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The Macroeconomic Effects of Monetary Policy and Government Expenses in Response to Covid-19: Evidence from Saudi Arabia

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Abstract

The purpose of this paper is to test the effectiveness of the interaction between monetary and budgetary policies during the Covid-19 crisis in Saudi Arabia. To this end, we use the Markov regimes technique to take into account change in regimes of the two policies. We adopt the SVAR modelling of sign restrictions to test the joint effect of a stagnation in tax revenues and a 1% increase in government spending over a time horizon of four periods identified as tax shocks during the Covid-19 period. The results of impulse response tests show that this shock did not lead to an improvement in industrial production. The results show tax dominance by financing state resources to compensate for the burden of government expenditure. If the central bank has raised the interest rate to anchor inflationary expectations, it will in turn have negative effects on economic activity as measured by the industrial production index. This scenario coincides with the second regime of the monetary rule, where the central bank acts in response to expected inflation.

Keywords: *Monetary Policy, Budgetary Policy, Government Expenses, Covid-19, Change of Regimes, SVAR.*

Introduction

Modern macroeconomic theory has largely focused on developing models that improve our understanding of economic mechanisms and the interrelationships between key economic variables. This focus has come along a complementary move that uses macroeconomic models to make positive, as well as normative, assessments about government policies. In both these paradigms, the study of monetary and budgetary policy stands out clearly. The reason for this interest among academics, policy-makers and the general public is the now solid empirical evidence that monetary policies have a significant short-term impact on the real economy and that the choice of how to conduct the two policies has important consequences for overall activity, both on the business cycle and on long-term economic growth. However, coordination between budgetary and monetary policy has become a key global factor in recent years, both to counter the consequences of the recent pandemic crisis and to support economic recovery. At the beginning of 2020, the world was rocked by a new viral infection called Covid-19, combining at least three shocks, health, financial and economic. This shock led to one of the most serious crises since the Second World War, and it was out of the question not to intervene. As a result, governments around the world moved swiftly to take unprecedented actions to curb the pandemic, with the top priority being to contain the virus, followed closely by limiting financial panic and economic fallout, supported of course by central banks and supervisors. According to Boeckx et al., (2020), the monetary and budgetary authorities worldwide implemented unprecedented measures, in terms of both size and speed, to curb financial panic and cushion the economic impact caused by Covid-19. These policies have been advocated by global economic institutions such as the International Monetary Fund (IMF), which was called to reconsider the scale and importance of conventional and non-conventional tools and the instruments that have made their transmission mechanisms effective, thus affecting production and prices through public and private consumption and investment. As a result, a fresh look has been placed at the interaction between budgetary policy and monetary policy. The recession caused by the pandemic increased pressure on budgetary and monetary policy, triggered the need for closer coordination of domestic policies and led to greater use of central banks' balance sheets. This policy-mix, or macroeconomic mix, refers to the government's combination of these two policies in order to achieve well-defined objectives. The macroeconomic policy mix differs according to countries' position in the economic cycle and is a pillar of a country's economic

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policy in both normal times and crisis times. This has given rise to a new theoretical and empirical debate about how monetary policy interacts with budgetary policy and financial markets, most notably during the recent Covid-19 crisis. In this regard, the aim of this paper is to examine the issue of budgetary dominance in times of crises and the conditions under which it is possible to accept the loss of monetary policy autonomy. This brings us back to a number of research questions, including how it is possible to rethink the paradigm of monetary policy autonomy during a great recession period, when budgetary dominance has been introduced in response to a crisis of such magnitude. It will therefore be important to examine the pandemic scenario in which epidemiological shocks occur in all countries to varying degrees, hampering economic activity. In terms of economic impact, this scenario assumes that these shocks are temporary. The first line of intervention is emergency budget support for the health sector and the reinforcement of social protection for vulnerable households, forced to stop work during the containment period. In such a context characterised by a predominant budgetary stance, it is necessary to question the role and contribution of the central bank in mitigating the undesirable effects of the crisis and ensuring the financing of the State budget, at the risk of fuelling inflation. It would therefore be useful to examine and understand the trade-off between monetary stability and 'social' stability via the instrument of public spending during a period of a severe crisis. The other research question is the nature of exogenous health shocks and their effects on budgetary policy and other macroeconomic variables during the Covid-19 pandemic. Similarly, it is important to consider the measures taken to mitigate the damage caused by the pandemic and to examine their effectiveness. The other important question is whether or not there has been a change in the rules applied by the monetary and budgetary authorities to respond effectively to well-defined objectives. In other words, we need to examine the nature of the central bank's reaction to changes in lagged inflation, expected inflation and the output gap, as well as the government's reaction to changes in debt and the output gap. Then, this paper is structured as follows: the second section presents and reviews the different transmission channels for monetary and budgetary policy, as well as the theories that examined the interactions between the two policies. In the same vein, the third section reviews the literature. The fourth section empirically tests the effect of pandemic shocks in Saudi Arabia, taking into account change in the monetary and budgetary regimes of the Saudi economy. Section 5 presents and discusses the results. Section 6 concludes the paper.

Theoretical Background

The nature of a policy mix as an optimal coordination of monetary and budgetary policy has changed as a result of changes in the economic environment. The autonomy of monetary policy is limited by the mobility of international capital, while budgetary policy is constrained by the high level of public debt. Furthermore, the growing internationalisation of economies has led to a radical change in the content of this policy mix, which consists of abandoning internal coordination in favour of international coordination of economic policies through institutional mechanisms, including central banks and exchange rate regimes (Mbuyi and Kojack, 2021). As a result, the study of a policy mix implies a problem of optimal allocation of instruments to objectives (Mundell 1962). Years ago, Mundell (1962) advocated allocating monetary policy to external equilibrium and budgetary policy to internal equilibrium. In 1977, Kydland and Prescott pointed out that stabilisation policies are best conceived within the framework of a strategic interplay between monetary authority, budgetary authority and public authority. The analysis goes beyond the problem of allocating instruments to objectives to a second problem, namely the problem of coordination between economic policy authorities. Initially, the focus was on the credibility of monetary policy in the fight against inflation. Then, in the 1980s and 1990s, the emphasis shifted to the dynamic stability of policy mix (Sargent and Wallace, 1981). Furthermore, as financing public spending is an area of interdependence, monetary policy and the budget raise strategic questions between policies. Central bank independence therefore means that the strategic game is up, and that each of the two policies pursues its own objectives without concern for the overall coherence of the policy mix. The question that arises in this regard: why not have a single economic policy authority that integrates both a monetary policy and an optimal budgetary policy? (Bartsch, Bénassy-Quéré et al, 2020). Studying the effectiveness of economic policies shows that

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the number of instruments must meet the number of objectives (Tinbergen, 1952). Tinbergen's analysis was developed by Mundell (1962). According to Mundell (1962), it is not enough to have a certain number of instruments for a certain number of targets; you have to select the instruments that are most frequently used for each target. The question of a policy mix closely relates to a stabilisation policy, which raises two types of issues: the objectives and instruments to be used, and the proper use of these instruments. Mbuyi and Kojack (2021) have schematised the answer to this question according to Mundell's classic reasoning. This is done through a so-called dynamic treatment of the cross-effects of means on the setting of objectives. In other words, given a system with two instruments (1) and (2) and two targets (A) and (B), monitoring target (A) with instrument (1) means that target (B) can be removed from target (A). Mundell's solution is to allocate means to ends according to the comparative advantage principle. In other words, each instrument should be allocated to an objective that has the greatest relative impact. Mundell (1962) argues that this principle bears on the comparative advantage principle. Thus, while all instruments ultimately affect all objectives through the economic system, some instruments may be better placed to achieve specific goals, i.e. they are more "efficient". Therefore, each instrument should be "assigned" to an objective in line with its relative effectiveness. Another response draws attention to the need to assess the policy mix against the set of desirable short- and long-term objectives, such as debt sustainability or external competitiveness. These two approaches can be illustrated by two famous debates, one in the early 1960s led by Mundell, the other in the early 1980s heralded by Tobin. In the early 1960s, Mundell "shocked the American establishment" by asserting that the United States had the mix backwards. At the time, the United States was practising "loose money" to maintain a high employment rate and a "tight budget" to improve balance of trade and reduce pressure on the balance of payments. Mundell disagreed with the assumption that contracting domestic demand to "make more room for exports" and improve foreign trade was an effective strategy for reducing the pressure on the US balance of payments. According to Mundell, the root of the imbalance was financial. The US needed to reward capital more to stem potential outflows. In other words, through a financial channel, monetary policy was a more effective instrument to purse balance of payments objectives than a budgetary policy (Mbuyi et al, 2021). Consistently, Mundell argued that monetary policy should have been allocated to achieving the external balance objective. Essentially, the US had to raise interest rates sufficiently to attract or retain international capital. The contractionary effects of money on domestic activity should have been offset by an expansionary budgetary policy. A different principle, put forward by Tobin, had great resonance in the early 1980s. During these years, Tobin echoed economists' dissatisfaction with the combination of monetary tightening and budgetary loosening resulting from Volcker's determination to bring down US inflation and Reagan's policy agenda of tax cuts and increased (military) spending. According to Tobin, the resulting high real interest rates and a strong dollar undermined investment and growth, while creating budgetary imbalances conducive to instability, not to mention negative international spillovers. The author argued strongly for a shift to a flexible monetary system and a tight budget, which would be more likely to promote growth, maintain US cost competitiveness and improve the trade balance (Bartsch et al., 2020). Tobin's argument sets in stone what could be defined as a "growth and stability criterion" for choosing the right policy mix. For a given current stimulus, a restrictive monetary policy and a flexible budget lead to high real rates and real appreciation. This mix reduces investment and the current account balance, with negative effects on the national capital supply and foreign wealth. To the extent that it increases public debt, it also worsens the budgetary outlook. The opposite is true with a flexible currency and a tight budget, a combination that Tobin considers more desirable overall as it leads to higher growth and a more balanced external position (Nadji et al, 2019). Tobin's approach is still relevant today. Firstly, Tobin wrote at a time when bank credit to households, particularly in the form of mortgages, was quite limited compared to recent decades (Jorda et al., 2014). He therefore did not take into account the possibility that just as loose budgetary policy could lead to excessive accumulation of public debt, cheap money could also stimulate excessive accumulation of private debt (Mian and Sufi, 2014). In light of the 2008 international financial crisis, we are now aware that private credit booms can lead to financial instability, which indirectly creates budgetary vulnerability. However, and this is the second caveat, Monetary Policy (MP) and especially Budgetary Policy (BP) can draw on a plurality of potentially useful

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instruments to correct the undesirable effects of a given stance on long-term objectives. Tobin himself argues that a mixture of tight money and flexible budgeting may not be unfavourable to investment if the budgetary measures are designed to support capital accumulation. Now, in the wake of the recent pandemic crisis, we are considering the idea that the potential negative effects of low interest rates on private debt accumulation could be mitigated by macro- and micro-prudential instruments. Finally, the consequences for growth and stability may depend on the state of the economy and the policy instruments available to decision-makers. GDP growth may be compromised more by serious under-investment in public infrastructure than by the marginal increase in the tax rate needed to finance public investment. With negative real rates and key rates constrained to their effective lower bound, a public deficit can have a favourable impact on the budgetary outlook. (Bartsch, Bénassy-Quéré et al, 2020). With regard to the problem of coordination between authorities, Tinbergen (1952) points out that the concept of a policy mix depends on the existence of independent policy instruments. As Tobin argues, the ability to choose a policy mix requires that public deficits are not entirely financed by printing money, and that public debt is not merely a mirror image of bank reserves. The price of bank deposits and government bonds cannot be fixed by an open-ended commitment from the central bank. These instruments must be differentiated from the monetary base and its close substitutes, budget deficits determine growth in the money supply, and budgetary policy is inseparable from monetary policy (Tobin, 1987). For Tinbergen (1952), the optimal policy mix is the coordinated solution to the policy problem, handled jointly by budgetary and monetary authorities sharing the same objective function, a cooperative and Pareto-efficient solution to the basic optimal control problem. However, instrument independence is conceptually distinct from institutional independence. The latter can lead to costly coordination failures, as policy makers may not have the same objectives or the same preferences over different objectives, or face different constraints. It is remarkable, however, that many of the economists who shared Tinbergen's intellectual legacy are strongly in favour of strict central bank independence from coordination between monetary and budgetary authorities. The reason for this position resonates with current circumstances (F Bianchi, C Ilut, 2017; Corsetti; 2020). One of the main problems is that the process by which budgetary and monetary decisions are taken follows distinct logics specific to the remit of each authority. The objectives, deadlines and accountability mechanisms are different in the two cases. Consequently, while routine cooperation in the form of information exchanges takes place on a regular basis, strict coordination backed by binding ex ante commitments would probably result in budgetary considerations predominating over other considerations. These difficulties can be partly circumvented by policy rules that help each authority to anticipate the policy of the other, although experience with policy rules is not entirely convincing, particularly on the budgetary front. Of course, this does not mean that, in the event of greater stabilisation needs, monetary and budgetary policymakers should not take advantage of the complementarity between the two instruments. Without prejudice to its core mandate, monetary policy should consider such complementarities in the overall interest of stabilisation (Summers (2019), Debrun (2020), Bernanke (2020)).

One of the key messages is that an appropriate mix of expansionary monetary and budgetary policies jointly creates space for the other. This complementarity is essential for devising the right response to extreme events. In a crisis situation, the central bank creates budgetary space by significantly reducing the Treasury's borrowing costs - through its forward guidance and measures to influence risk-free rates further down the interest rate structure - and by effectively providing a monetary guarantee for government debt - with the implication, if not the explicit objective, of forcing market beliefs to converge towards the correct equilibrium (Thioune, 2021; Bianchi, 2017; Bénassy-Quéré et al.2020). For its part, the Treasury creates a monetary space by supporting the monetary authorities. The budgetary safety net prevents the central bank from having to operate with thin or negative capital if it suffers major portfolio losses linked to its monetary policy operations. This assurance preserves the independence and credibility of the central bank by allowing significant risk-taking inherent in unconventional monetary operations. Furthermore, budgetary policy can also create monetary space by internalising the costs and risks of a low equilibrium interest rate. Interdependence between the monetary and budgetary authorities in creating room for manoeuvre is a central element of the hydraulics involved if an effective policy mix is to be put in place in the event of a

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crisis. The institutional governance of this policy mix must allow sufficient stabilisation in the short term while preserving the benefits of credible commitments to price stability and the sustainability of public finances - and hence favourable financing conditions and financial stability. The ability of expansionary monetary policy and budgetary policy together to create additional space for each other is not necessary in normal times, i.e., outside extreme events. This is because, in normal times, monetary and budgetary policy are strategic substitutes; policy space is abundant and the right policy mix is not necessary to achieve the desired degree of macroeconomic stabilisation in the short term. On the other hand, in the event of extreme events, these policies both lack room for manoeuvre; they need to support each other to ensure that stimulation of demand is correctly dosed. They are strategic complements (Bartsch, 2020; Corsetti, 2020; Thioune, 2021), hence the importance of interdependence between the monetary and budgetary authorities in the creation of policy space, but also the importance of the institutional framework governing this interdependence, which has a strong impact on the success of the policy mix, in the short and long term.

Review of the Literature

Effectiveness of economic policies has been the interest of several economists for years (Friedman and Meiselman, 1963; Darrat, 1984; Garnison and Lee, 1995; Gramlich, 1971; Adefeso and Mobolaji, 2010 and Uhlig, 2005)). The conclusions drawn from various empirical studies differ depending on the country studied. Friedman and Meiselman (1963) conducted an empirical study to test the validity of Keynesian and monetarist theory, using a simple equation. The results support the stability of the monetarist model compared with the model based on the Keynesian multiplier. However, these results have been criticised by a number of economists who have pointed out that the study of Fiedman and Meiselman (1963) suffers from econometric shortcomings, namely the poor specification of the model used and the bias inherent in the endogeneity problems of the macroeconomic variables. In the same vein, Jordan and Anderson (1968) used a dynamic model and reached conclusions suggesting that monetary policy is more effective than budgetary policy. Waud (1974) used a similar econometric model and found that both types of policies had a very significant impact on real GDP. Similar studies have been carried out on developing countries. Ajayi (1974) noted that policy-makers use budgetary policy instead of monetary policy. The author estimated the impact of variables representing budgetary and monetary policies, using the ordinary least squares (OLS) technique. The results show that the impact of monetary policy is greater than that of budgetary policy. Consequently, efforts should be targeting monetary actions. However, Andersen and Jordan (1968) obtained contradictory results. They tested the effects of budgetary variables i.e., budget surplus, government spending and tax revenue and monetary variables i.e., money supply to the Gross Domestic Product of the United States. They found that budgetary policy has a faster and higher impact on US GDP. Studying Bangladesh, Chowdhury (1986) used the OLS technique to study the effectiveness of the two policies, estimating the modified St Louis equation. The main conclusions are that budgetary policy is more effective than monetary policy. Indeed, the sum of the coefficients of the budgetary variables is statistically higher than the sum of the coefficients of the monetary variables. Abbas (1991) examined the relationship between one-period lagged monetary variables and economic growth in Asian countries. The author found bidirectional causality between the two variables. Examining monthly data from 1986 to 1991, Olaloye and Ikhide (1995) attempted to estimate the modified St-Louis equation in the Nigerian economy. The results show that budgetary policy has a greater influence on the economy than monetary policy. However, most of these studies overlooked the non-stationary nature of the time series, the causality direction and endogeneity of the variables. In this regard, many researchers have criticised the use of the St-louis equation, which does not take into account other appropriate variables such as the interest rate, the exchange rate and the general price level. Consequently, the use of such an equation generates inefficient estimators that suffer from bias associated with the omitted variables. Hassan (2006) used VAR modelling to study the effectiveness of budgetary policy in Egypt. The data used are annual, covering the 1981-2005 period. The study showed that the effect of budgetary policy on growth is poor. The main conclusion of their estimates suggests that it is necessary for the two economic policies to coordinate in order to achieve

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maximum efficiency. Adefeso and mobolaji (2010) re-examined the relative effectiveness of monetary and budgetary policies on economic growth in Niger using annual data for a period from 1970 to 2007. By estimating an error-correction model, the authors show that the impact of monetary policy on real GDP is greater than the effect of budgetary policy in achieving macroeconomic stability. Suleiman (2009) focuses on the long-run effects of money supply as defined by M2, and public spending on economic growth in Pakistan. The study was carried out over a 30-year period from 1977 to 2007 and revealed the presence of a cointegrating relationship between the different variables, using the Johansen cointegration test. The main empirical results showed a negative impact of public spending on growth, while money supply had a positive effect. The conclusions affirm that monetary policy has an unlimited impact on economic growth in Pakistan. In the Swedish economy, Patterson and Sjoberj (2003) found a cointegrating relationship between economic growth and public spending for the 1961-2003 period. Public spending was divided into three broad categories: private consumption expenditure, investment expenditure and interest payments. They found that all variables significantly affect real output. Jordan, Roland and Carter (1999) examined the effectiveness of budgetary and monetary policies in some Caribbean countries i.e., Trinidad, Barbados and Guyani. In this study, budgetary policy was measured by public expenditure, while monetary policy was approximated by net domestic assets. Estimates of the VAR model showed that monetary policy had a statically significant negative impact on real GDP. This result indicates that an expansionary monetary policy leads, in the long term, to a fall in real GDP. It is clear that the results of the various empirical studies have been marked by controversy. The contradictions on the effects of budgetary and monetary policies on growth have been attributed to the choice of variables and the econometric methodology adopted. Büyükbas et al (2020) attempted to test the effects of the interaction between monetary and budgetary policies in Turkey. The results confirm the importance of the nature of shocks in terms of the interaction between monetary policy and political shocks, which remain complementary in response to demand and supply shocks. Azad et al (2021) examined budgetary and monetary policy interactions in Canada over a period that includes the global financial crises and Covid-19. The authors showed that interest rate rules for monetary policy and budgetary rules for budgetary policy change stochastically between two regimes. The authors also used a structural vector autoregression (VAR) model to analyse the effects of budgetary policies, similar to those undertaken by the Canadian government during the coronavirus pandemic. The results showed that budgetary policy was more active than monetary policy and that government spending helps to stimulate economic activity in the short term. However, the positive effects on real GDP and real private consumption disappear with the end of the budgetary stimulus. However, long-term interest rates rise, investment falls and inflation rises, creating problems for a central bank to miss the inflation target. Until now, there has been no empirical study of the effect of monetary and budgetary policies on economic growth in Saudi Arabia. Our study fills this gap by studying the interaction between the two policies during the Covid-19 period.

Methodology

Preliminary Analyses: Markov Regime-Switching Model

Chung et al (2007) and Davig and Leeper (2007, 2011) have criticised the assumption that monetary and budgetary regimes are fixed and have examined the impact of changing monetary and budgetary policies. Building on their work, as well as the work of Xu and Serletis (2016), we examine which monetary and budgetary rules change stochastically. To this end, we first construct an initial model consisting of two monetary and budgetary rules and follow a regime-switching Markov process to determine the probability and nature of each of the two policies in each regime. Finally, we determine the effects of shocks on policy variables via a 2nd SVAR model with sign restrictions, following Nahiyan Fayçal Azadun, Apostolos Serletisun,, Libo Xub (2021). Referring to Chung et al (2007) and David and Leeper (2007, 2011), we consider the following monetary Taylor rule:

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$$i_t = a_0(s_{m,t}) + a_1(s_{m,t})\pi_{t-1} + a_2(s_{m,t})\pi_t + a_3(s_{m,t})\pi_{t+1} + a_4(s_{m,t})y_t + \varepsilon_{m,t}$$

Avec it désigne le taux d'intérêt nominal, π t désigne le taux d'inflation, yt dénote l'output-gap. (sm t,) indique le régime de la politique monétaire non observable, qui suit un processus à régime markovien de deux états, gouvernés par la matrice de probabilités suivante :

$$\Pi_m = \begin{bmatrix} p_{m,11} & p_{m,12} \\ p_{m,21} & p_{m,22} \end{bmatrix}$$

With

$$p_{m,ij} = P[s_{m,t} = j \mid s_{m,t} = i]; i, j = 1, 2$$

$$p_{m,11} = 1 - p_{m,21} \; et \; p_{m,12} = 1 - p_{m,22}$$

« i » indique le régime 1 ou 2 de la politique monétaire « m » à l'instant t-1

« j » indique le régime 1 ou 2 de la politique monétaire « m » à l'instant t

D'un autre coté la règle budgétaire prendra l'équation suivante :

$$\tau_t = a_0(s_{f,t}) + a_1(s_{f,t})g_t + a_2(s_{f,t})y_t + a_3(s_{f,t})debt_t + \varepsilon_{f,t}$$

Avec t τ désigne les recettes fiscales, yt dénote l'output-gap et gt désigne les dépenses publiques, debtt dénote le taux d'endettement publique. (sf t,) indique le régime de la politique budgétaire non observable, qui suit un processus a régime markovien de deux états, gouvernés par la matrice de probabilités suivante :

$$\Pi_f = \begin{bmatrix} p_{f,11} & p_{f,12} \\ p_{f,21} & p_{f,22} \end{bmatrix}$$

With

$$p_{f,ij} = P[s_{f,t} = j \mid s_{f,t} = i]; i, j = 1, 2$$

$$p_{f,11} = 1 - p_{f,21} \; et \; p_{f,12} = 1 - p_{f,22}$$

The monetary rule equation suggests that monetary policy responds to changes in past, present and expected inflation and output gap under two regimes. The budgetary rule equation suggests that budgetary policy responds to changes in output gap and government spending under two different regimes insofar as a1(sf, t) and a2(sf, t) change across regimes. The data have a quarterly frequency from the first quarter of

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2000 to the second quarter of 2022. This period includes the Covid-19 period. Table 1 presents the definition of the variables used in our study as well as their sources.

Table 1. Definition of Variables and Sources

	Acronyms	Definition	Source
Nominal interest rate	*INT*	SCB's key rate	Saudi Central Bank (SAMA)
Money supply	*M2*	Money supply as defined by M2	SAMA
Price index	CPI_t	The consumer price index	General Authority for Statistics
Tax revenue	*RFISC*	Tax revenue	General Authority for Statistics
Government expenditure	*DEP*	Public spending	General Authority for Statistics
Industrial production index	*IPI*	Industrial production index (2010=100)	General Authority for Statistics
Exchange rate	*REER*	The real effective exchange rate index	IMF

Figure 1 shows the quarterly change in the variables over the period from 2000 to 2022.

Figure 1. The Quarterly Change in the Variables Over the Period From 2000 To 2022

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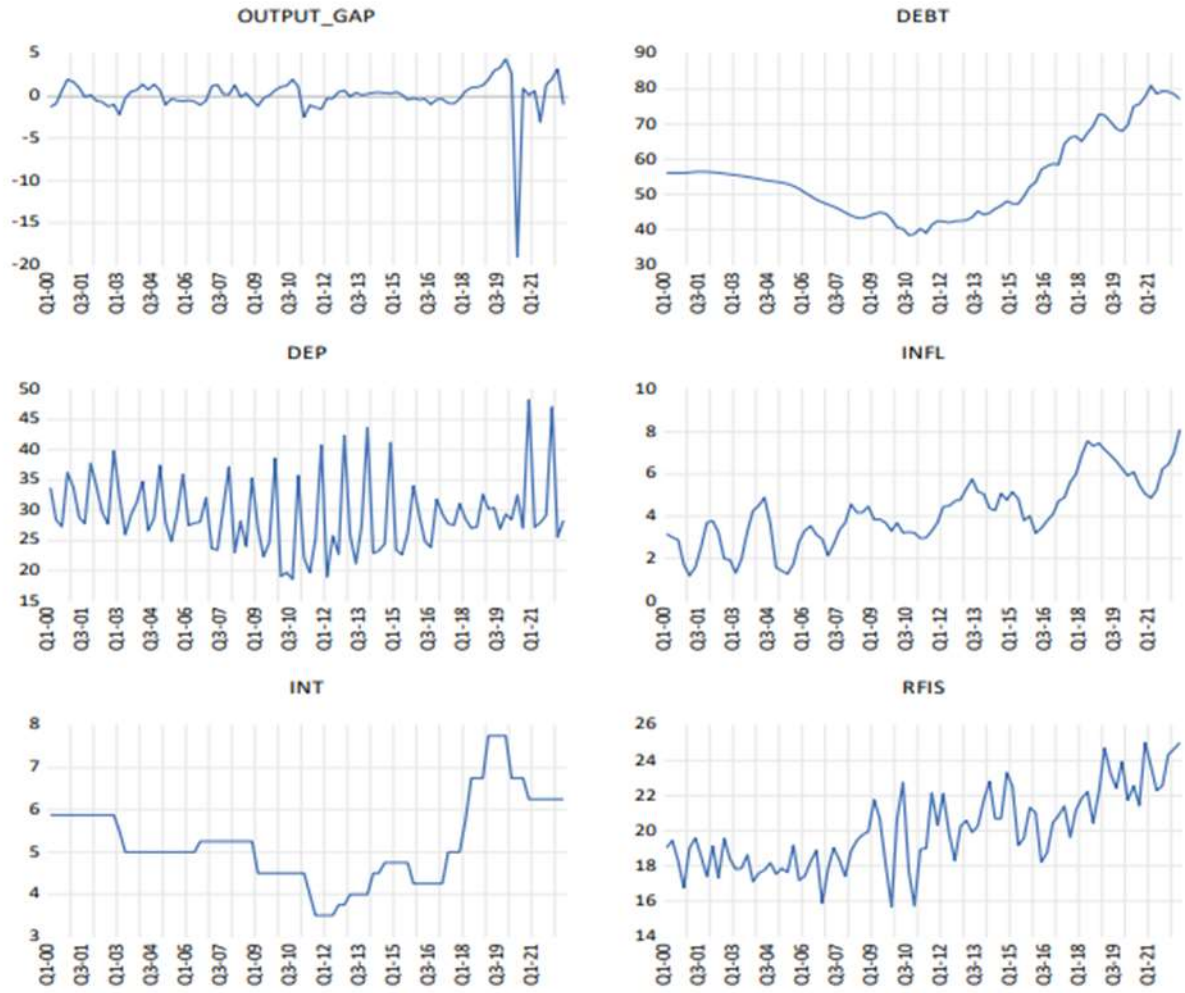

Source: Author

The correlation results in Table 2 show positive and statistically significant coefficients between public debt, inflation and tax revenue and the interest rate, with coefficients of +0.76, +0.35 and +0.30 respectively. The inflation rate has a positive and statistically significant effect on tax revenues (+0.69) and debt levels (+0.51). There is a positive and statistically significant correlation between the latter and tax revenues (0.48). The multicollinearity test shows an absence of multicollinearity for both monetary and budgetary rules, given that the VIF statistic is less than 10 for all variables. The Cusum Squares test for parameter stability shows that the coefficients are unstable in the long term, which suggests that there has been a regime change in the long-term relationship between the variables.

Table2. Matrix Correlations

Probability	OUTPUT_GAP	DEBT	DEP	INFL	INT	RFIS
OUTPUT_GAP	1.000000					
DEBT	-------					
	-0.049907	1.000000				
p-value	0.6443	-----				
DEP	-0.080724	0.125298	1.000000			

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p-value	0.4547	0.2448	-----			
INFL	0.074054	0.510979	-0.067745	1.000000		
p-value	0.4929	0.0000	0.5306	-----		
INT	0.091467	0.768028	0.131533	0.357720	1.000000	
p-value	0.3967	0.0000	0.2219	0.0006	-----	
RFIS	0.008261	0.481487	-0.150663	0.695842	0.309240	**1.000000**
p-value	**0.9391**	**0.0000**	**0.1612**	**0.0000**	**0.0034**	**-----**

The results in Tables 3 and 4, illustrated in Figure 2, show the transition from a passive monetary policy in the first regime to an active policy responding to a high level of inflation expectations in the second regime. This regime anchors inflationary expectations. In the first regime, the coefficient of expected inflation is very low (0.01), whereas the active regime displays a positive coefficient that is statistically significant at a threshold of 1% (+0.78). We can therefore conclude that monetary policy does not react to fluctuations in the output gap. Indeed, the coefficient of the output-gap remains statistically insignificant in both regimes, which shows the main mandate of price stability provided by the Saudi central bank. We can also see that (1) the probability of moving from the first regime to the second regime is 1.1%; (2) the probability of moving from the second regime to the first regime is 1.5%; (3) the probability of remaining in the first regime at time (t) knowing that we are in the same regime at time (t-1) is 98. 8%; (4) the probability of remaining in the second regime at time (t) given that we are in the same regime at time (t-1) is 98.4%. and (5) monetary policy remains an active policy during the 2010-2020 period (including the Covid-19 period).

Table3. Monetary Rule

Variable	Coefficient	Std. Error	z-Statistic	Prob.
Regime 1				
Inflation anticipée	0.016568	0.154539	0.107207	0.9146
Inflation retardée	1.021656***	0.158277	6.454849	0.0000
OUTPUT_GAP	-0.024666	0.038230	-0.645197	0.5188
Regime 2				
Inflation anticipée	0.783103***	0.224376	3.490135	0.0005
Inflation retardée	1.014279***	0.232566	4.361254	0.0000
OUTPUT_GAP	-0.333823	0.303831	-1.098712	0.2719
Note: *** p<.01, ** p<.05, * p<.1				

Figure 2. Filtered Probability for Each Monetary Regime

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 5663 – 5680
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
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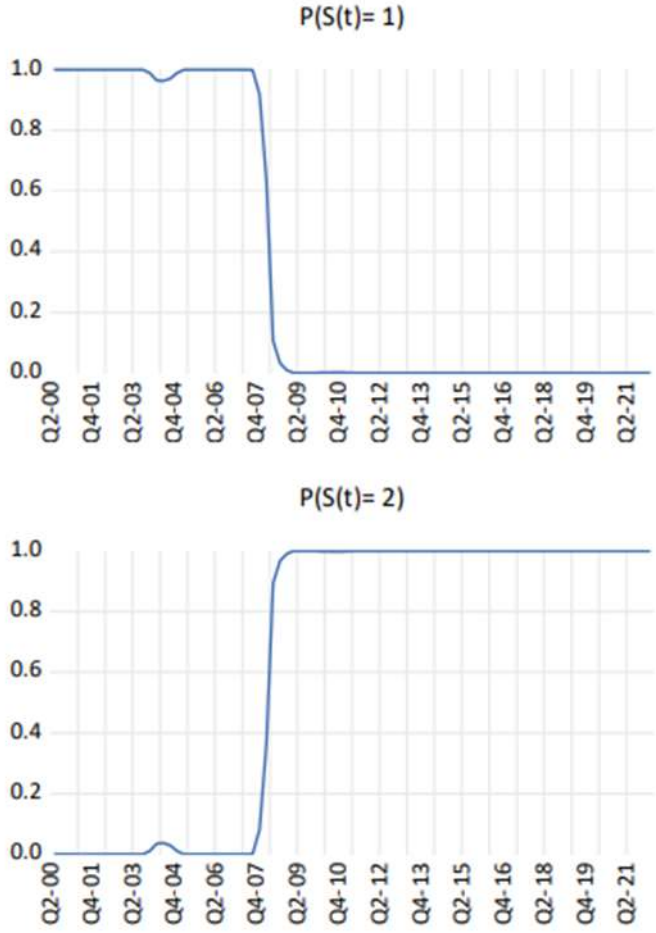

Table 4. Conditional Probability for Each Monetary Regime

	1	**2**
1	0.984925	0.015075
2	0.011079	0.988921

The results of Tables 5 and 6, illustrated in Figure 3, show that in the first regime, budgetary policy becomes active by reacting negatively to fluctuations in the output gap. Indeed, the coefficient of the output gap is -0.70 and statistically significant at a threshold of 10%. In the second regime, budgetary policy becomes passive to fluctuations in the output gap; (2) The figures also show the filtered probabilities of active and passive monetary and budgetary policies. From 2016 onwards, budgetary policy remains more active in the face of increases in public spending during the Covid-19 period, i.e. an increase in health spending during the pandemic has an economically significant effect on the dependent variable (tax revenue); (3) The probability of switching from the first regime to the second regime is 1. 4%; (4) The probability of switching from the second regime to the first regime is 3.5%; (5) The probability of remaining in the first regime at time (t) given that we are in the same regime at time (t-1) is 96.4% and (6) The probability of remaining in the second regime at time (t) given that we are in the same regime at time (t-1) is 98.5%. In conclusion, according to the Markovian regimes graph for the budgetary rule applied in Saudi Arabia, there has been a change in regime since 2015, which could be explained by the occurrence of a security shock due to the Bardo terrorist attacks, which hampered tourism and the economy. This regime will apply from 2015 until 2022, including the Covid-19 period. The next step is to perform a robustness analysis using the SVAR technique with sign restrictions, in order to determine the effect of stagnating tax revenues and rising expenditure during the Covid-19 period.

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 5663 – 5680
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
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Table 5. Budget Rule

Variable	Coefficient	Std. Error	z-Statistic	Prob.
Regime 1				
OUTPUT_GAP	-0.702272*	0.405830	-1.730458	0.0835
DEBT(-1)	0.470699***	0.032071	14.67694	0.0000
DEP	-0.026711	0.049493	-0.539702	0.5894
Regime 2				
OUTPUT_GAP	0.012784	0.061133	0.209123	0.8344
DEBT(-1)	0.282122***	0.015046	18.75029	0.0000
DEP	0.089949***	0.031173	2.885496	0.0039
****, **, * : désignent la significativité*	*tivité respective a un seuil de significativité de 1%, 5% et 10%*			

***, **, * : désignent la significativité tivité respective a un seuil de significativité de 1%, 5% et 10%

Figure 3. Filtered Probability for Each Budget Regime

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 5663 – 5680
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
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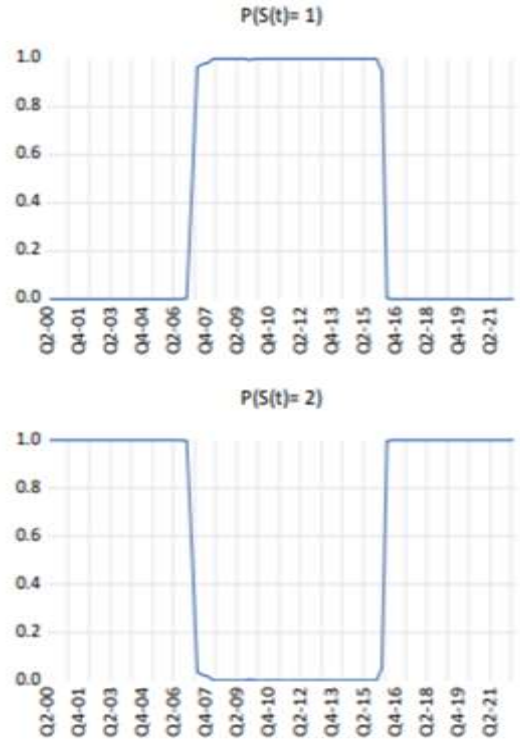

Table 6. Conditional Probability for Each Budget Regime

Régime	**1**	**2**
1	0.964673	0.035327
2	0.014087	0.985913

Model

In the SVAR model, we start with the scenario where government expenditure increases by 1%, while government revenues remain unchanged, four months after this shock. The construction of the SVAR model follows the methodology of Mountford and Uhlig (2009). The reduced form of the SVAR model is given by:

$$Y_t = \sum_{i=1}^{L} B_i Y_{t-i} + \bar{u}_t, t = 1.....T$$

With Y_t the vector of endogenous variables of dimension m*m, L the number of lags of the VAR model (chosen by the Schwartz information method), B_i is a matrix of m*m, and u_t is a vector of error terms

with $E(u_t, u_t') = \Sigma$. We assume the presence of m economic shocks. $E(v_t, v_t') = I_m$. $u_t = Av_t$, $AA' = \Sigma$

The restrictions are as follows: An interest rate shock is a shock that increases the interest rate reducing money supply M2 and the consumer price index during a given period after the initial shock. This method of identifying the business cycle and the interest rate shocks helps us to filter out the effects of these shocks on our two budget variables. In addition, the shocks are assumed to be orthogonal. The two budgetary shocks are orthogonal to both the interest rate shock and the business cycle shock. An overview of our identification of sign restrictions is given in Table (3.8).

Table 7. Sign Restrictions Imposed in the Svar Model

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 5663 – 5680
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5168

Shocks	Tax revenue	Government expenditure	Interest rates	M2	Consumer price index
Interest rates			+	-	-
Tax revenue	0				
Government expenditure		+			

We consider the following SVAR model:

$$RFIS_t = \sum_{i=1}^{n} b^i_{11} RFIS_{t-1} + \sum_{i=0}^{n} b^i_{12} DEP_{t-i} + \sum_{i=0}^{n} b^i_{13} M2_{t-i} + \sum_{i=0}^{n} b^i_{14} INT_{t-i} + \sum_{i=0}^{n} b^i_{15} REER_{t-i} + \sum_{i=0}^{n} b^i_{16} IPI_{t-i} + \sum_{i=0}^{n} b^i_{17} CPI_{t-i} + \varepsilon^{FIS}$$

$$DEP_t = \sum_{i=1}^{n} b^i_{21} RFIS_{t-1} + \sum_{i=0}^{n} b^i_{22} DEP_{t-i} + \sum_{i=0}^{n} b^i_{23} M2_{t-i} + \sum_{i=0}^{n} b^i_{24} INT_{t-i} + \sum_{i=0}^{n} b^i_{25} REER_{t-i} + \sum_{i=0}^{n} b^i_{26} IPI_{t-i} + \sum_{i=0}^{n} b^i_{26} CPI_{t-i} + \varepsilon^{DEP}$$

$$M2_t = \sum_{i=1}^{n} b^i_{31} RFIS_{t-1} + \sum_{i=0}^{n} b^i_{32} DEP_{t-i} + \sum_{i=0}^{n} b^i_{33} M2_{t-i} + \sum_{i=0}^{n} b^i_{34} INT_{t-i} + \sum_{i=0}^{n} b^i_{35} REER_{t-i} + \sum_{i=0}^{n} b^i_{36} IPI_{t-i} + \sum_{i=0}^{n} b^i_{37} CPI_{t-i} + \varepsilon^{M2}$$

$$INT_t = \sum_{i=1}^{n} b^i_{41} RFIS_{t-1} + \sum_{i=0}^{n} b^i_{42} DEP_{t-i} + \sum_{i=0}^{n} b^i_{43} M2_{t-i} + \sum_{i=0}^{n} b^i_{44} INT_{t-i} + \sum_{i=0}^{n} b^i_{45} REER_{t-i} + \sum_{i=0}^{n} b^i_{46} IPI_{t-i} + \sum_{i=0}^{n} b^i_{47} CPI_{t-i} + \varepsilon^i$$

$$REER_t = \sum_{i=1}^{n} b^i_{51} RFIS_{t-1} + \sum_{i=0}^{n} b^i_{52} DEP_{t-i} + \sum_{i=0}^{n} b^i_{53} M2_{t-i} + \sum_{i=0}^{n} b^i_{54} INT_{t-i} + \sum_{i=0}^{n} b^i_{55} REER_{t-i} + \sum_{i=0}^{n} b^i_{56} IPI_{t-i} + \sum_{i=0}^{n} b^i_{67} CPI_{t-i} + \varepsilon^{REER}$$

$$IPI_t = \sum_{i=1}^{n} b^i_{61} RFIS_{t-1} + \sum_{i=0}^{n} b^i_{62} DEP_{t-i} + \sum_{i=0}^{n} b^i_{63} M2_{t-i} + \sum_{i=0}^{n} b^i_{64} INT_{t-i} + \sum_{i=0}^{n} b^i_{65} REER_{t-i} + \sum_{i=0}^{n} b^i_{66} IPI_{t-i} + \sum_{i=0}^{n} b^i_{67} CPI_{t-i} + \varepsilon^{IPI}$$

$$CPI_t = \sum_{i=1}^{n} b^i_{71} RFIS_{t-1} + \sum_{i=0}^{n} b^i_{72} DEP_{t-i} + \sum_{i=0}^{n} b^i_{73} M2_{t-i} + \sum_{i=0}^{n} b^i_{74} INT_{t-i} + \sum_{i=0}^{n} b^i_{75} REER_{t-i} + \sum_{i=0}^{n} b^i_{76} IPI_{t-i} + \sum_{i=0}^{n} b^i_{77} CPI_{t-i} + \varepsilon^{CPI}$$

$$BX_t = \Gamma_0 + \Gamma_1 X_{t-1} + \varepsilon_t$$

According to Gali (1992), our system can have the VMA writing as follows:

$$\begin{bmatrix} RFISC_t \\ DEP_t \\ M2_t \\ INT \\ REER_t \\ IPI_t \\ CPI \end{bmatrix} = A(L) \begin{bmatrix} \varepsilon^{RFISC} \\ \varepsilon^{DEP} \\ \varepsilon^{M2} \\ \varepsilon^{INT} \\ \varepsilon^{REER} \\ \varepsilon^{IPI} \end{bmatrix}$$

Avec A(L) est une matrice (6*6), la matrice des fonctions des retards polynomiaux.

ε^{RFISC}, ε^{DEP}, ε^{M2}, ε^{INT}, ε^{REER}, ε^{IPI}, ε^{CPI}, denote respectively a positive shock to tax revenues, a shock to public spending, a shock to M2 money supply, a positive shock to the key interest rate, a positive shock to the real effective exchange rate, a shock to industrial production, and an inflation shock to the consumer price index. The variables used are monthly from 2010 to 2022 and include the following: Tax revenue, government expenditure, M2 money supply, the central bank's key rate, the real effective exchange rate, the industrial production index and the consumer price index.

Table 8 shows the presence of a few outliers, which we eliminated before moving on to the model's estimation stage, in order to check normality of the distribution functions of our variables. For example, the Industrial Production Index (IPI) variable has a Jarque-Bera test p-value of 0.45, which exceeds the 0.1 threshold, showing that this variable follows the normal distribution after eliminating a few outliers. However, it should also be borne in mind that according to the central limit theorem if the number of

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 5663 – 5680
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5168

observations exceeds 30, the distribution function asymptotically follows the reduced centred normal distribution, even if the variables individually follow another probability distribution.

Table 8. Descriptive Statistics of SVAR Model Variables

	INT	M2	IPC	RFISC	DEP	IPI	REER
Mean	5.169463	6.158887	4.874986	4.194923	4.361163	4.545924	4.497394
Median	4.750000	6.141216	4.846549	4.395894	4.557540	4.548600	4.514370
Maximum	7.750000	6.339930	5.231922	5.199851	5.499031	4.644391	4.619467
Minimum	3.500000	5.930587	4.593107	2.406486	2.281165	4.441474	4.295651
Std. Dev.	1.280463	0.106220	0.184940	0.706544	0.770205	0.043949	0.083475
Skewness	0.657615	0.019776	0.212238	-0.903132	-0.873241	-0.124899	-0.511575
Kurtosis	2.199435	2.125203	1.844066	2.943211	3.025074	2.548278	2.227183
Jarque-Bera	14.71832	4.760762	9.414091	20.27524	18.94054	1.587604	10.20702
Probability	0.000637	0.092515	0.009031	0.000040	0.000077	0.452122	0.006075

Results and Discussion

There are several advantages for the sign-restriction SVAR model. First, in the traditional structural VAR model, the sign restrictions of conventional views are often used implicitly as criteria for checking the validity of hypothesis identification. Under the sign restriction approach, these restrictions are made more explicit by being imposed directly on impulsive responses. Finally, the sign-restriction method involves the Bayesian Monte Carlo procedure, which, according to Sims (1988), does not require the use of first-difference (stationary) variables (Ann and Wang, 2011). Then, we can estimate our model without recourse to the various stationarity tests.

In Figure 4, we notice that public spending increased during the first four months, while tax revenues remained unchanged during the same period, since we have imposed two conditions on these two budgetary variables. It is assumed that tax revenues do not vary over a time horizon of 4 periods (4 months in our model), and that public spending increases by 1% over the same period. The combined impact of increased public spending and stagnating tax revenues is negative on output, i.e., output tends to decrease. In other words, adoption of a budgetary policy that consists of increasing deficits does not necessarily lead to an increase in industrial production for the Saudi economy. However, if the economy is at a point where the output gap is negative, an expansionary budgetary policy could stimulate the economy in the short term to reduce the output gap.

An important debate among policymakers focuses on the impact of expansionary budgetary policies on economic growth. Blanchard and Perotti (2002) provided empirical evidence that positive government spending shocks have a positive effect on output in the US in the post-war period and found that discretionary budgetary policies adopted in the Eurozone during the global financial crisis led to an increase in quarterly real output growth. Owyang, Ramey and Zubairy (2013) also conclude that government spending multipliers are significantly higher during economic downturns and find that during the Great Recession, government spending shocks had a significant positive effect on survey-based consumer trust and private consumption expenditure in the US. The authors also hypothesise that, during the Great Recession, the trust channel could have been an important factor that stimulated the output effects due to public spending shocks. However, the graph shows that this was not the case for Saudi Arabia following a positive spending shock during the coronavirus period (Output index almost negligible). Thus, we notice a falling real effective exchange rate, i.e., the domestic currency depreciates against the foreign currency, in a deficit budgetary policy scenario. Increase in aggregate demand creates domestic inflationary pressures and so domestic prices rise against foreign prices, which explains the upward deviation of the consumer price index, which is a measure of inflation.

In conclusion, a "zero" restriction on tax revenues and an increase in public spending led to a real depreciation of the real effective exchange rate, then a return to equilibrium over the 35-month period, and

Journal of Ecohumanism
2024
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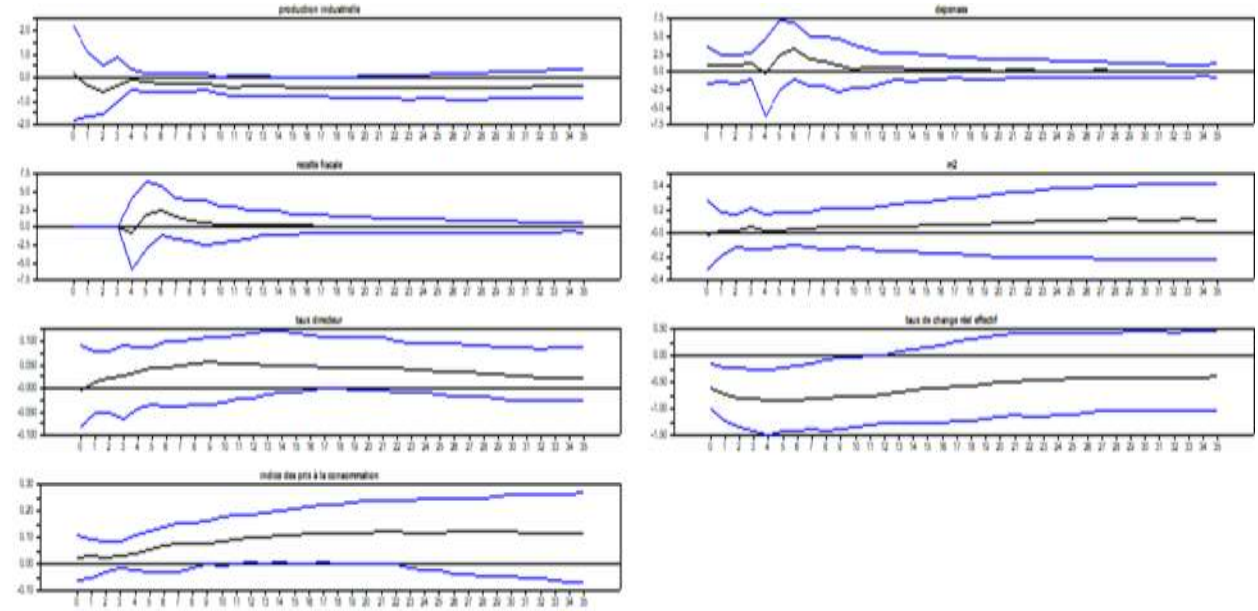
a high inflation rate. This led to an increase in the key rate, to anchor inflationary expectations, which in turn led to a low but positive level of money supply and hampered production. However, despite the SCB's efforts, the inflation rate has remained at unsustainable levels. This is because inflation could also be of non-monetary origin. The Saudi central bank would therefore be forced to align its objectives with those of budgetary policy by financing the State budget through open market operations and the purchase of public securities to increase money supply, out of concern for economic stability, which shows a dominance of budgetary policy.

Figure 4. Joint Effect of The Absence of Tax Revenues and An Increase in Public Spending



Responses to Spending (delayed)

Conclusion

During the recent Coronavirus pandemic, many countries, including Saudi Arabia, responded to the slowdown in economic activity with extraordinary policy measures. Budgetary authorities implemented large budgetary stimulus packages and monetary authorities also introduced unconventional monetary policies. In this paper, we have examined the macroeconomic effects of these policies using regime-switching models and structural VAR models with sign restrictions. Examining Saudi Arabian data, covering the 2000 to 2022 period, we found that budgetary policy has been more active than monetary policy during the pandemic crisis, acting through an increase in public spending in a regime where tax revenues are influenced by this increase in spending. This is the primary budgetary instrument used during the pandemic crisis in the form of compensation, aid and social allowances for vulnerable people and those who are off work during lockdowns. We therefore observe a change in regime from 2015 to 2022, including the Covid-19 period. When estimating the VAR model, we identified the combined effect of a stagnation in tax revenues and an increase in public spending, as this was the scenario that took place during the Covid-19 period in Saudi Arabia. The aim is to determine the impulse responses of our key variables of industrial production, inflation, the interest rate, M2 money supply and the exchange rate, and their behaviour over a time horizon of 35 months in our model and to determine whether there is a return to equilibrium. An increase in public spending is considered as an imposed budgetary shock in our 2nd VAR estimation whose aim is to determine the behaviour of macroeconomic variables as well as the impact on the incentives given by monetary policymakers. Our results show that this shock did not lead to an improvement in industrial production. It might be possible to accept the notion of a loss of monetary policy autonomy in the sense that the central bank would be forced to finance the government budget for the sake of economic stability. The results show a budgetary dominance reflected in financing the resources of the State to offset the cost of government expenditure. If the central bank has raised the interest rate to anchor inflationary

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 5663 – 5680
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https://ecohumanism.co.uk/joe/ecohumanism
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expectations, this would have a negative impact on economic activity as measured by the industrial production index. This case coincides with the second regime of the monetary rule, where the central bank acts according to expected inflation.

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2024
Volume: 3, No: 8, pp. 5663 – 5680
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