UNDERSTANDING THE ROLE OF MARKOV CHAIN MODELING IN ASSESSING THE GOVERNANCE MONETARY TRANSMISSION MECHANISMS: A GOVERNANCE OUTLOOK

Maher Al-Mahrouq *, Ahmad A. Al-Majali **

* Association of Banks in Jordan, Amman, Jordan
** *Corresponding author,* Economics, Business & Finance Department, College of Business, Mutah University, Mutah, Jordan
Contact details: Mutah University, Mutah, Karak 61710, Jordan

Abstract

This study investigates Jordan's monetary policy impact through empirical data analysis from January 2006 to December 2022, focusing on the influence of the Central Bank of Jordan's (CBJ's) official interest rate on key economic indicators, using the Markov chain approach following Ayo and Uwabor (2021) and Vulpiani (2015). It analyzes transmission mechanisms affecting inflation rate, deposit rate, lending rate, private sector credit, and foreign reserves. Findings reveal significant effects of interest rate changes on these indicators, with notable short-term reactions in deposit rates and more robust medium-term responses to rate decreases. The study recommends utilizing Markov chain techniques for forecasting monetary variables, offering valuable insights into transmission dynamics for informed policy decisions. Understanding the relationships between interest rates and economic indicators can aid the central bank in effectively managing policy and ensuring financial stability.

Keywords: Central Bank of Jordan, Markov Chain, Interest Rate, Inflation, Deposit, Lending, Official Reserve

Authors' individual contribution: Conceptualization — M.A.-M. and A.A.A.-M.; Methodology — A.A.A.-M.; Writing — Original Draft — M.A.-M. and A.A.A.-M.; Writing — Review & Editing — M.A.-M. and A.A.A.-M.

Declaration of conflicting interests: The Authors declare that there is no conflict of interest.

1. INTRODUCTION

Globally, there is broad consensus on the goals of monetary policy, where its purpose is to maintain production and inflation variations stable near their target levels and to act preventively to avoid the occurrence of a currency, banking, and financial crisis (Cobham, 2015). However, there are significant differences in the use of monetary policy tools and their priorities, particularly in the field of different exchange systems and their relationship to the existence of financial markets and an efficient banking sector, which would improve the effectiveness and impact of monetary policy in achieving its goals (Merko & Habili, 2023). Theoretically, Keynesian economic thought provided the rationale for analyzing the impact of monetary policy to counter the fluctuations of economic cycles (Adrian & Liang, 2016), as the theories focused on the main tasks of central banks, achieving monetary stability by

controlling inflation rates and contributing to promoting economic growth using monetary policy tools (quantitative monetary policy and interest rate change), foremost of which is determining the appropriate interest rate and money supply levels to effect on aggregate demand and controlling inflation (Galí, 2015). At the same time, the inflation target does not harm growth and achieves a balanced effect on aggregate demand.

The movement of interest rates has considerably influenced micro and macro factors in the economy during the recent decade for a small and open economy. However, central bank action may restrict the fixed exchange rate regime (Saymeh & Abu Orabi, 2013). The central bank intervenes to attain and maintain the target exchange rate (Ghosh et al., 2016). This system's balance of payments and the money supply are linked directly (by interest rates). In other words, changing the balance of payments (imbalance) equals modifying the foreign exchange reserves (Mussa, 1977). In this instance, monetary policy loses some of its independence since it must produce interest differentials from the pegged currency's interest rate (Edwards, 2015). Suppose the central bank's buildup of foreign reserves raises the monetary base and inflation for nominal exchange rate appreciation. In that case, central bank actions have a minor impact on the real exchange rate (Ha et al., 2020). On the other hand, the effectiveness of monetary policy in influencing other monetary and banking variables, such as interest rates on deposits and credit facilities in the banking market, as well as its impact on credit facilities and the money creation process, is unclear, particularly when local economic cycles conflict to maintain foreign reserve accumulation (Apanisile & Osinubi, 2020). From this point, the paper's motivation and attempt to answer the question:

RQ1: What is the probability of changing foreign reserves, the banking deposit rate, the banking lending rate, banking credit to the private sector, and the inflation rate in response to monetary policy change (changing the overnight deposit window rate according to the exchange rate regime pegged to other currencies?

According to the Central Bank of Jordan (CBJ) Law No 23 of 1971, the target of monetary policy is ensuring monetary and financial stability by maintaining price stability, protecting the value of the Jordanian Dinar and through an interest rate structure consistent with the level of economic activity thereby contributing toward an attractive investment environment and a sound macroeconomic environment. Furthermore, the Jordanian monetary policy is dependent on the United States (US) monetary policies. When the US Federal Reserve raises interest rates, the CBJ is compelled to hike interest rates on its tools to keep its currency rate pegged to the US dollar since 1995. Based on the preceding, this paper examines the effectiveness of Jordan's monetary policy in terms of monetary indicators. The primary hypothesis examined the efficiency of central bank interventions (represented by a change in the overnight deposit window rate) on foreign reserves, the banking deposit rate, the banking lending rate, banking credit to the private sector, and the inflation rate. To test the hypothesis, the paper employs a nonparametric technique to solve the identification issues mentioned

above and allow for the analysis of the combined time-varying impacts of monetary policy.

This study investigates the effectiveness of Jordan's monetary policy in influencing key economic indicators, focusing on the impact of the CBJ's overnight deposit window rate on variables such as foreign reserves, deposit and lending rates, credit to the private sector, and inflation rate. Drawing upon the Keynesian economic framework and considering the context of Jordan's pegged exchange rate regime, the research aims to address gaps in understanding Jordan's monetary policy transmission mechanisms, using a Markov chain modeling methodology, using monthly time series data from January 2006 to November 2022.

Findings tell significant short and medium-term effects of variations in the overnight deposit window rate on many economic indicators, shedding light on the dynamics of Jordan's monetary policy transmission mechanisms. The empirical result presented here contributes to theoretical knowledge and realistic policymaking in Jordan's monetary sphere.

This research emphasizes the importance of adopting innovative methodologies similar to the Markov chain model to explore and estimate the effects of monetary policy in small, open economies like Jordan. By providing insights into the effectiveness of policy interventions, this study suggests valuable guidance for policymakers, researchers, and stakeholders concerned with maintaining monetary and financial stability in Jordan.

The structure of this paper is as follows. Section 2 provides insights into previous studies on transmission mechanisms. Section 3 presents the research methodology, the Markov chain modeling approach, and the data sources. Section 4 presents the empirical results. Finally, Section 5 concludes and discusses the implications for policymaking and future research endeavors.

2. LITERATURE REVIEW

Monetary transmission mechanisms are the channels via which monetary policy instruments, identical changes in interest rates or money supply, influence the economy's aggregate demand, prices (inflation), and real domestic product. Policymakers need a solid comprehension of these dynamics to conduct monetary policy positively and realize macroeconomic goals such as achieving full employment and maintaining price stability (low inflation) (Beaudry et al., 2024).

The interest rate is one of the crucial transmission channels. Moreover, it operates by using variations in the interest rates at which borrowing and lending are taking place, respectively (Hasani & Beqaj, 2023). Commercial banks often vary their lending and deposit rates in response to changes in policy interest rates, such as the overnight deposit rate, which central banks implement. Promote borrowing, investment, and interest rates should be lowered (As Sahara & Setiawan, 2022). This would lead to an expansion in consumption and aggregate demand, expanding economic activity, and increasing inflation and vice versa.

The credit channel is another significant transmission channel that focuses on the impact of monetary policy on credit availability to consumers and companies. It is simpler for people and businesses to have access to credit when central banks lower interest rates since this lowers the cost of obtaining money via borrowing. This, in turn, may promote investment in housing, corporate development, and consumer purchasing, ultimately leading to increased economic activity and inflation (Mahdich et al., 2024). The exchange rate channel is a vital transmission mechanism in economies with flexible regimes, influencing economic activity (exports and imports). Adjustments in monetary policy can improve growth by reducing inflation or depreciating the domestic currency (Al-Zoubi et al., 2013).

The monetary transmission mechanism of a country with a fixed exchange rate to the US dollar is impacted by both actions taken by the domestic monetary policy and changes made by the external environment. Those who favor it believe it is stable, encouraging investor confidence and pegging inflation expectations, making it easier to plan and invest for the long run. Not directly targeting domestic economic factors, changes in domestic monetary policy, such as adjustments to interest rates, are primarily targeted at preserving the currency peg rather than directly targeting domestic economic variables by directly tying domestic interest rates to those set by the currency it is pegged (Al-Lozi, 2023). The central bank's capacity to pursue independent monetary policy aims may be hampered, which is a criticism raised by critics of fixed exchange rate regimes. These critics are concerned about the possibility of losing monetary policy autonomy. Despite these arguments, the monetary transmission mechanism continues to be effective because of the differences in interest rates and the alignment of monetary cycles with the currency peg. This is because differences in interest rates, caused by differences in economic conditions and policy divergence between the pegged currency and the domestic economy, can influence capital flows and borrowing costs, which in turn can affect the activity level of the domestic economy (Adayleh et al., 2024).

Monetary policy procedures vary globally due to numerous economic conditions, institutional frameworks, and policy goals. In advanced economies like the US and the European Union (EU), central banks' interest rate targeting influences economic activity and inflation (Alexandre & Lima, 2020). They apply forward guidance and quantitative easing measures to control financial conditions and promote economic growth. Communication strategies increase credibility and transparency, supporting policy effectiveness and fixing inflation expectations. Central banks prioritize exchange rate management alongside inflation targeting in emerging economies like Jordan, where currency stability is crucial due to peg exchange rate regimes with the US dollar (Sweidan, 2011).

The CBJ adjusts interest rates to maintain the dinar's peg to the US dollar. Still, this approach limits the central bank's flexibility in responding to domestic economic conditions. It may require additional policy tools to effectively address inflationary pressures or financial stability risks. Challenges such as limited data availability, financial

market development, and external vulnerabilities further complicate monetary policy in Jordan compared to advanced economies (Al-Lozi, 2023).

Numerous studies have been conducted using various approaches and ideas to examine the link between central bank interest rate changes and macroeconomic indicators. We will look at various applied studies relevant to the research factors. The field of studies conducted on the Jordanian economy (Poddar et al., 2006) discovered an effective influence of the interest rate on certificate deposits issued by Jordan's central bank on bank retail rates, as well as the spread between the three-month certificate of deposit (CD) rate and the US Federal Funds rate on foreign reserves, using vector autoregression (VAR) model for the period 1995 to 2005. The other methodology demonstrates that monetary policy inertia is significant in Jordan (Sweidan, 2011). The lagged interest rate coefficient is expected to be between 0.60 and 0.69. In Jordan, the inflation rate and the gross domestic product (GDP) gap have a negligible impact on the policy rate. The policy interest rate appears progressively determined in response to other variables, such as unobserved and foreign interest rates. Using quarterly data from 1994 to 2007 and two approaches, ordinary least squares (OLS) and the Kalman filter, where Khataybeh and Al-Tarawneh (2016) supported the explanation that monetary policy has a significant effect on financial stability by affecting its medium target, using its instruments, mainly excess reserve. On the other direction, Obeid and Awad (2017) demonstrated the positive long-term and short-term impacts of monetary policy tools on economic activity from reserve ratio, rediscount rate, and the overnight interbank lending rate on real GDP growth. It uses quarterly data from 2005 to 2015 and the vector error correction model (VECM).

Mugableh (2019) using autoregressive distributed lag (ARDL) and VECM estimations, it was discovered that Jordanian monetary policy variables (i.e., real interest rate and money supply) have a positive impact on economic growth in the long-run and short-run, except the inflation rate, for the period (1990–2017). Moreover, the opposite result (Obeidat et al., 2021) demonstrates that monetary policy is ineffective in its lending channel. Changes in interest rates do not induce a reciprocal and opposite change in total bank loans to the private sector, according to the VECM for 1992–2019. In a recent study on Jordanian monetary policy, using the generalized method of moments (GMM) model and quarterly data from 2000 to 2019, it was discovered that the CBJ's monetary policy has a moderate impact on inflation and the output gap but has a significant impact on foreign reserves (Almajali & Almubidin, 2022).

As for the latest studies on the transmission mechanisms of monetary effects, we find that many studies and methodologies are used to examine them. From these studies, we find an estimated dynamic stochastic general equilibrium (DSGE) model of a small open economy found that a long-term interest rate that includes a time-varying term premium stabilizes GDP and has no significant effect on inflation volatility in Poland (Wesołowski, 2016). The result shows that the term "premium shock" had a minor impact on GDP and inflation

volatility. Furthermore, Kilci (2019) studies the long-term link between overnight repo rates and the consumer price index (CPI) to approximate central bank interest rates. Using the Fourier-Granger causality test, the data suggest a one-way causal link between overnight repo rates and CPI. Also, Bhar and Malliaris (2021) constructed a model of unconventional monetary policy and investigated its usefulness in resolving the global financial crisis. It begins with basic mathematical modeling concepts before delving into Milton Friedman's 1968 presidential address. From 2002 to 2015, a Markov switching econometric model examined the modeling of monetary policy with its novelty of quantitative easing to target unusually high unemployment The findings of the VECM study of the link between the inflation rate and the Bank Indonesia rate demonstrate that the policy of adjusting the Bank Indonesia rate influences the rise and fall of the inflation rate (CPI) (Indrajaya, 2022). Yilmazkuday (2022) examines Turkish inflation causes using a structural VAR model, one of the variable inflation rates, and central bank policy rates. The empirical findings suggest that Turkish inflation rises after a negative policy rate shock. Using principal component analysis (PCA), Hamdar et al. (2022) examine the impact of negative policy rates on real estate price inflation and nominal unit labor cost. The model's results demonstrate a substantial association between negative policy rates and housing prices, as well as the index and nominal unit labor cost. In the study by Mwamkonko (2023), the interest rate and stock price channels were ineffective in Tanzania. However, the bank credit channel is weakly operational. Furthermore, the exchange rate and expected inflation are the primary monetary policy transmission channels using the error correction model (ECM).

Markov chain modeling methodologies provide an opportunity to investigate the details of monetary transmission processes, particularly in Jordan's economy. The above studies have attested to the effectiveness of Markov chain techniques in exploring the dynamics of monetary policy transmission, making them well-suited for discovering Jordan's exceptional economic landscape. Utilizing Markov chain techniques, this paper focuses on running a nuanced estimation of how Jordan's monetary policy choices, in particular shifts in the overnight deposit window rate, reverberate via the economy and induce key economic indicators. In light of the challenges modeled by Jordan's pegged exchange rate regime and its dependence on exterior influences, such as the monetary policies of the US, an in-depth examination using the Markov chain model can deliver a valuable understanding of the transmission channels. This study objects to contribute to Jordan's learning of monetary transmission mechanisms by performing empirical data.

3. DATA AND METHODOLOGY

The study develops time series data from the CBJ to analyze the impact of the overnight deposit window interest rate (*WR*) on numerous Jordanian economic variables. The interest rate represents the CBJ's monetary policy decisions, including rate cuts, hikes, and stable rates. The variables that respond to these policy choices are the inflation rate (*INF*), banking

deposit rate (*DR*), banking lending rate (*LR*), banking credit to the private sector (*CP*), and the Central Bank's foreign reserves (*FX*). The study utilizes monthly data spanning from January 2006 to November 2022.

The research analyzes economic models and trends over time, which constructs the use of time series data to conduct the analysis. This methodology specifies insights into the dynamic nature of monetary policy. Using this data, it is feasible to uncover links and dependencies with variables, making it possible to conduct a comprehensive analysis of monetary policy's effect on other significant economic indicators. Using historical data makes it simpler to establish baselines, conduct benchmarking, and conduct trend analysis to develop policy recommendations. All of these activities are used to formulate policy suggestions.

One type of mathematical model that can describe a series of occurrences is the Markov chain. Literature that depicts a range of possible events that have occurred in the world's past, present, and future. Andrey Markov, a Russian mathematician who developed the concept in 1928, is honored with the naming of the algorithm (Vulpiani, 2015). It can characterize how time-dependent systems behave like molecules and living cells. A similar approach may be seen in various artificial systems, including social networks and computer programs. In addition, a Markov chain is used in probabilistic modeling, which is utilized in statistics and other fields. The simulation of a wide variety of ecological and artificial processes may be achieved using a Markov chain. Because the future state (X_{t+1}) is independent of the previous states ($X_t, X_{t-1}, \dots X_{t-n}$), it can be written as a series of random variables. This is the case under the assumption that the present state is familiar. This is known as the Markov property. Assume (*P*) represents the probability of the phenomena transitioning from state (*i*) to state (*j*) in a given time (*ij*). The Markov chain has (*N*) states, where *N* is a positive integer. In such a situation, the transitional probabilities may be expressed as a square matrix of degree ($n \times n$) with the following formula (Ayo & Uwabor, 2021):

$$P_{ij} = \begin{bmatrix} P_{11} & P_{12} & . & . & P_{1n} \\ P_{21} & P_{22} & . & . & P_{2n} \\ . & . & . & . & . \\ . & . & . & . & . \\ P_{n1} & P_{n2} & . & . & P_{nn} \end{bmatrix} \qquad (1)$$

Because all the transition probabilities P_{ij} are fixed and independent of time, the matrix P is termed a homogeneous transition or stochastic. P_{ij} must fulfill elements with non-negative probability ($P_{ij} \geq 0$ for every *ij*), and the total of each row equals one ($\sum P_{ij} = 1$). The situation If we wanted to calculate the value of the probability of the occurrence from state (*i*) to state (*j*) in a finite number of steps or periods of (*m*), we might do it as follows:

$$P_{hi}^m = P\left\{X_{n+m} = \frac{j}{X_n} = i\right\} \qquad (2)$$

Subsequently P_{hi}^m represents the transitional probabilities during (m) of the steps and what is mentioned in the relationship (2), since for each (m, $n \in N$) is:

$$P^{n+m} = P^n \cdot P^m \qquad (3)$$

The transition probabilities matrix of the Markov chain represents ($n + m$) steps, and the element located in a row (i) and column (j) of the P matrix (called Kolmogorov-Chapman equation) is as follows.

$$P^{n+m} = \sum_{h=o}^{\infty} P_{ih} P_{hj} \quad for\ all\ n, m > 0 \qquad (4)$$

In the case of monetary policy, t the data may be classified into three instances based on the transmission of overnight deposit window rate on the current month, the previous three months, or the previous six months, and the cases are (rise (R), decline (D), stability(S)) then Eq. (4) will be:

$$P^{R+D+S} = \sum_{h=o}^{\infty} P_{ih} P_{hj} \quad for\ all\ R, D, S > 0 \qquad (5)$$

The reaction of foreign reserves (FX) to change in overnight deposit window rate (WR):

$$P_{ij,z} = \begin{bmatrix} P_{R\_WR_{t-z},R\_FX_t} & P_{R\_WR_{t-z},D\_FX_t} & P_{R\_WR_{t-z},S\_FX_t} \\ P_{D\_WR_{t-z},R\_FX_t} & P_{D\_WR_{t-z},D\_FX_t} & P_{D\_WR_{t-z},S\_FX_t} \\ P_{S\_WR_{t-z},R\_FX_t} & P_{S\_WR_{t-z},D\_FX_t} & P_{S\_WR_{t-z},S\_FX_t} \end{bmatrix} \qquad (6)$$

The reaction of banking deposit rate (DR) to change in overnight deposit window rate (WR):

$$P_{ij,z} = \begin{bmatrix} P_{R\_WR_{t-z},R\_DR_t} & P_{R\_WR_{t-z},D\_DR_t} & P_{R\_WR_{t-z},S\_DR_t} \\ P_{D\_WR_{t-z},R\_DR_t} & P_{D\_WR_{t-z},D\_DR_t} & P_{D\_WR_{t-z},S\_DR_t} \\ P_{S\_WR_{t-z},R\_DR_t} & P_{S\_WR_{t-z},D\_DR_t} & P_{S\_WR_{t-z},S\_DR_t} \end{bmatrix} \qquad (7)$$

The reaction of banking lending rate (LR) to change in overnight deposit window rate (WR):

$$P_{ij,z} = \begin{bmatrix} P_{R\_WR_{t-z},R\_LR_t} & P_{R\_WR_{t-z},D\_LR_t} & P_{R\_WR_{t-z},S\_LR_t} \\ P_{D\_WR_{t-z},R\_LR_t} & P_{D\_WR_{t-z},D\_LR_t} & P_{D\_WR_{t-z},S\_LR_t} \\ P_{S\_WR_{t-z},R\_LR_t} & P_{S\_WR_{t-z},D\_LR_t} & P_{S\_WR_{t-z},S\_LR_t} \end{bmatrix} \qquad (8)$$

The reaction of banking credit to the private sector (CP) to change in overnight deposit window rate (WR):

$$P_{ij,z} = \begin{bmatrix} P_{R\_WR_{t-z},R\_CP_t} & P_{R\_WR_{t-z},D\_CP_t} & P_{R\_WR_{t-z},S\_CP_t} \\ P_{D\_WR_{t-z},R\_CP_t} & P_{D\_WR_{t-z},D\_CP_t} & P_{D\_WR_{t-z},S\_CP_t} \\ P_{S\_WR_{t-z},R\_CP_t} & P_{S\_WR_{t-z},D\_CP_t} & P_{S\_WR_{t-z},S\_CP_t} \end{bmatrix} \qquad (9)$$

The reaction of the inflation rate (INF) to change in the overnight deposit window rate (WR):

$$P_{ij,z} = \begin{bmatrix} P_{R\_WR_{t-z},R\_INF_t} & P_{R\_WR_{t-z},D\_INF_t} & P_{R\_WR_{t-z},S\_INF_t} \\ P_{D\_WR_{t-z},R\_INF_t} & P_{D\_WR_{t-z},D\_INF_t} & P_{D\_WR_{t-z},S\_INF_t} \\ P_{S\_WR_{t-z},R\_INF_t} & P_{S\_WR_{t-z},D\_INF_t} & P_{S\_WR_{t-z},S\_INF_t} \end{bmatrix} \qquad (10)$$

where, P is the probability, t is the current month, z is the current month, after three months or after six months, and the cases are (rise (R), decline (D), and stability(S)). The matrix (7–10) was applied to the remaining variables: 1) banking deposit rate (DR), 2) banking lending rate (LR), 3) banking credit to the private sector (CP), and 4) inflation rate (INF). Using monthly data, Figure 1 describes the framework for obtaining evidence on the time-varying reaction of the CBJ's foreign reserves, banking deposit rate, banking lending rate, banking credit to the private sector, and inflation rate to changes in monetary policy (interest rate on the overnight deposit window).

Structural econometric models, such as DSGE models, could be considered a prospective alternative to the Markov chain modeling methodology. This would be valuable. These simulations include economic theory and microeconomic underpinnings to reproduce the behavior of significant macroeconomic variables over time. This permits a full assessment of the processes accountable for monetary policy transmission. Also, Bayesian econometric approaches, such as Bayesian vector autoregression (BVAR) models, might offer an alternate method. These techniques include prior knowledge and uncertainty in the analysis to perform robustness tests.

Figure 1. Time frame of effective monetary policy (*WR*) on the study variables
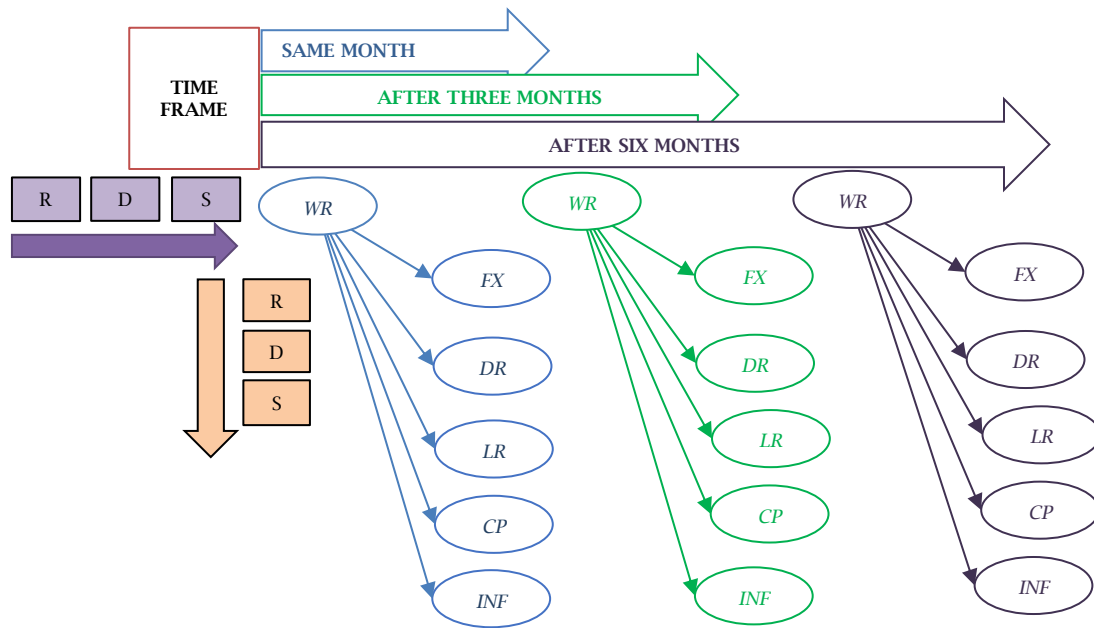
4. EMPIRICAL RESULTS

4.1. Foreign reserve reaction to the Central Bank of Jordan's overnight window deposit rate

The CBJ is bound to adjust its interest rates in response to changes in international interest rates, particularly those of the US dollar. This is done to maintain the competitiveness of the Jordanian dinar as a means of local savings and to ensure monetary and financial stability. This policy also leads to the accumulation of foreign reserves, which support the exchange rate policy pegged to the US dollar. Changes in interest rates may have implications for the valuation channel of foreign reserve accumulation (Pina, 2017).

In light of these considerations, the findings of the Markov chain analysis, depicted in Figure 2, indicate a significant impact of changing the official interest rate on the overnight deposit window rate

(*WR*) on the probability of changing the central bank's foreign reserves. An increase in *WR* increases the likelihood of rising foreign reserves, with probabilities ranging from 43% to 47% in the short term (current to six months) and from 52% to 61% in the steady-state/long-term forecast during the same period and on the other hand, reducing *WR* results in the probability of declining foreign reserves, with probabilities ranging from 12% to 41% in the next month to six months and from 39% to 47% over the next year. These findings underscore the strong connection between monetary policy decisions and the response of foreign reserves. These results are also consistent with earlier studies (Bank for International Settlements [BIS], 2005; Wang et al., 2012; Al-Zoubi et al., 2013). Furthermore, the study reveals that the response of foreign reserves to an increase in the official interest rates (*WR*) is more robust than its response to a decrease in *WR*.

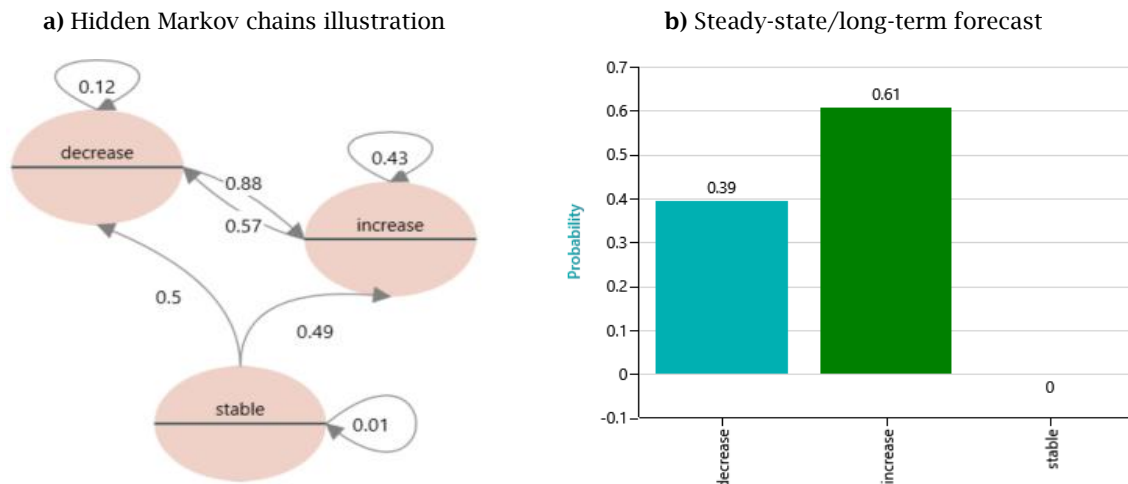**Figure 2a.** Foreign reserve reaction to the CBJ's overnight window deposit rate in the current month's moment

a) Hidden Markov chains illustration

b) Steady-state/long-term forecast

Figure 2b. Foreign reserve reaction to the CBJ's overnight window deposit rate after three months of the CBJ movement

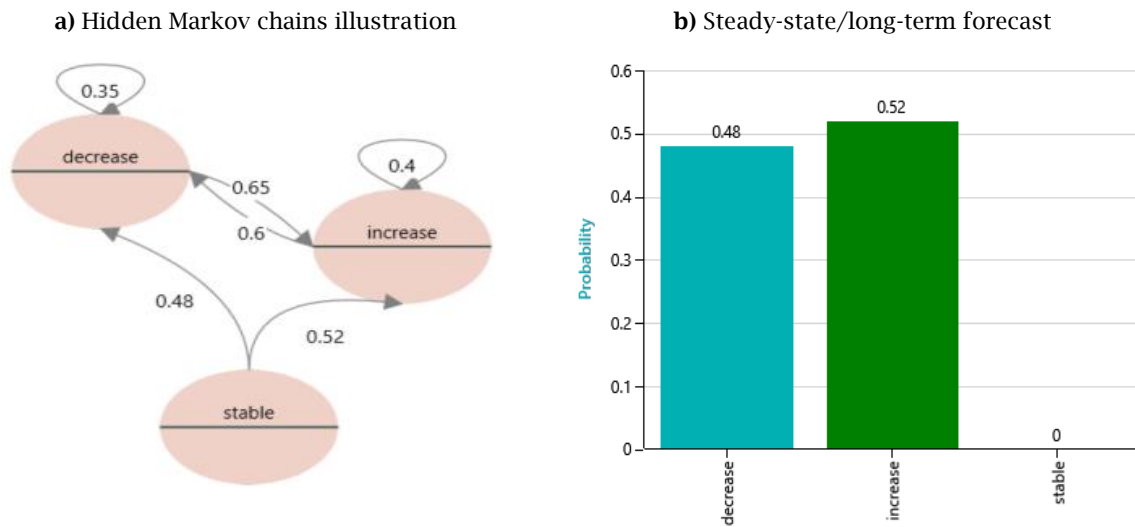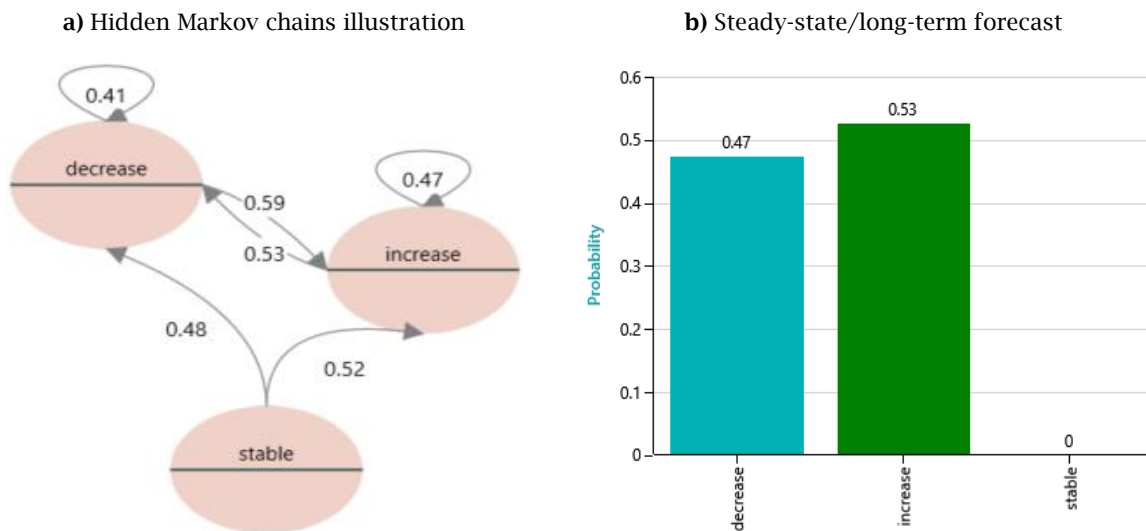**a)** Hidden Markov chains illustration

b) Steady-state/long-term forecast

Figure 2c. Foreign reserve reaction to the CBJ's overnight window deposit rate after six months of the CBJ movement

a) Hidden Markov chains illustration

b) Steady-state/long-term forecast

4.2. Banking deposit rate reaction to the Central Bank of Jordan's overnight window deposit rate

After the CBJ determines the policy rate, banks play a crucial role in determining retail deposit interest rates, marking the initial step in transmitting the policy rate's impact on the economy (Gharaibeh & Farooq, 2022). This relationship is evident in the results of the Markov chain analysis, as depicted in Figure 3. The analysis reveals a significant probability of changing the banking deposit rate in Jordanian banks in response to fluctuations in the central bank policy rate (official interest rate on the overnight deposit window, *WR*). These findings align with previous studies on the topic, such as Almajali and Almubidin (2022), and Biefang-Frisancho Mariscal and Howells (2002).

When the *WR* increases, there is a higher likelihood of the banking deposit rate rising, ranging from 80% to 76% in the short term (one to six months) and from 68% to 39% in the steady-state/long-term forecast. Conversely, when the *WR* decreases, the probability of a decline in the banking deposit rate ranges from 60% to 80% in the short term and from 25% to 52% in the steady-state/long-term forecast. These findings emphasize the significant connection between monetary policy actions and the responses of banking deposit rates.

It is worth noting that the reaction of interest rates on deposits is more pronounced in the short term than its response to a decrease. However, over the medium term, the reaction is stronger for decreases in the interest rates.

Figure 3a. The effect of the CBJ's overnight window deposit rate on banking deposit rate movement in the current month's moment
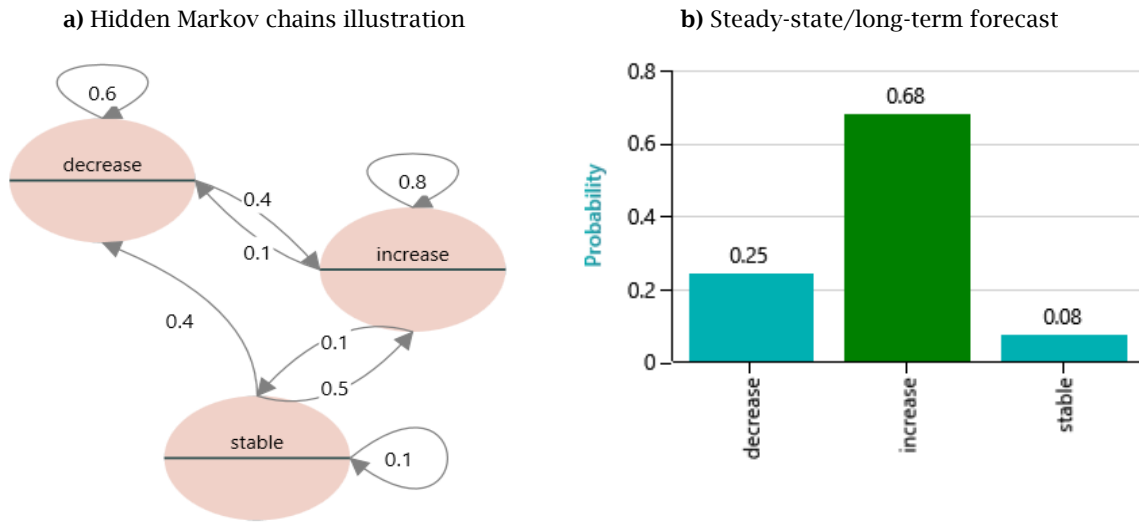
a) Hidden Markov chains illustration

b) Steady-state/long-term forecast

Figure 3b. The effect of the CBJ's overnight window deposit rate on banking deposit rate movement after three months of the CBJ movement
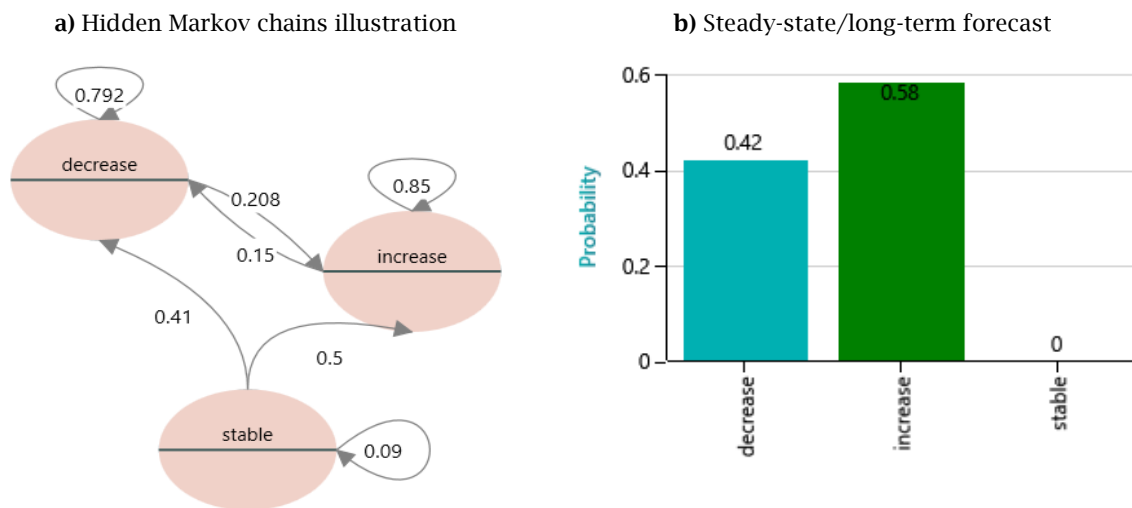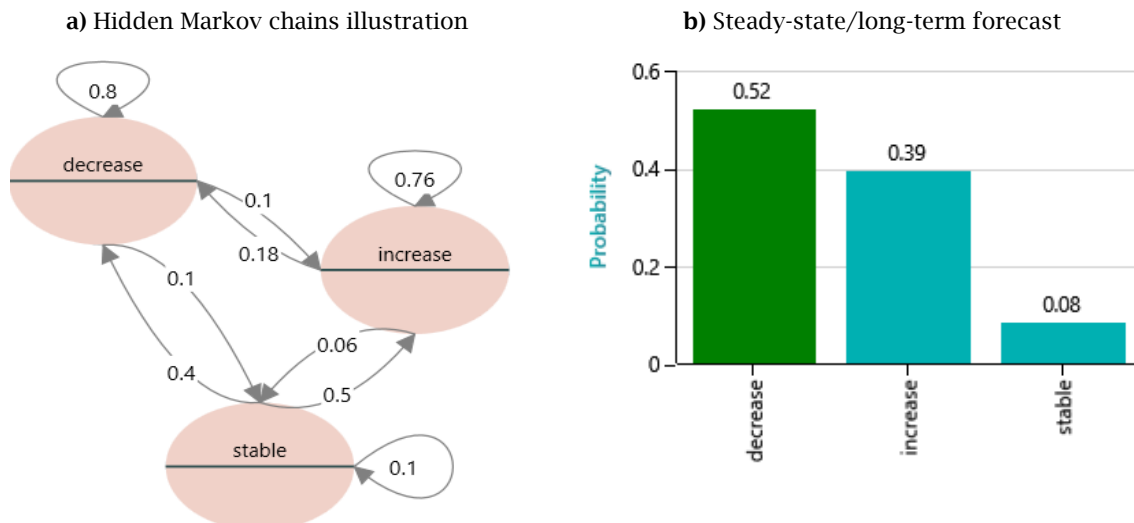
a) Hidden Markov chains illustration

b) Steady-state/long-term forecast

Figure 3c. The effect of the CBJ's overnight window deposit rate on banking deposit rate movement after six months of the CBJ movement

a) Hidden Markov chains illustration

b) Steady-state/long-term forecast

4.3. Banking lending rate reaction to the Central Bank of Jordan's overnight window deposit rate

Based on the bank lending channel, changes in monetary policy, particularly the CBJ's interest rate, impact bank assets, specifically loans. An expansionary monetary policy, characterized by a reduction in the CBJ's interest rate, leads to an increase in the money supply and a subsequent decrease in the interest rate on bank loans (Amidu, 2006).

The findings of this study align with the credit channel theory, as evidenced by the results of the Markov chain analysis illustrated in Figure 4. The analysis reveals a significant probability of changing the banking lending rate in response to fluctuations in the official interest rate on the overnight deposit window (*WR*). When the *WR* increases, there is a considerable probability of the banking lending rate rising, ranging from 50% to 65% in the short term (one to six months) and from 44% to 54% in the steady-state/long-term forecast. Conversely, when the *WR* decreases, the probability of a decline in the banking lending rate ranges from 50% to 59% in the short term and from 40% to 47% in the steady-state/long-term forecast. These findings emphasize the close relationship between monetary policy actions and the response of banking lending rates.

The results of this study are consistent with previous research, such as Siklar (2021), and Alpanda et al. (2019), which also support the influence of monetary policy on banking lending rates. Additionally, the study findings indicate that, in the short term, the reaction of interest rates on lending is comparable for increases and decreases in the *WR*. However, in the long run, the response to an increase in the WR is more pronounced than the response to a decrease.

Figure 4a. Banking lending rate reaction to the CBJ's overnight window deposit rate in the current month's moment

a) Hidden Markov chains illustration
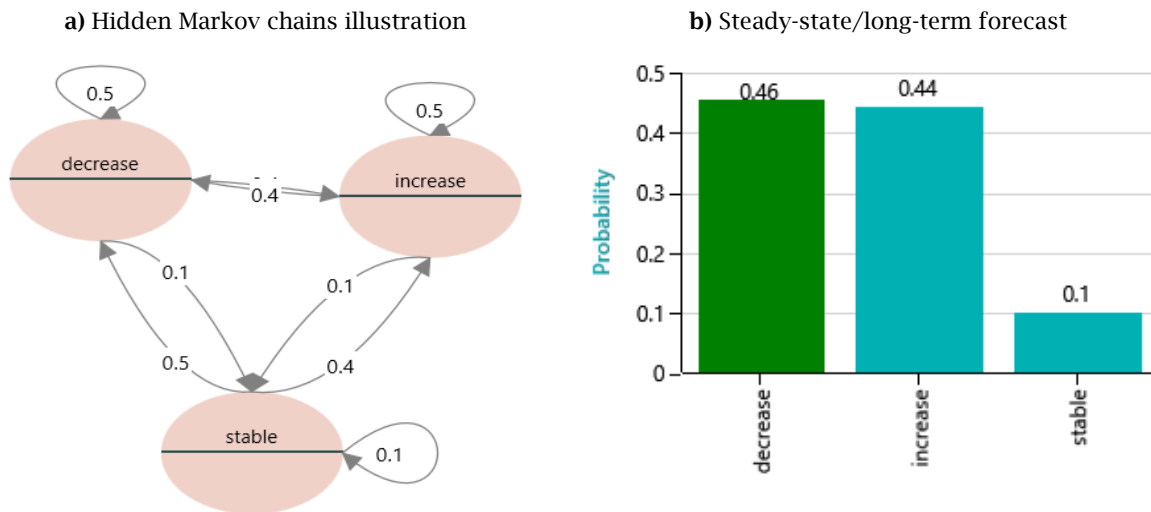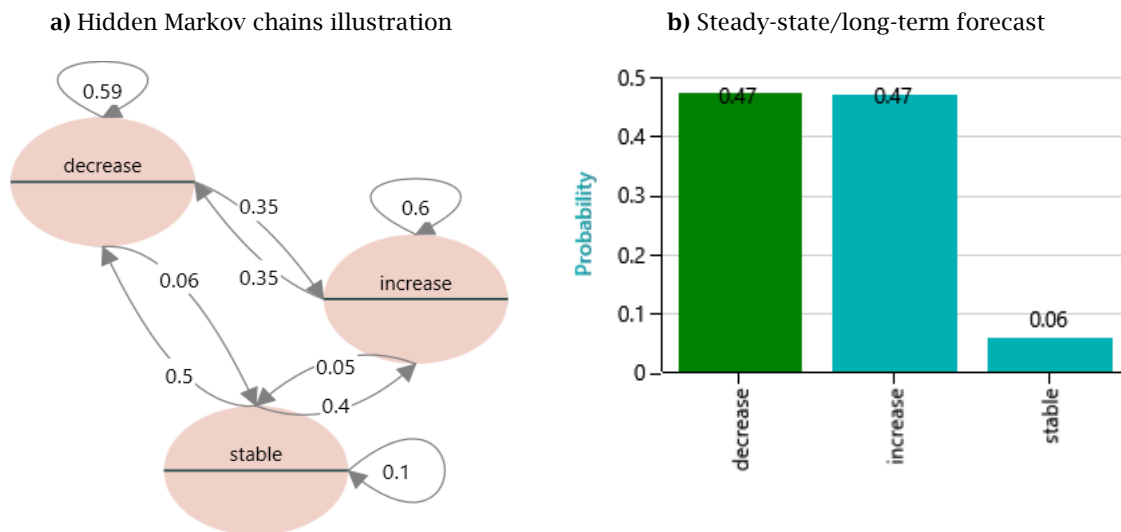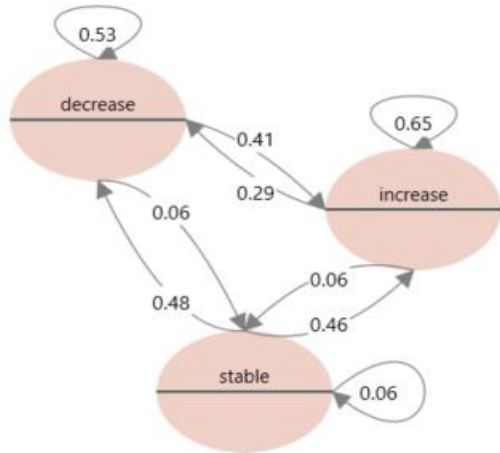
b) Steady-state/long-term forecast

Figure 4b. Banking lending rate reaction to the CBJ's overnight window deposit rate after three months of the CBJ movement

a) Hidden Markov chains illustration

b) Steady-state/long-term forecast

Figure 4c. Banking lending rate reaction to the CBJ's overnight window deposit rate after six months of the CBJ movement

a) Hidden Markov chains illustration

b) Steady-state/long-term forecast
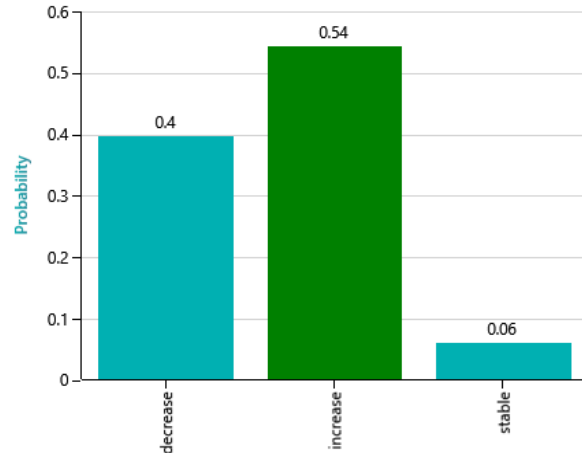
4.4. Banking credit to privet sector reaction to the Central Bank of Jordan's overnight window deposit rate

The interest rate channel is the traditional Keynesian monetary transmission channel. A reduction in interest rates reduces the cost of capital, causing an increase in credit to the private sector and vice versa. Markov chains were used to investigate the reversal trend. According to the findings, which are illustrated in Figure 5, there is a meaningful probability of a decrease in credit to the private sector from 5% to 29% over one to six months and from 7% to 31% over the time of the steady-state/long-term forecast when the official interest rate on the overnight deposit window (*WR*) increase. Also, the probability of increasing credit to the private sector in response to reducing *WR* ranges between 59% to 82% for the one- to six-month period and from 64% to 93% for the steady state/long-term forecast. This indicates the close connection between monetary policy actions and how credit to the private sector behaves to those decisions. This result is consistent with the findings, which also showed that when WR rises, the reaction of facilities is limited; however, when *WR* decreases, the response is considerable. The interest rate channel is a traditional Keynesian mechanism through which monetary policy influences the economy. A decrease in interest rates lowers the cost of capital, leading to increased credit extended to the private sector. In contrast, an increase in interest rates has the opposite effect (Chirinko & von Kalckreuth, 2003). In this study, Markov chains were utilized to examine the behavior of the interest rate channel.

The results of this study are consistent with previous research conducted by Asaleye et al. (2018), Siklar (2021), and Maziad (2009), which also support the influence of monetary policy on credit to the private sector. Additionally, the findings indicate that the reaction of credit facilities is limited when the *WR* increases. In contrast, a considerable response is observed when the *WR* decreases.

Figure 5a. Banking credit to private sector reaction to the CBJ's overnight window deposit rate in the current month's moment

a) Hidden Markov chains illustration
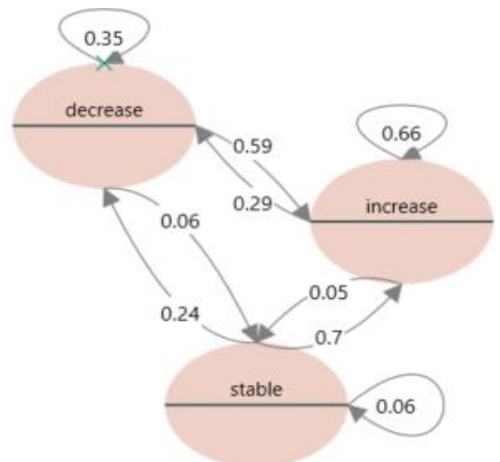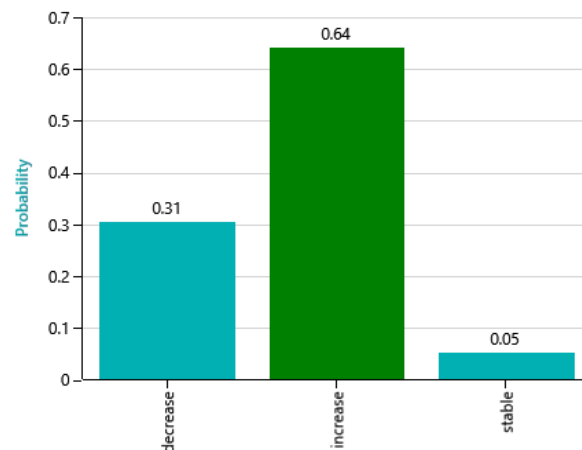

b) Steady-state/long-term forecast

Figure 5b. Banking credit to private sector reaction to the CBJ's overnight window deposit rate after three months of the CBJ movement

a) Hidden Markov chains illustration

b) Steady-state/long-term forecast

Figure 5c. Banking credit to private sector reaction to the CBJ's overnight window deposit rate after six months of the CBJ movement
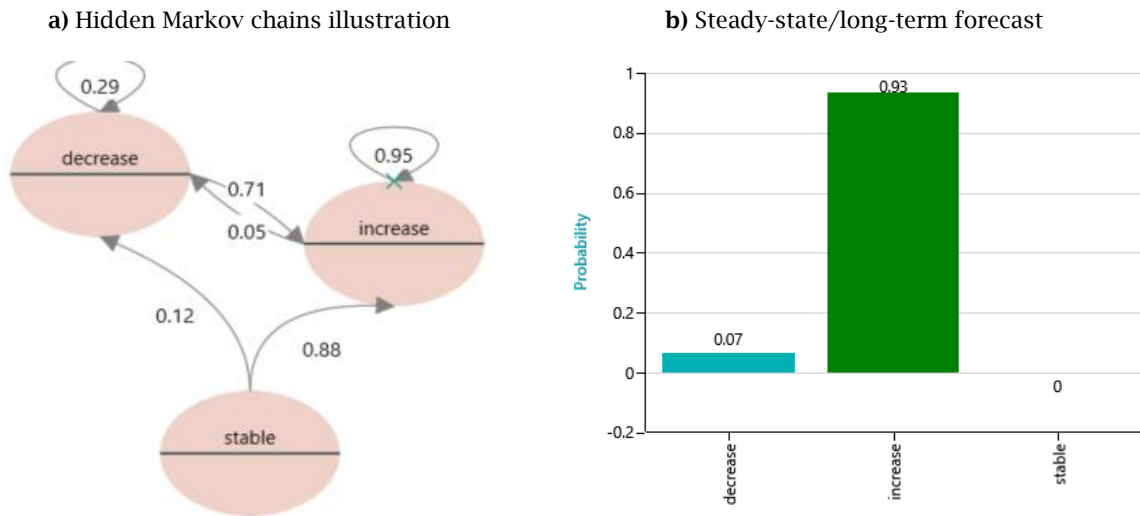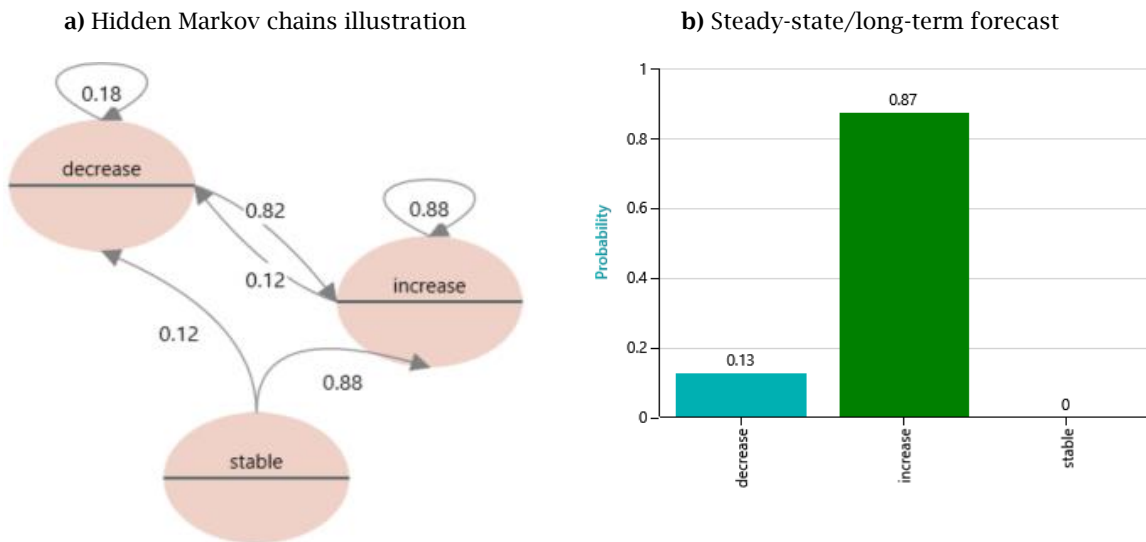
a) Hidden Markov chains illustration

b) Steady-state/long-term forecast

4.5. Inflation rate reaction to the Central Bank of Jordan's overnight window deposit rate

The study findings demonstrate that official interest rate (*WR*) changes significantly impact interest rates and credit facilities, influencing the demand for goods and services, a key driver of inflation (Smal & de Jager, 2001). The analysis using the Markov chain approach reveals noteworthy probabilities of changing the inflation rate in response to fluctuations in the overnight deposit window rate (*WR*). Specifically, increasing *WR* shows a considerable probability of decreasing inflation in the short-term (one to six months) and the long-term (steady-state/long-term forecast), while reducing *WR* indicates a higher probability of inflationary pressure in both timeframes (Figure 6). The study also highlights that inflation rates are more responsive to a decrease in *WR* than an increase. This suggests that the CBJ's ability to reduce inflation effectively is limited, given that a significant portion of inflation in Jordan is driven by external factors such as import costs, particularly oil prices, which are beyond the bank's control (Hijazine & Al-Assaf, 2022).

Figure 6a. Inflation rate reaction to the CBJ's overnight window deposit rate in the current month's moment
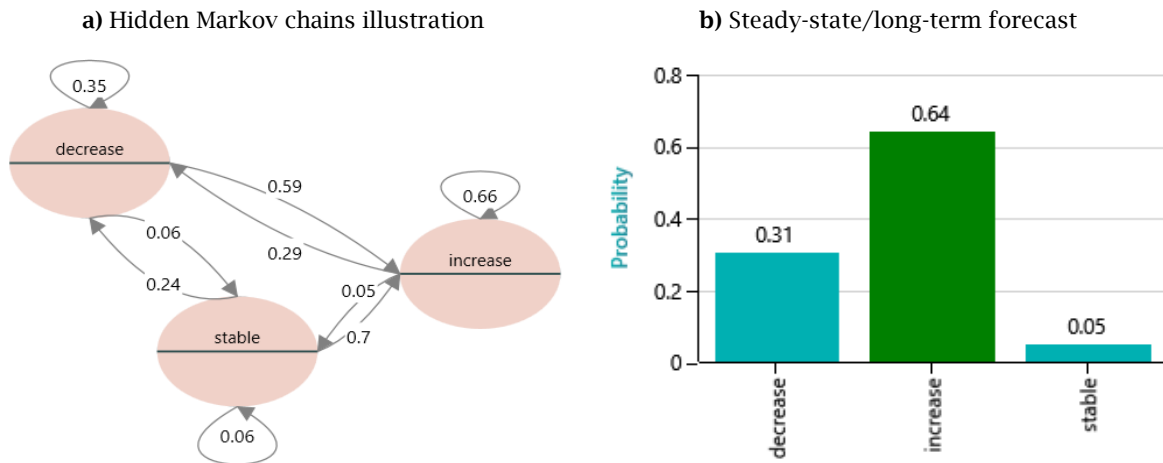
a) Hidden Markov chains illustration   **b)** Steady-state/long-term forecast

Figure 6b. Inflation rate reaction to the CBJ's overnight window deposit rate after three months of the CBJ movement
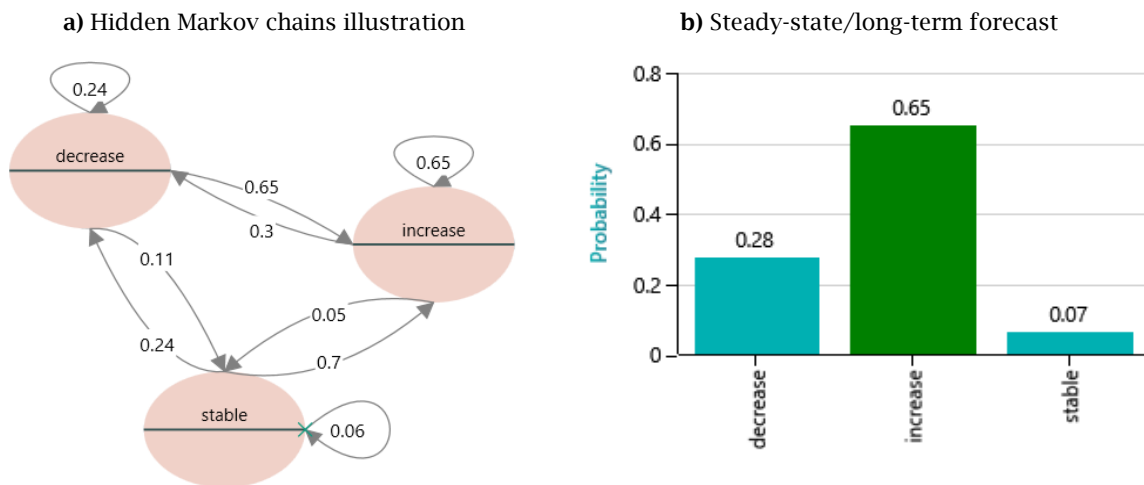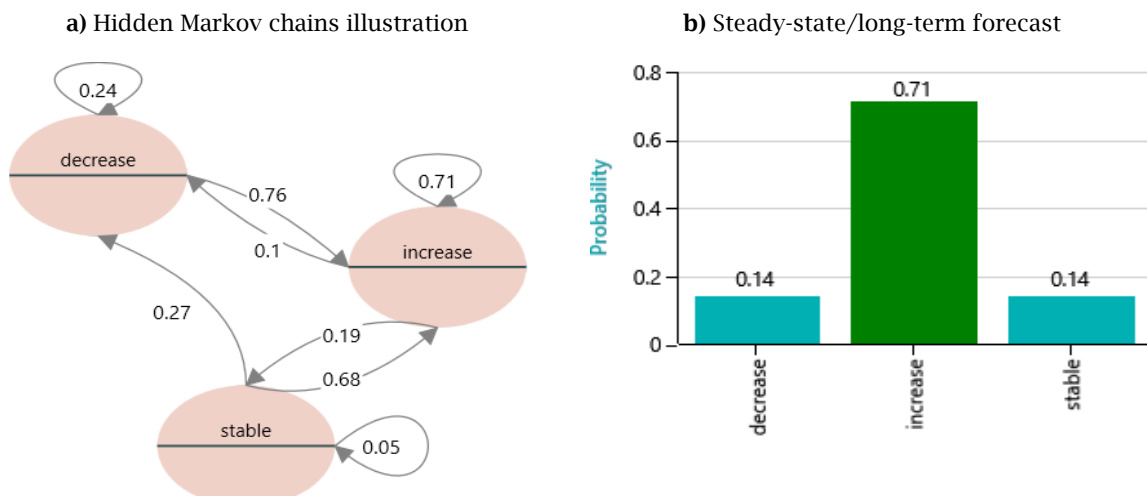
a) Hidden Markov chains illustration   **b)** Steady-state/long-term forecast

Figure 6c. Inflation rate reaction to the CBJ's overnight window deposit rate after six months of the CBJ movement

a) Hidden Markov chains illustration   **b)** Steady-state/long-term forecast

4.6. Discussions of results

The analysis of Jordan's monetary policy shows its influence on critical economic indicators. The foreign reserve response to changes in the CBJ's overnight window deposit rate demonstrates the importance of interest rate policy in preserving monetary stability and keeping the exchange rate fixed to the US dollar. The response of banks' deposit rates to changes in the overnight window deposit rate indicates the transmission mechanism via which monetary policy actions impact lending and deposit behavior in the banking sector. The effectiveness of monetary policy in altering credit conditions is stressed, but the complexities of policy execution need subtle modifications.

5. CONCLUSION

The study used Markov chains analysis to explore how influences of overnight deposit window rate, affected monetary and economic variables, including inflation rate, banking lending rate, banking deposit rate, credit to the private sector, and foreign reserves. The results show a significant possibility of modifications. in these variables in response to changes in the CBJ interest rate, with diverse patterns and variations across time. The study found that rises in bank deposit rates caused a stronger response in the short term than drops, and falls caused a more robust response in the medium term. Likewise, lending interest rates reacted to rises and drops in window rates, but in the long term, rate increases outperformed rate cuts. Particularly,

the research found that the effect of window rate changes on loan facilities was low when rates increased but significant when rates fell.

Moreover, the conclusions demonstrated that the CBJ's influence on managing inflation is limited, mainly owing to external variables such as import costs, notably oil prices. Given this constraint, the paper suggests that the CBJ uses the Markov chain approach to foresee inflation changes and the likelihood of inflationary pressures in Jordan.

Also, the result proposes further research on the issue of Markov switching, specifically emphasizing the impact of oil prices on Jordanian inflation. Future research might give further insight into the factors responsible for Jordan's inflationary patterns by investigating the relations between oil prices and inflation dynamics.

In conclusion, this study proves the efficacy of the Markov chain technique in assessing the change of interest rate fluctuations on some monetary and economic indicators in Jordan. The results have important implications for the CBJ regarding monetary policy control and economic forecasting.

The study investigates the impact of Jordan's monetary policy on economic indicators. It is restricted by its scope and dependency on a particular methodology. Furthermore, the January 2006 to December 2022 dataset might overlook relevant economic dynamics. Future investigations could integrate more data. Furthermore, conducting comparative assessments with another country may offer valuable insights into the efficacy of diverse policy strategies.

REFERENCES

Adayleh, R. M., Al-Damour, S. B., & Al-Majali, A. (2024). The impact of global energy price volatility on oil derivative and local price in Jordan: Using DCC-GARCH model. *International Journal of Energy Economics and Policy, 14*(1), 336–348. https://doi.org/10.32479/ijeep.15158

Adrian, T., & Liang, N. (2016). *Monetary policy, financial conditions, and financial stability* (CEPR Discussion Paper No. DP11394). CEPR Press.

Alexandre, M., & Lima, G. (2020). Combining monetary policy and prudential regulation: An agent-based modeling approach. *Journal of Economic Interaction and Coordination, 15*, 385–411. https://doi.org/10.1007/s11403-017-0209-0

Al-Lozi, M. (2023). Identifying monetary policy under fixed exchange rates in a small open economy. International *Journal of Professional Business Review, 8*(10), Article e03574 https://doi.org/10.26668/businessreview/2023.v8i10.3574

Almajali, A. A., & Almubidin, R. F. (2022). Estimating the indirect effects of monetary policy on inflation, the output gap and foreign reserves in Jordan using the new Keynesian model. *Jordan Journal of Economic Sciences, 9*(2), 172–188. https://doi.org/10.35516/jjes.v9i2.225

Alpanda, S., Granziera, E., & Zubairy, S. (2019). *State dependence of monetary policy across business, credit and interest rate cycles* (Research Discussion Paper No. 16/2019). Bank of Finland. https://doi.org/10.2139/ssrn.3943787

Al-Zoubi, O., Saqfalhait, N., & Al-Majali, A. (2013). Interaction between monetary and fiscal policy in Jordan. *Journal of Economics and Economic Education Research, 14*(1), 19–40. https://www.alliedacademies.org/articles/interaction-between-monetary-and-fiscal-policy-in-jordan.pdf

Amidu, M. (2006). The link between monetary policy and banks lending behaviour: The Ghanaian case. *Banks and Bank Systems, 1*(4), 38–48. https://www.businessperspectives.org/images/pdf/applications/publishing/templates/article/assets/1593/BBS_en_2006_04_Amidu.pdf

Apanisile, O. T., & Osinubi, T. T. (2020). Financial development and the effectiveness of monetary policy channels in Nigeria: A DSGE approach. *Journal of African Business, 21*(2), 193–214. https://doi.org/10.1080/15228916.2019.1625021

As Sahara, M., & Setiawan, D. (2022). The effect of ethical values on Islamic banking performance. *Corporate & Business Strategy Review, 3*(2), 34–42. https://doi.org/10.22495/cbsrv3i2art3

Asaleye, A. J., Popoola, O., Lawal, A. I., Ogundipe, A., & Ezenwoke, O. (2018). The credit channels of monetary policy transmission: Implications on output and employment in Nigeria. *Banks and Bank Systems, 13*(4), 103–118. https://doi.org/10.21511/bbs.13(4).2018.10

Ayo, A. S., & Uwabor, E. S. (2021). Markovian approach to stock price modelling in the Nigerian oil and gas sector. *CBN Journal of Applied Statistics, 12*(1), 23–43. https://doi.org/10.33429/Cjas.12121.2/6

Bank for International Settlements (BIS). (2005). *Foreign exchange market intervention in emerging markets: Motives, techniques and implications* (BIS Paper No. 24). https://doi.org/10.2139/ssrn.1188513

Beaudry, P., Hou, C., & Portier, F. (2024). Monetary policy when the Phillips curve is quite flat. *American Economic Journal: Macroeconomics, 16*(1), 1–28. https://doi.org/10.1257/mac.20220088

Bhar, R., & Malliaris, A. G. (2021). Modeling U.S. monetary policy during the global financial crisis and lessons for COVID-19. *Journal of Policy Modeling, 43*(1), 15–33. https://doi.org/10.1016/j.jpolmod.2020.07.001

Biefang-Frisancho Mariscal, I., & Howells, P. (2002). Central banks and market interest rates. *Journal of Post Keynesian Economics, 24*(4), 569–585. https://doi.org/10.1080/01603477.2002.11490344

Central Bank of Jordan (CBJ). (1971). Central Bank of Jordan Law No. 23 of 1971. *Official Gazette, 2301.* https://www.cbj.gov.jo/ebv4.0/root_storage/en/eb_list_page/a6d37e65-4ed7-41d0-8799-60962f082f77_(1).pdf

Chirinko, R. S., & von Kalckreuth, U. (2003). *On the German monetary transmission mechanism: Interest rate and credit channels for investment spending* (CESifo Working Paper No. 838). Center for Economic Studies and Ifo Institute (CESifo). https://doi.org/10.2139/ssrn.378521

Cobham, D. (2015). Monetary analysis and monetary policy frameworks: Introduction. *The Manchester School, 83*(S1), 1–4. https://doi.org/10.1111/manc.12105

Edwards, S. (2015). Monetary policy independence under flexible exchange rates: An illusion? *The World Economy, 38*(5), 773–787. https://doi.org/10.1111/twec.12262

Galí, J. (2015). *Monetary policy, inflation, and the business cycle: An introduction to the new Keynesian framework and its applications* (2nd ed.). Princeton University Press.

Gharaibeh, M., & Farooq, O. (2022). Determinants of bank lending rates: Empirical evidence from conventional retail banks in Bahrain. *Banks and Bank Systems, 17*(4), 140–153. https://doi.org/10.21511/bbs.17(4).2022.12

Ghosh, A. R., Ostry, J. D., & Chamon, M. (2016). Two targets, two instruments: Monetary and exchange rate policies in emerging market economies. *Journal of International Money and Finance, 60*, 172–196. https://doi.org/10.1016/j.jimonfin.2015.03.005

Ha, J. S., Stocker, M. M., & Yilmazkuday, H. (2020). Inflation and exchange rate pass-through. *Journal of International Money and Finance, 105*, Article 102187. https://doi.org/10.1016/j.jimonfin.2020.102187

Hamdar, B., Skheita, Y., & Hamdar, M. B. (2022). An econometric approach to assess the impact of negative interest rate policy (NIRP) on real estate price inflation in the Eurozone. *Economics, 11*(1), 49–68. https://doi.org/10.11648/j.eco.20221101.17

Hasani, E., & Beqaj, B. (2023). New product development: Evidence from a banking sector. *Corporate & Business Strategy Review, 4*(2), 76–82. https://doi.org/10.22495/cbsrv4i2art7

Hijazine, R., & Al-Assaf, G. (2022). The effect of oil prices on headline and core inflation in Jordan. *OPEC Energy Review, 46*(3), 362–382. https://doi.org/10.1111/opec.12233

Indrajaya, D. (2022). Relationship of inflation, BI rate and deposit interest rate. *Ekonomi, Keuangan, Investasi Dan Syariah, 3*(3), 401–407. https://doi.org/10.47065/ekuitas.v3i3.1108

Khataybeh, M., & Al-Tarawneh, A. (2016). Impact of monetary policy on financial stability evidence from Jordan. *Administrative Sciences, 43*(1), 301–313. https://doi.org/10.12816/0028464

Kilci, E. (2019). Analysis of the relationship between inflation and central bank interest rates in Turkey: Fourier approach. *UIIID-IJEAS, 22*, 135–146. https://doi.org/10.18092/ulikidince.426035

Mahdich, A., Zadoia, O., & Honcharuk, B. (2024). Analiz efektyvnosti vykorystannya instrumentiv valyutnoyi polityky v Ukrayini v periody kryz 2008–2009 ta 2019–2020 rokiv [Analysis of the efficiency of using monetary policy instruments in Ukraine during the crises of 2008–2009 and 2019–2020]. *Academic Review, 1*(60), 150–163. https://doi.org/10.32342/2074-5354-2024-1-60-11

Maziad, S. (2009). *Monetary policy and the Central Bank in Jordan* (IMF Working Paper No. 09/191). International Monetary Fund (IMF). https://www.imf.org/external/pubs/ft/wp/2009/wp09191.pdf

Merko, F., & Habili, M. (2023). Impact of interest rate, exchange rate, and inflation on commercial banks' performance. *Corporate & Business Strategy Review, 4*(2), 15–28. https://doi.org/10.22495/cbsrv4i2art2

Mugableh, M. I. (2019). Does monetary policy affect economic growth in Jordan? Evidence from ordinary least square models. *International Business Research, 12*(1), 27–34. https://doi.org/10.5539/ibr.v12n1p27

Mussa, M. (1977). The exchange rate, the balance of payments and monetary and fiscal policy under a regime of controlled floating. In J. Herin, A. Lindbeck, & J. Myhrman (Eds.), *Flexible exchange rates and stabilization policy* (1st ed., pp. 97–116). Palgrave Macmillan.

Mwamkonko, M. A. (2023). The relative effectiveness of monetary policy transmission channels in Tanzania: Empirical lesson for post COVID-19 recovery. *African Journal of Economic Review, 11*(1), 65–82. https://www.ajol.info/index.php/ajer/article/view/240120

Obeid, R., & Awad, B. (2017). Effectiveness of monetary policy instruments on economic growth in Jordan using vector error correction model. *International Journal of Economics and Finance, 9*(11), 194–206. https://doi.org/10.5539/ijef.v9n11p194

Obeidat, M., Tarawneh, A., Khataibeh, M., & Omet, G. (2021). The lending channels of monetary policy transmission mechanisms: The case of Jordan. *Journal of Economics Finance and Accounting, 8*(4), 167–173. https://doi.org/10.17261/Pressacademia.2021.1471

Pina, G. (2017). International reserves and global interest rates. *Journal of International Money and Finance, 74*, 371–385. https://doi.org/10.1016/j.jimonfin.2017.02.026

Poddar, T., Sab, R., & Khachatryan, H. (2006). *The monetary transmission mechanism in Jordan* (IMF Working Paper No. 06/48). International Monetary Fund (IMF). https://www.imf.org/external/pubs/ft/wp/2006/wp0648.pdf

Saymeh, A. A. F., & Abu Orabi, M. M. (2013). The effect of interest rate, inflation rate, GDP, on real economic growth rate in Jordan. *Asian Economic and Financial Review, 3*(3), 341–354. https://archive.aessweb.com/index.php/5002/article/view/997

Siklar, I. (2021). Transmission of monetary policy through credit interest rates in Turkey: A microeconomic perspective. *Business and Economic Research, 11*(4), 122–140. https://doi.org/10.5296/ber.v11i4.19257

Smal, M. M., & de Jager, S. (2001). *The monetary transmission mechanism in South Africa* (Occasional Paper No. 16) South African Reserve Bank. https://www.resbank.co.za/content/dam/sarb/publications/occasional-papers/2005/2515/occ16.pdf

Sweidan, O. D. (2011). Monetary policy inertia: Case of Jordan. *Journal of Economic Studies, 38*(2), 144–155. https://doi.org/10.1108/01443581111128389

Vulpiani, A. (2015). Andrey Andreyevich Markov: A furious mathematician and his chains. *Lettera Matematica, 3*, 205–211. https://doi.org/10.1007/s40329-015-0099-8

Wang, X., Krause, A., & Tong, C. S. P. (2012). Foreign exchange reserve accumulation, domestic stability, and foreign exchange policy: The case of China (2001–2010). *International Journal of Economics and Finance, 4*(12), 39–50. https://doi.org/10.5539/ijef.v4n12p39

Wesołowski, G. (2016). *Do long term interest rates drive GDP and inflation in small open economies? Evidence from Poland* (NBP Working Paper No. 242). Narodowy Bank Polski (NBP). https://static.nbp.pl/publikacje /materialy-i-studia/242_en.pdf

Yilmazkuday, H. (2022). Drivers of Turkish inflation. *The Quarterly Review of Economics and Finance, 82*(1), 315–323. https://doi.org/10.1016/j.qref.2022.03.005