958635
2	-38.94364	20.88503*	0.005867*	0.537204*	0.822197*	0.652392*
3	-49.84912	382.7316	0.006261	0.602350	0.824012	0.691940
4	-247.7494	729.9600	0.039002	2.431598	2.589927	2.495591

Figure 2: impulse responses of deficit to debt and vice versa



In the second exercise, we try to estimate the policy reaction function of the Central Bank of Algeria and Algerian government. So, we identify the main determinants of both interaction decisions, i.e. interest rate equation and fiscal balance equation.

As in [Chakraborty \(2010\)](#) ; [Kuncoro and Sebayang \(2013\)](#); [Asamoah and Adu \(2016\)](#) and [Obeng, and Sakyi \(2017\)](#), the econometric model for monetary and fiscal reaction function is postulated as the following linear specification⁹:

$$int = \alpha_0 + \alpha_1 inf + \alpha_2 Gap + \alpha_3 dep + \alpha_4 oil + \alpha_5 FB + \alpha_6 M \dots \dots (6)$$

$$FB = \alpha_0 + \alpha_1 inf + \alpha_2 Gap + \alpha_3 dep + \alpha_4 oil + \alpha_5 int_{t-1} + \alpha_6 M \dots \dots (7)$$

Where:

int = interest rate ratio

inf = inflation rate

Gap = output gap¹⁰

M = change of real money supply

Dep = depreciation rate of Algerian Dinar against US Dollar

oil = oil price

FB = ratio of fiscal balance to GDP

As required by standard econometrics of time series, all of variables are first tested whether they have unit roots respectively. The test is conducted for both level and first-difference and using automatic lags selection based on Schwartz and Akaike info criterion. The results of the Augmented Dickey-Fuller (ADF) unit roots test are presented in [Table 1](#). As shown in this table, the degree of integration of all variables is different from each other. According to [Pesaran and al.\(2001\)](#) the ARDL bounds test approach is valid for variables that are stationary either at level I(0) or at first difference I(1), or even fractionally integrated .

Since none of the variables is integrated of order two, cointegration can be investigated using the ARDL bounds test approach .The bounds test is conducted to determine the existence of a long run relationship between variables in equation (6) and (7). Since we use annual data, we choose two as the maximal lag length in the bounds test. The results of the test are shown in [Table 3](#) below.

Table 3: Bounds test for cointegration analysis

Fiscal reaction function (equation 6)		
Critical Value	Lower Bound Value	Upper Bound Value
1%	2.88	3.99
5%	2.27	3.28
10%	1.99	2.94
Computed F-statistic : 5.168671		
Monetary reaction function(equation 7)		
Critical Value	Lower Bound Value	Upper Bound Value
1%	2.88	3.99
5%	2.27	3.28
10%	1.99	2.94
Computed F-statistic : 5.501521		

As the calculated F-statistics (5.168671) and (5.501521) is greater than the upper bound at the one percent level (3.99) and five percent level (3.28), we conclude that there exists a long run relationship between the variables of our two models.

Once cointegrating relationship between the variables has been established, the estimate of the long run coefficients of the ARDL model can be obtained. The optimal lag order of each variable in the ARDL system is selected on the basis of Akaike Information Criterion (AIC). The estimation results are presented in [Table 4 and 5](#).

⁹ For further details on the choice of explanatory variables and the relationship signal between variables, refer to these four studies.

¹⁰ To estimate the potential GDP, we performed Hodrick-Prescott filter technique, a widely used smoothing parameter among macroeconomists.

Table 4: Estimation Results of long-run Fiscal and Monetary reaction function

	Fiscal Policy Dependent Variable: FB		Monetary Policy Dependent Variable: int
Selected Model	ARDL (2, 0, 2, 0, 1, 2, 2)		ARDL (1, 2, 0, 0, 1, 0, 1)
C	11.00268*	C	1.711006**
FB(-1)	0.522152*	INT(-1)	0.697851*
FB(-2)	0.338909**	INF	0.142539**
INT	-0.134320	INF(-1)	-0.067114
INF	-0.377395**	INF(-2)	0.106526**
INF(-1)	0.236798	GAP	-7.69E-11
INF(-2)	-0.258835***	dep	0.023602
GAP	-4.99E-10***	OIL	0.021585***
dep	0.103859**	OIL(-1)	-0.036715
dep (-1)	0.091326***	FB	0.025190***
OIL	0.282677*	M	-0.048350*
OIL(-1)	-0.214055***	M (-1)	-0.037117**
OIL(-2)	-0.191855***		
M	-0.147744***		
M (-1)	-0.266303*		
M (-2)	0.123395***		
<i>R-squared</i>	0.854102	<i>R-squared</i>	0.939933
<i>Log likelihood</i>	-127.4455	<i>Log likelihood</i>	-84.84113
<i>F-statistic</i>	13.65961	<i>F-statistic</i>	58.32444
<i>Prob(F-statistic)</i>	0.000000	<i>Prob(F-statistic)</i>	0.000000

*, **, *** denote respectively statistical significance at the 1%, 5% and 10% levels.

Table 5: Estimation Results of short-run Fiscal and Monetary reaction function

	Fiscal Policy Dependent Variable: FB		Monetary Policy Dependent Variable: int
Selected Model	ARDL (2, 0, 2, 0, 1, 2, 2)		
D(FB(-1))	-0.338909***	D(INF)	0.142539*
D(INF)	-0.377395*	D(INF(-1))	-0.106526**
D(INF(-1))	0.258835**	D(OIL)	0.021585**
D(dep)	0.103859*	D(M)	-0.048350*
D(OIL)	0.282677*	CointEq(-1)*	-0.302149*
D(OIL(-1))	0.191855*		
D(M)	-0.147744**		
D(M (-1))	-0.123395*		
CointEq(-1)*	-0.138939*		
<i>R-squared</i>	0.756476	<i>R-squared</i>	0.576497
<i>Log likelihood</i>	-127.4455	<i>Log likelihood</i>	-84.84113
<i>F-statistic</i>	17.05419	<i>F-statistic</i>	37.53090
<i>Prob(F-statistic)</i>	0.000000	<i>Prob(F-statistic)</i>	0.000000

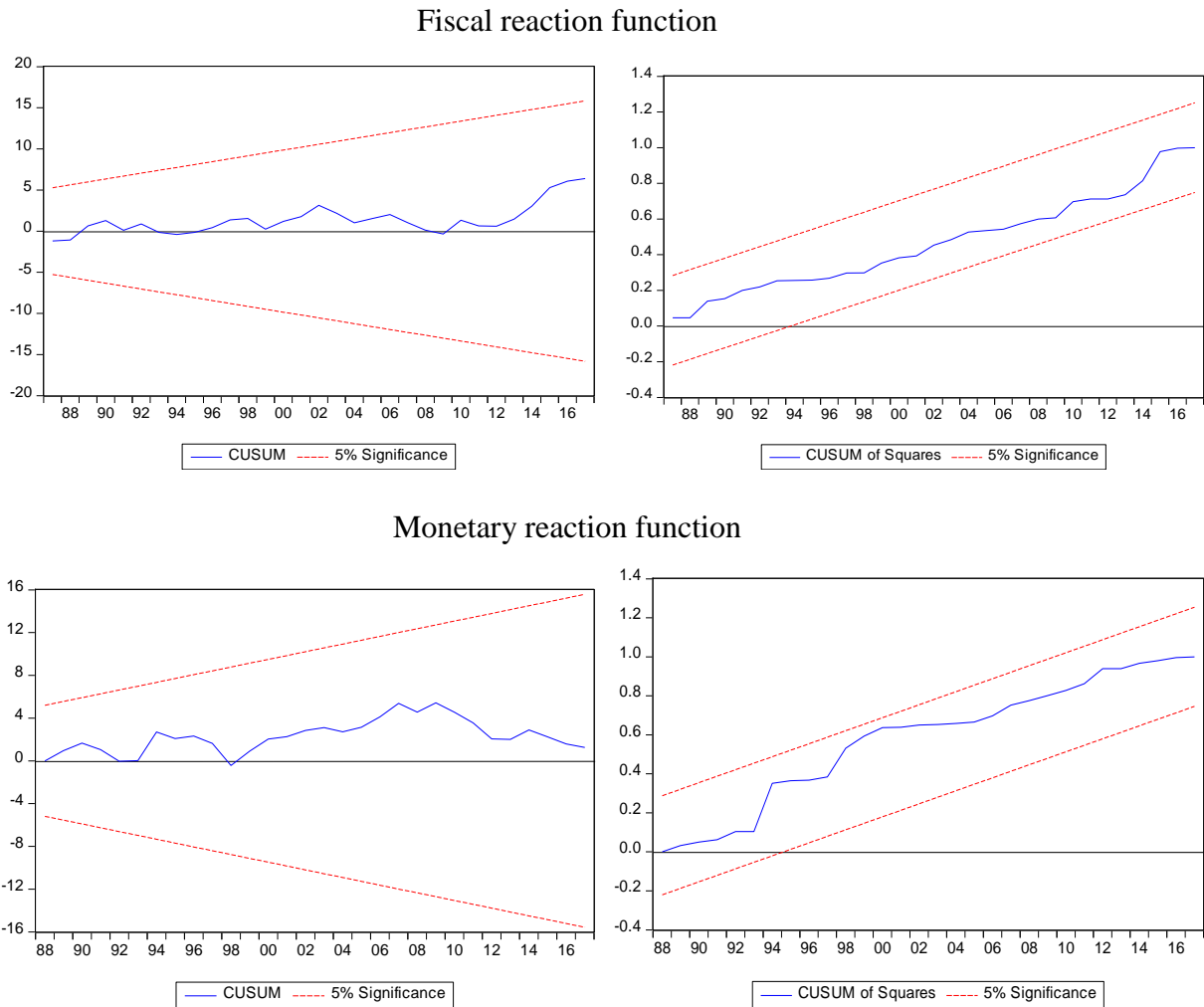
The estimation result of long-run fiscal policy reaction function shows that the movement of inflation, depreciation, output gap, money supply and oil price is significantly determining fiscal balance. Fiscal policy is not responsive to monetary policy during this period. It is supported by the coefficient of interest rate which is statistically non-significant in determining fiscal balance.

On the other hand, the variables which play significant role in determining monetary policy are: inflation, growth of real money supply, oil price and fiscal balance in Long-run. The output gap rate which represents the cyclical situation in economy and depreciation rate of Algerian Dinar does not play an important rule in determining monetary policy. At this period, the Central Bank of Algeria seems more concern to inflation and financial stability than output gap (unemployment). With regard to interaction of monetary and fiscal policy, the Central Bank of Algeria considered fiscal policy in conducting monetary policy. It is supported by the coefficient of fiscal balance which is statistically significant in determining interest rate.

The stability of the estimate model is examined using the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests. As shown in [Figure 3](#), the graphs of the CUSUM

and CUSUMSQ test lie within the 5% critical bounds which confirm that the estimated model is stable.

Figure 3: Plots of CUSUM and CUSUMQ statistics for coefficients Stability Tests



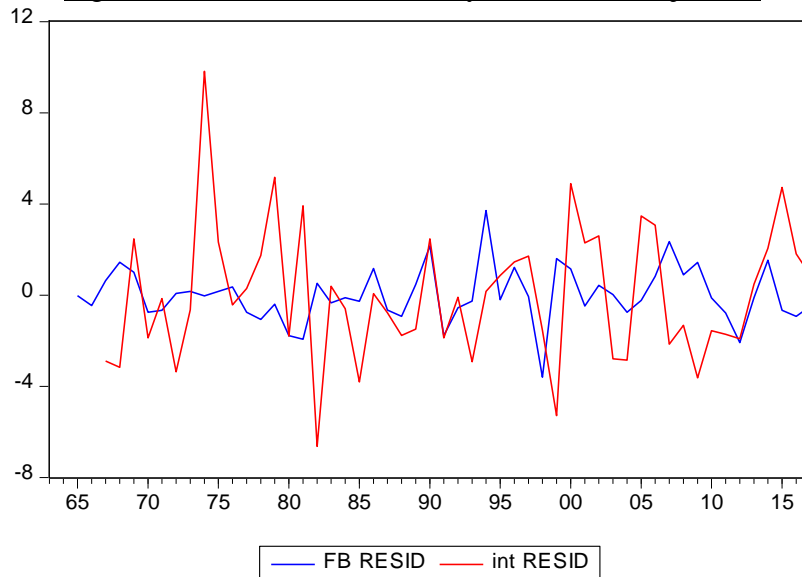
Based on the results obtained above, we identify now the optimal interaction between monetary policy and fiscal policy. Here, optimal is defined as a stable position that if one of the policy (because, among other things) changed to achieve certain objectives, the policy will harm the other policies in order to achieve other goals¹¹. We assume that the main objective of monetary policy is assumed to focus on price stability, while fiscal policy is the main goal of output stabilization.

In achieving the main goal each, both policies will always have a deviation from the intended target in spite of the adjustments have been held. The negative deviation means that the policy is too high (expansive/ active) from the target. Conversely, a positive deviation means that the policy had been pursued too low (contractive/passive) from the target. The policy is said to be appropriate and optimal if there is no deviation¹². Plot of deviations of monetary (int RESID) and fiscal (FB RESID) policies during the study period is presented in Figure 4. This figure shows that fiscal policy has smaller deviations from the intended target than monetary policy.

¹¹ Refer to the idea of Pareto optimal in microeconomics (see for example: [Varian, 1992](#)).

¹² For more detail see: [Arby & Hanif \(2010\)](#) and [Kuncoro & Sebayang\(2013\)](#).

Figure 4: Deviation of Monetary and Fiscal Projection



Overall, the deviation of interaction between monetary and fiscal policies is summarized in Table 6. It includes an active monetary/fiscal policy (expansive) and passive (contractive). Of the 55 samples, monetary policy occurs 28 times passive and the remaining 27 cases are active. The active fiscal policy comprises 31 cases and 24 other cases are passive. The combination of active and passive policies between the monetary and fiscal policy generate the optimal pay-off that is 14 based on the mini-max and maxi-min criteria¹³. Pay off 14 is in the active column. In general, fiscal policy is more dominant for the case in Algeria.

Table 6: Interaction Matrix and Pay off between Monetary and Fiscal Policy

interaction		monetary policy		Total	Max -min criteria
fiscal policy	Pay off	passive	Active		
	passive	11	13	24	13
	Active	17	14	31	14
	Total	28	27	55	
	Mini-max criteria	17	14		14

Therefore, the optimal interaction is when both monetary and fiscal policies are active (expansive). In this circumstance, the prudent monetary policy followed by sound fiscal policy would probably be the best choice of an optimal policy mix in Algeria.

The third procedure we follow now is to estimate the time-varying parameters in a State-Space model with Markov-Switching. Since nonlinear econometric methods require a lot of data, we have converted the annual data to the corresponding quarterly data using cubic spline interpolation method¹⁴. We use the interest rate (exactly the money market rate) (denoted by *int*), as a measure of the central bank's monetary policy, and the budget balance to GDP ratio (denoted by *FB*) as a measure for fiscal policy. In order to implement the state-dependent analysis we estimate a MS-VAR model with parameters which vary across regimes (MSIA-VAR model). We have chosen the MSIA(2)- VAR(1) specification. The choice of this specification derives from the fact that by increasing the number of lags the parameters increases noticeably.

Estimation results of MS-VAR model are reported in Table 7. The non-linear specification is more suitable in this context (AIC and HQ criteria select the non-linear model). More evidence is given by the linearity tests that reject the hypothesis of linearity at 99% level. The high values of transition probabilities p_{11} and p_{22} confirm the presence of highly persistent regimes. The average

¹³ There are four possible combinations of monetary and fiscal policy stances that have been referred to as monetary-fiscal policy interactions. The four combinations are: (i) an M regime; (ii) an F regime; (iii) a regime where no authority provides the nominal anchor and the price level is indeterminate; (iv) a regime where both authorities try to provide the nominal anchor and debt is unbounded. By dividing 55 views into 4 cases, we will get approximately 14.

¹⁴ The data period is from the first quarter in 1963 to the first quarter in 2017 (giving 217 observations). For more details about interpolation method see the appendix in Chibi et al 2014.

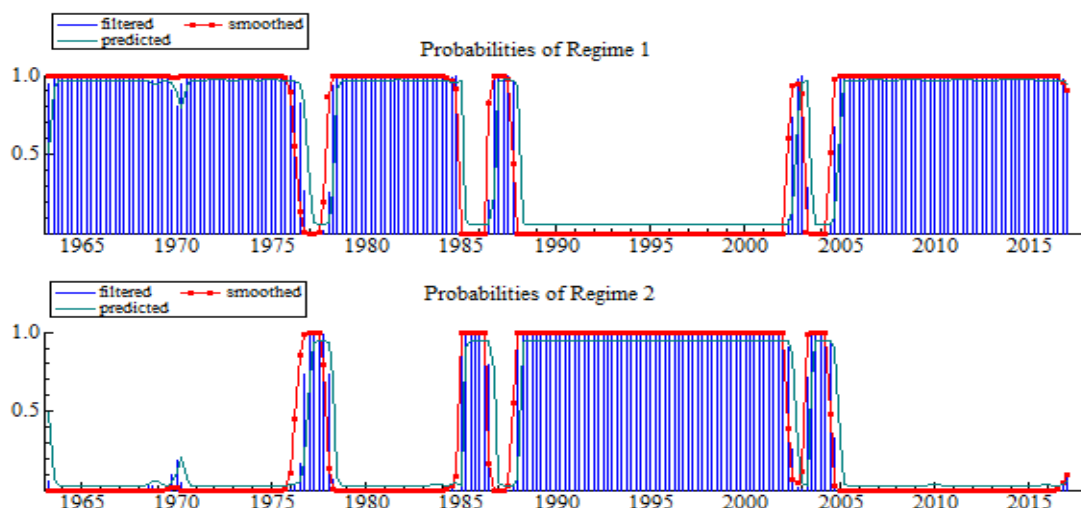
duration of regime 1 (34.04) gives support to this fact. The low value of ergodic probability indicates that the number of periods which belong to the regime 2 is relatively small if compared to that of regime 1. In addition, the ergodic probabilities imply that the economy would spend about 0.6436 of the time spanned by our sample of data in the first regime. In contrast, regime 2 has an ergodic probability of about 0.3564 %. Hence, these transition probabilities reveal the presence of important asymmetries. Figure 5 shows the associated smoothed, filtered, and predicted transition probabilities.

Table 7: Estimation Results using MSIA (2) -VAR (1) specification

Regime 1		
<i>Coefficients</i>	<i>FB</i>	<i>int</i>
C	0.860219 * (0.4288)	0.079268 * (0.1281)
<i>FB</i> (-1)	0.960411 * (0.3887)	0.03366 *** (0.2215)
<i>int</i> (-1)	-0.360986 *** (0.8065)	0.988624 * (0.2862)
Regime 2		
C	0.348593** (0.5952)	-0.591190** (0.6715)
<i>FB</i> (-1)	0.954523* (0.2189)	-0.031522*** (0.2371)
<i>int</i> (-1)	0.057726*** (0.5553)	0.913346* (0.3537)
		<i>Standard Errors</i>
Regime 1		0.4817110
Regime 2		0.2017272
<i>Transition Probabilities Matrix</i>		
Regime 1	0.9706	0.0294
Regime 2	0.0531	0.9469
<i>regime properties</i>		
Erg. Prob.	0.6436	0.3564
Duration	34.04	18.85
N. Obs	139.4	76.6
Log Lik.	-789.1920	
LR linearity test	553.5639	Chi =[0.0000]

The (-1) term into parentheses refers to the AR(1) process. Standard errors are in parentheses
 ***, **, * denote respectively statistical significance at the 1%, 5% and 10% levels.

Figure 5: MSVAR: Regime probabilities. MSIA(2)-VAR(1), 1963 (2) - 2017 (1)



The point estimates of the regime dependent means which are statistically different. The estimated mean in regime 1 is negative and for regime 2 is positive. These signs validate hypothesis that within the sample period, the variables dichotomises into phases that exhibit declining and growing interactions. We label the growing phase as the period of accommodative monetary-fiscal policies (i.e. regime 2), and the declining phase as the period of counteractive monetary-fiscal policies (i.e. regime 1). Since the signs assumed by regime 1 and regime 2 are opposing (i.e. negative and positive), it implies that during the early stages of our sample period, both policies were counteractive and that latter on, they were accommodative (in the first situation both policies were expansionist¹⁵, and that in the second situation, they were contractionist). Muscatelli et al. (2002) refer to this kind of behaviour of monetary and fiscal policy as being strategic substitutes and complements, respectively. This may show the predominance of a single regime (1), whereas regime (2) would only be an adjustment strategy of policies originating from macroeconomic disturbances in economy and not a change in paradigm representing a new regime. By analyzing regime (2) more closely, we observe that this regime is feasible in more turbulent moments in the history of the Algerian economy. The period between 1985-1999 which was predominantly counteractive, coincides with the oil price crunch of the 1980's, and the period when Algeria implemented the structural adjustment programme. Also, the Bank of Algeria has used the cash-back liquidity and deposit facility tools mainly during the period 2003-2005 due to the excessive increase in cash flow. The use of these tools has allowed the recovery of an important part of excess liquidity in the interbank market.

Therefore, the behavior of monetary policy in regime (2) would be just a response to these external shocks instead of a policy that varies according to a change in the macroeconomic paradigm. At those times, monetary policy reactions were quite contractionist, that is, with a large increase in interest rates, whereas the fiscal policy did not show a significant change in its path.

VI. Conclusion

The present study provides quantitative evidence to explore the monetary and fiscal policy interactions in Algeria between 1963 and 2017.

First, we propose the reaction function between monetary and fiscal policies, and examined the nature of fiscal policies in Algeria using a vector Autoregression (VAR) model. The results provide evidence of a non-Ricardian fiscal policy in Algeria (a negative correlation between fiscal balances and government liability). These results suggest the validity of the fiscal theory of the price level determination, which postulates that changes in prices are driven by fiscal policies, and that the price level has to adjust to ensure equilibrium in private sector wealth, and government solvency.

In the second exercise, we try to estimate the policy reaction function of the Central Bank of Algeria (Interest Rates equation) and Algerian government (fiscal balance equation) using ARDL model. The reaction function between fiscal and monetary authorities indicates that fiscal policy is not responsive to monetary policy during this period and monetary policy is responsive to the fiscal policy. Also, we test the deviation of both policies (i.e., active or passive policies) from the intended target. The results show that fiscal policy has more deviations smaller than monetary policy (fiscal policy is more dominant for the case of Algeria). Therefore, the optimal interaction is when both monetary and fiscal policies are active (expansive). In this circumstance, the prudent monetary policy followed by sound fiscal policy would probably be the best choice of an optimal policy mix in Algeria.

Further, the paper analyzes the interactions between monetary and fiscal policies by applying a State-space model with Markov-switching to estimate the time-varying parameters of the relationship. The evidence indicates that monetary and fiscal policies in Algeria have interacted in a counteractive manner for most of the sample period. With these results we identify

¹⁵ The Algerian government has pursued a very expansionary fiscal policy, through the implementation of a series of substantial public investment programs (2001-2004, 2005-2009, and 2010-2014) with initial allocation of US \$ 500 billion.

a game where the fiscal authority plays first (or it is active) while the monetary authority have a passive behavior determining the debt levels to the prices given by the fiscal policy. This is favorable to the fiscal dominance, as founded in before.

For the policy maker, our results imply the existence of fiscal dominance in the interactions between monetary and fiscal policies in Algeria. The evidence on the implementation of the non-Ricardian fiscal policy and the fiscal theory of the price level implies that inflation, predominantly results from fiscal problems, and not from lack of monetary control. Based on the results obtained, government should pay attention to monetary activities before embarking on fiscal policies, especially with respect to government liabilities.

It is thus straightforward to recommend that monetary policy should be independent and aimed at containing inflation. In this regard, we encourage the authorities to stand ready to tighten the monetary stance if inflationary pressures arise. While discouraging monetary financing of the deficit, we underline the need to put in place safeguards, including time and quantity limits, to contain its negative impact¹⁶ should such financing continue. In this context, we recommend the central bank's commitment to sterilizing liquidity resulting from monetary financing as needed.

¹⁶ Repeated government demands for liquidity injections (fiscal dominance) would: Put further pressures on foreign reserves (will fuel import demand); primarily support consumption rather than investment; risk plunging the economy into an inflationary spiral; and undermine BA's capacity to control monetary conditions and achieve price stability, and weaken its balance sheet.

References

- Arby, M. F., & Hanif, M. N. (2010). Monetary and fiscal policies coordination-Pakistan's experience. MPRA Paper No. 24160
- Asamoah, L. A., & Adu, G. (2016). An empirical analysis of the determinants of interest rates in Ghana. *Journal of African Business*, 17(3), 377-396.
- Barro, R. and D. Gordon, (1983), "Rules, Discretion and Reputation in a Model of Monetary Policy", *Journal of Monetary Economics*, 12, 101-121.
- Bajo-Rubio, O., Diaz-Roldan, C., & Esteve, V. (2014). Deficit sustainability, and monetary versus fiscal dominance: the case of Spain, 1850–2000. *Journal of Policy Modeling*, 36(5), 924-937.
- Bennett, C., & Loayza, N. (2000). Policy Biases when the Monetary and Fiscal Authorities have Different Objectives. *Journal Economía Chilena (The Chilean Economy)*, 3(2), 53-72.
- Bianchi, Francesco (2012). Evolving monetary/fiscal policy mix in the united states.' *American Economic Review*, 102(3), 167-72.
- Bohn, H. (1998): "The Behavior of U.S. Public Debt and Deficits", *Quarterly Journal Of Economics*, 113, 949-963.
- Buiter, w. h. (2002): "the fiscal theory of the price level: a critique", *economic journal* 112, 459-480.
- Buiter, W. H., & Sibert, A. C. (2018). The fallacy of the fiscal theory of the price level: One last time. *Economics: The Open-Access, Open-Assessment E-Journal*, 12(2018-48), 1-56.
- Carlstrom, c. t. and fuerst, t. s. (2000): "the fiscal theory of the price level", *Federal reserve bank of Cleveland economic review* 36, 1, 22-32.
- Canzoneri, M. B., R. E. Cumby and B. T. Diba (2000). "Is the price level determinacy by the needs of fiscal solvency?" *The American Economic Review*, 91(5) 1221-1238.
- Canzoneri, M., Cumby, R., & Diba, B. (2010). The interaction between monetary and fiscal policy. In *Handbook of monetary economics* (Vol. 3, pp. 935-999). Elsevier.
- Çekin, S. E. (2013). Monetary and fiscal policy interactions in Turkey: a markov switching approach. *Texas Tech University, Texas*.
- Chakraborty, L. S. (2010). *Determination of interest rate in India: empirical evidence on fiscal deficit-interest links and financial crowding out*. Publications Unit, National Institute of Public Finance and Policy.
- Chibi, A., Benbouziane, M., & Chekouri, S. M. (2014). The Impact of Fiscal Policy on Economic Activity over the Business Cycle: An Empirical Investigation in the Case of Algeria. In *Economic Research Forum Working Papers* (No. 845).
- Chuku, C. A. (2010). Monetary and fiscal policy interactions in Nigeria: an application of a state-space model with Markov-switching. *CBN Journal of Applied Statistics*, 1(1), 39-51.
- Davig, Troy, and Eric Leeper (2006). Fluctuating macro policies and the fiscal theory. In *NBER Macroeconomics Annual 2006, Volume 21*. (National Bureau of Economic Research, Inc) pp. 247-316.
- Davig, Troy, and Eric Leeper (2007). Generalizing the taylor principle. *American Economic Review*. 97(3), 607- 635.
- Dixit, Avinash, and Luisa Lambertini. 2003. "Interactions of Commitment and Discretion in Monetary and Fiscal Policies." *American Economic Review*, 93(5): 1522-1542.

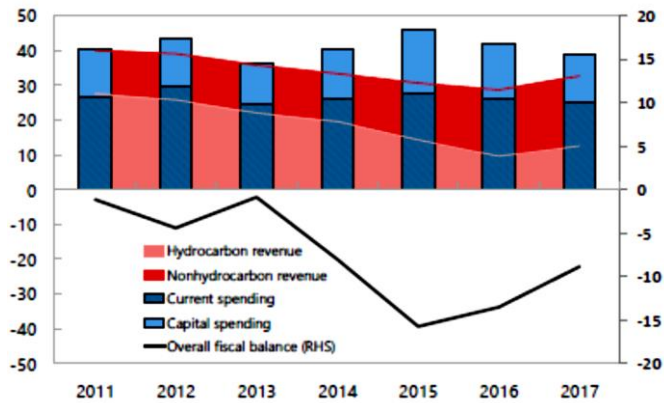
- Elbadawi, I., Goaid, M., & Tahar, M. B. (2017). Fiscal-Monetary Interdependence and Exchange Rate Regimes in Oil Dependent Arab Economies. In *Economic Research Forum Working Papers* (No. 1116).
- Fialho, M. L., & Portugal, M. S. (2005). Monetary and fiscal policy interactions in Brazil: an application of the fiscal theory of the price level. *Estudos Econômicos (São Paulo)*, 35(4), 657-685.
- Gerba, E., & Hauzenberger, K. (2013). *Estimating US fiscal and monetary interactions in a time varying VAR* (No. 1303). School of Economics Discussion Papers.
- Goncalves, C. E. (2017). Is fiscal dominance for real? Evidence from Brazil's high frequency data!.
- Gonzalez-Astudillo, M. (2013). Monetary-fiscal policy interactions: Interdependent policy rule coefficients. Finance and Economics Discussion Series. Federal Reserve Board, Washington, D.C., USA. 2013-58.
- Goyal, A. (2007). "Tradeoffs, delegation and fiscal-monetary coordination in a developing economy," *Indian Economic Review*, 42(2): 141-164.
- Goyal, A. (2018). The Indian fiscal-monetary framework: Dominance or coordination? *International Journal of Development and Conflict*, 8(1), 1-13.
- Javid, A. Y., & Arif, U. (2014). Fiscal and Monetary Regime Identification for Price Stability in Case of Pakistan's Economy. *Journal of Economic Cooperation & Development*, 35(3).
- Jevđović, G., & Milenković, I. (2018). Monetary Versus Fiscal Dominance In Emerging European Economies. *Facta Universitatis, Series: Economics and Organization*, 15 (2), 125-133.
- Kliem, M., Kriwoluzky, A., & Sarferaz, S. (2016). Monetary–fiscal policy interaction and fiscal inflation: A tale of three countries. *European Economic Review*, 88, 158-184.
- Krolzig, H.M. (1998). "Econometric modeling of Markov-switching vector autoregressions using MSVAR for Ox". *Discussion Paper*, Department of Economics, University of Oxford.
- Kuncoro, H., & Sebayang, K. (2013). The dynamic interaction between monetary and fiscal policies in Indonesia. *Romanian Journal of Fiscal Policy (RJFP)*, 4(1), 47-66.
- Leeper, E. M. (1991). "Equilibria under 'active' and 'passive' monetary and fiscal policies," *Journal of Monetary Economics*, 27(1), 129–147.
- Leith, Campbell, and Simon Wren-Lewis (2000) 'Interactions between monetary and fiscal policy rules.' *Economic Journal* 110(462), C93-108.
- Maddala, G. S., and I. Kim (1998). *"Unit Roots, Cointegration, and Structural Change"* Cambridge University Press, Cambridge.
- McCallum, b. t. (2001): "indeterminacy, bubbles, and the fiscal theory of price level determination", *journal of monetary economics* 47, 19-30.
- Merzlyakov, S. (2012). Strategic interaction between fiscal and monetary policies in an export-oriented economy. *Panoeconomicus*, 59(2), 201-216.
- Muscatelli, V. A., Tirelli, P., & Trecroci, C. (2004). Fiscal and monetary policy interactions: Empirical evidence and optimal policy using a structural New-Keynesian model. *Journal of Macroeconomics*, 26(2), 257-280.
- Obeng, S. K., & Sakyi, D. (2017). Macroeconomic determinants of interest rate spreads in Ghana. *African Journal of Economic and Management Studies*, 8(1), 76-88.
- Ornellas da Silva, R. (2011, September). Fiscal and monetary interaction in brazil. In *33^o Meeting of the Brazilian Econometric Society*.

- Panjer, N., de Haan, L., & Jacobs, J. (2017). *Is fiscal policy in the euro area Ricardian?* (Working Paper No. 562). Netherlands Central Bank, Research Department.
- Pesaran, M. H., Shin, Y. & Smith, R. J. (2001). "Bounds testing approaches to the analysis of level relationships". *Journal of Applied Econometrics*, 16, 289–326.
- Piergallini, A. (2017). *Interactions between Nonlinear Monetary and Fiscal Policies*. University of Rome Tor Vergata.
- Sargent, Thomas and Neil Wallace. (1981). "Some unpleasant monetarist arithmetic," *Quarterly Review*, 1981, Fall Issue, 5: 3, 1-17.
- Saulo, H., Rêgo, L. C., & Divino, J. A. (2013). Fiscal and monetary policy interactions: a game theory approach. *Annals of Operations Research*, 206(1), 341-366.
- Šehović, D. (2013). General aspects of monetary and fiscal policy coordination. *Journal of Central Banking Theory and Practice*, 2(3), 5-27.
- Semmler, W., and W. Zhang (2003) "Monetary and fiscal policy interactions: Some empirical evidence from the Euro-Area". Mimeo, Bielefeld University Working Paper No. 48, March, 2003.
- Semmler, W., & Zhang, W. (2004). Monetary and fiscal policy interactions in the euro area. *Empirica*, 31(2-3), 205-227.
- Shahid, M., Qayyum, A., & Shahid Malik, W. (2016). Fiscal and Monetary Policy Interactions in Pakistan Using a Dynamic Stochastic General Equilibrium Framework. MPRA Paper No. 85549.
- Sims, Christopher (1994). A simple model for study of the determination of the price level and the interaction of monetary and fiscal policy. *Economic Theory*, 4(3), 381- 99.
- Trehan, B. and Walsh, C. E. 1988. "Common trends, the government budget constraint and revenue smoothing". *Journal of Economics Dynamics and Control*, 17: 423–441.
- Varian, H.R., 1992. *Microeconomic Analysis*, third edition, Norton, W.W. & Company, Inc.
- woodford, m. (1995): "price-level determinacy without control of a monetary aggregate", *carnegie-rochester conference series on public policy* 43, 1-46.
- Woodford, M. (2003). *Interest and Prices: Foundations of a Theory of Monetary Policy*. NJ: Princeton University Press

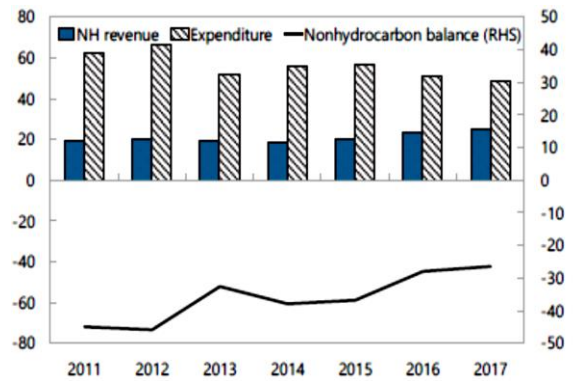
Appendix

Figure 1: Fiscal Indicators

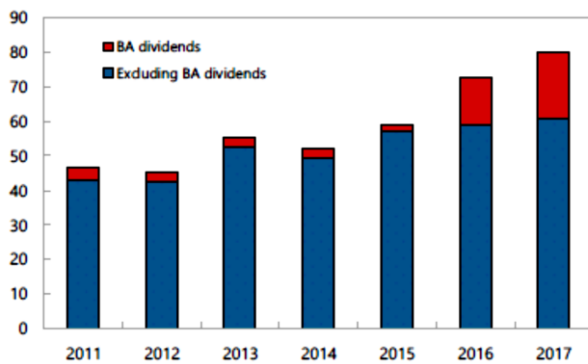
Overall Fiscal Balance (Percent of GDP, 2011–17)



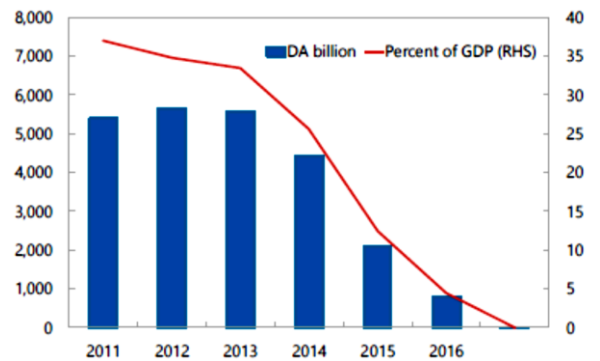
Nonhydrocarbon Fiscal Balance (Percent of NHGDP)



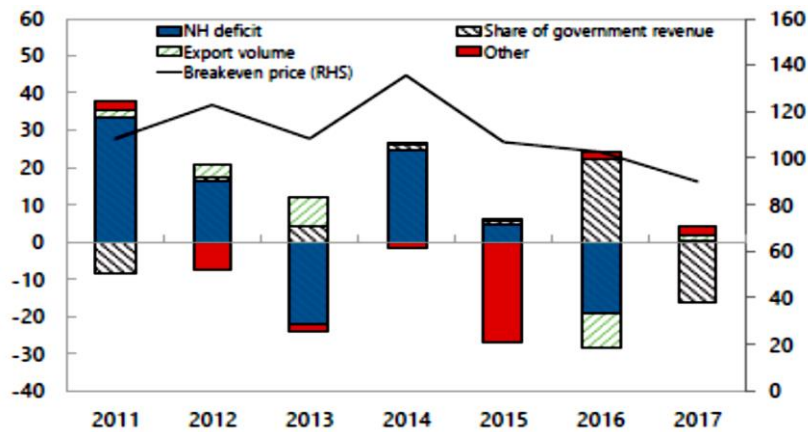
Share of Nonhydrocarbon Revenue to Current Spending (Percent)



Oil Stabilization Fund (Stock, 2011-17)

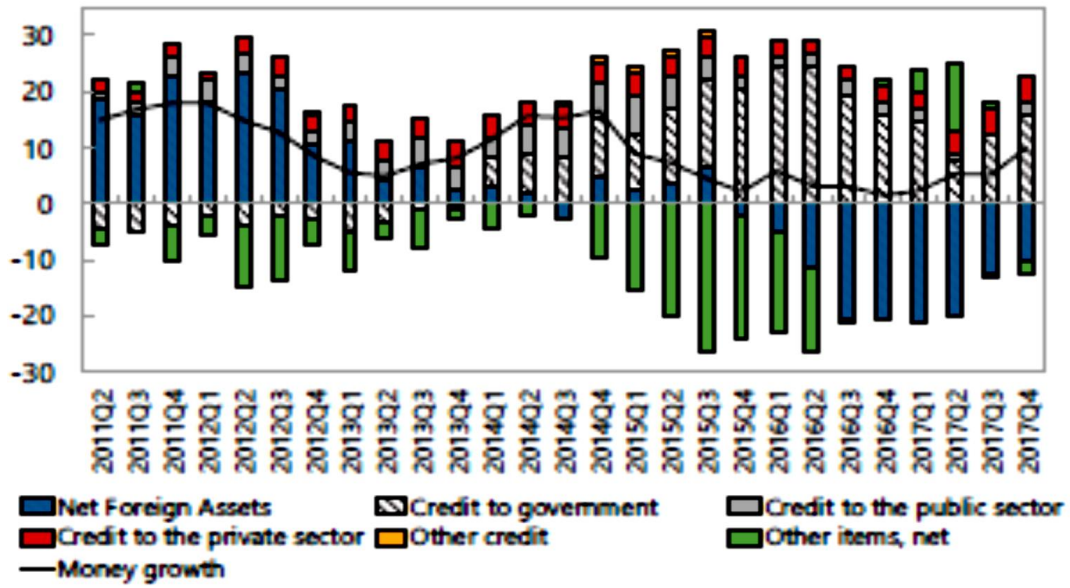


Change in the Fiscal Breakeven Price (Contribution in percent)



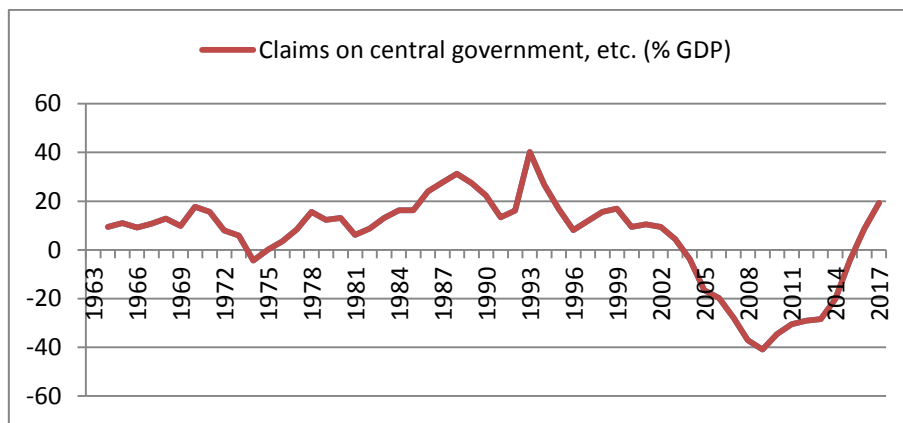
Source : IMF Country Report No. 18/168. P:7.

Figure 2: Contributions to M2 Growth (Percent)



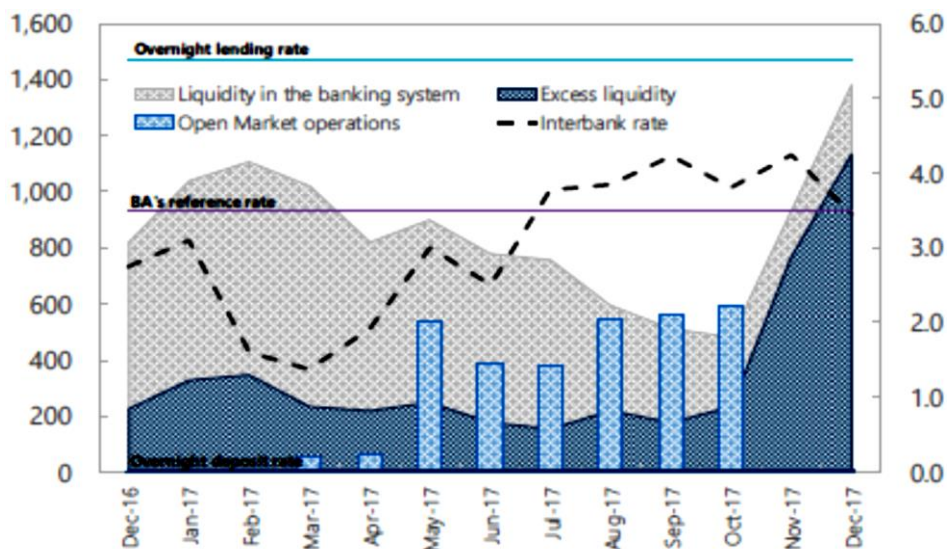
Source : IMF Country Report No. 18/168. P:8.

Figure 3: Claims on central government, etc. (% GDP) (1964-2017)



Source: WDI (2018).

Figure 4: Liquidity (in DZD) and interest rates (in percent)



Source : IMF Country Report No. 18/168. P:8.