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Developing a Network Theory-Based Tool to Assess Central Bank Policy Effectiveness

Khawaja Muhammad Umar[1], **Abdul Wahab Shah Bukhari**[2]

[1]Researcher, Department of Economics, Beaconhouse College Program, Multan, Pakistan.
[2]Researcher, Department of Commerce, Bahauddin Zakariya University, Multan, Pakistan.
Correspondence: muhammadumarkhawaja@gmail.com[1]

ABSTRACT

Aim of the Study: The paper aimed to create a mathematical tool that would aid economists in predicting the effectiveness of central banks in different countries.

Methodology: This study adopted an organized methodology starting with the specification of necessary parameters to be incorporated in the final equation. Country cases were provided for each variable and their significance was discussed and illustrated. Variables were then quantified and assigned a value between 0 and 1, with their mean calculated to provide a simplified representation of the overall impact. This approach helped in reaching a structured and clear conclusion with relation to the selected variables.

Findings/Results: The study proposed a new analytical tool that clearly linked various factors, including political stability, the informal economy, and Social and Religious attitudes, and their relationship with monetary policy outcomes. The tool could also predict the future possibilities regarding interest change in any country to favor its decision.

Conclusion: This study introduced a novel network theory-based quantitative tool to evaluate the effectiveness of central bank monetary policies globally. With features like the political stability index, the size of the informal economy, and social/religious acceptability of policies, the tool gave firm comprehensive benchmarks for the outcomes of policies. According to the observations made during this work, these and other variables depend on central bank effectiveness, as a quantitative analysis of various examples proved.

Keywords: Economics, Monetary Policy, Macroeconomics.

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1. INTRODUCTION

The macroeconomic policies are used by the government/central bank to accomplish its aims and objectives to come out from recession & shift to economic growth. Monetary policy according to Mehar (2022) is a macroeconomic policy that involves the setting of interest rates, exchange rates, and credit partition of the private sector as interference by the government for managing the economy. In some countries the money supply authority known as the central bank dominates the country's monetary policy as it impacts the monetary arena at domestic as well as at international levels. On the other hand, some nations have highly ineffective monetary systems that do not affect even their own economy. This means

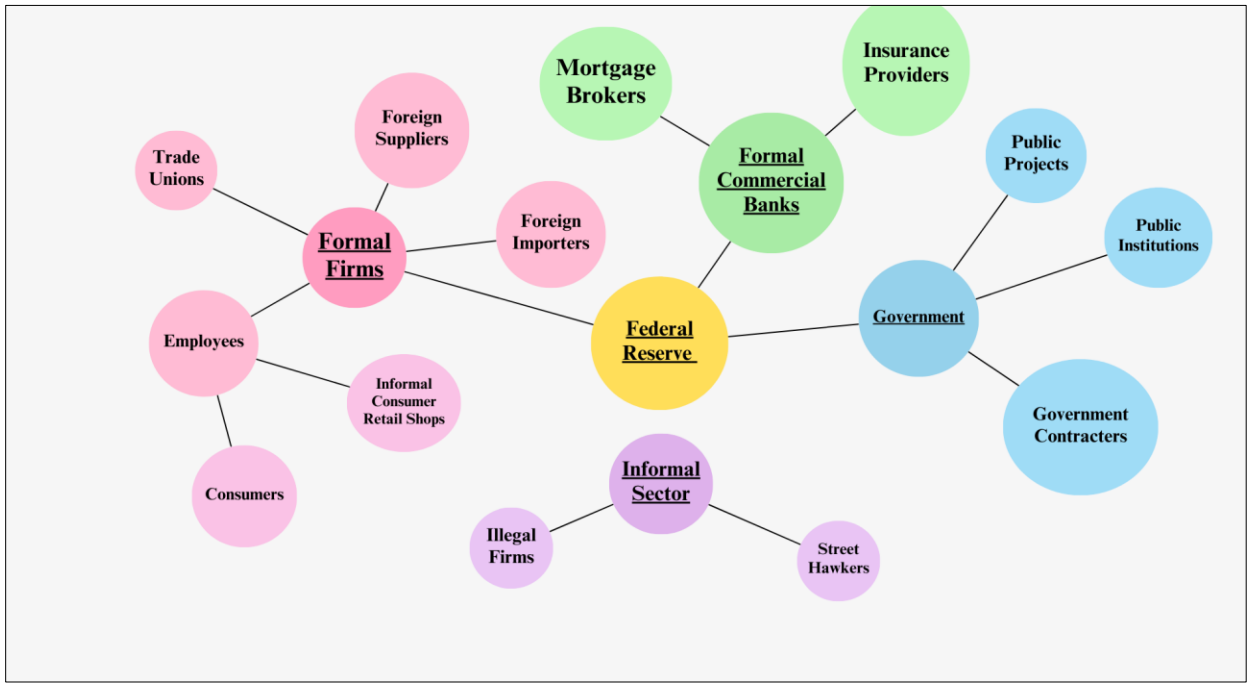
that the efficiency of monetary policy may depend much on structural characteristics within the economy. For instance, the IMF highlighted the unique inflation challenges faced by central banks in the Caucasus and Central Asia that limited the policy impact due to reliance on imported goods and currency volatility (Atamanchuk et al., 2023; Abbas and Tariq, 2023).

According to Ake (1975), political stability refers to a system's capacity to stay coherent and functional in the face of disruption. Political stability has a large bearing on both consumer and firm confidence; when government policies have been consistent, then firms are more likely to be willing to invest, and consumers are more likely to be willing to spend. On the other hand, with political instability or the uncertainties of policy changes, this confidence is dampened or even reduced with effects on investment and consequently consumption. Hielscher and Markwardt (2012) suggested that political stability and the quality of institutions were significant in influencing the CBI to reduce inflation. He even proposed that improved quality of political institutions would provide more credibility to the impact of CBI on reducing inflation thus making monetary policy more effective.

Social economics (SE) commonly known as socio economics is the study of how social structure, human behavior, and social relationships, affect economic systems in a society.It studies how different social forces influence economic decisions together with the behaviors of consumers and firms (Investopedia, 2024). In economics, a religious attitude (RA) encompasses the beliefs and values shaped by religious principles that influence economic behavior and decision-making. This concept suggests that religiosity affects individual choices, including consumption patterns, saving habits, and overall economic development (Eum, n.d.). Due to the effect of social and religious values on Consumer and firm behavior, the overall effectiveness of monetary policy may be influenced. For example, the concept of Islamic finance, especially the prohibition of charging and paying interest, will pose some difficulty to the kinds of instruments usually deployed by central banks in controlling monetary policy (International Monetary Fund, 2015). In places where Islamic finance is dominant, this prohibition may deter savings with the standard banking framework hence reducing the reserves for banks and consequently confining the capacity to provide loans. Therefore, normal levers such as interest rates and reserve requirements can fail because the intended economic shocks cannot penetrate through cultural and religious taboos that govern consumption patterns of the people and the operations of the institutions.

In many developing countries, the informal economy includes all economic activities of organizations and individuals who fail to register with the government and pay taxes. The main characteristic of the informal sector is that employment is not protected under formal labor laws, and may lack social security or job stability (Schneider, 2002; Abbas and Tariq, 2023; Dayo et al., 2023). Because corporate loans typically require formal registration, informal firms are often excluded from accessing mainstream financing. This makes them less sensitive to interest rate changes because they rely more on either retained business profits which are self-financing or borrow from other people for credit which are mostly informal credit sources and are not regulated by the banking sector (Govindharaj, 2023). Therefore, despite the interest rate many informal firms have continue to invest and offer fair wages to their employees resulting in consumers also equally continuing to spend since their disposable income remains unaffected by the interest rates. For formal businesses however, even a slight change in interest rates can have a big impact on manufacturing costs. The paper discusses the central bank's "centrality" in terms of network theory. The Central Bank may have greater sway if it establishes more "Vertices" with other economic actors, as is the case with the formal economy.

Graph 1: *Network Theory*



The application of network theory enabled the examination of structure and fabric of a system, focusing on the individual components and the interconnection and interaction between these entities in determining the overall behavior of a system as proposed by Barabási (2016). These relations between economic entities, including firms and consumers as well as regulatory entities give rise to feedbacks where individual behaviours coalesce to affect the overall economic system (Russo et al., 2018) Network theory provided us with such concepts as centrality, nodes and clustering to map these relations. The centrality points to the extent of direct connections, and any node's rate gives one an idea about its influence, nodes refer to individual entities, while clusters are groups of nodes connected by edges. Vertices are used interchangeably with nodes in this particular context (Liu, Sidhu, Beacom, & Valente, 2017).

1.1 Rationale of the study

Since monetary policy plays an important role in stabilizing an economy and promoting sustainable development, evaluation of the effectiveness of central banks is crucial to determine whether they are capable of addressing the problem of economic fluctuations. Although it is evident that several aspects affect the efficacy of monetary policy: stable exchange rate, competitiveness of the banking sector, and the coordination of monetary and fiscal policies (Lister, 2024), it is established that there is limited systematic empirical analysis of these variables against central bank efficiency in cross-section countries. Interest rate adjustments, a cornerstone tool of policy, are often noted for their variable and sometimes diffuse impacts (Bamford & Grant, 2020).There is paucity of financial instruments in evaluating the effect of monetary policy. This study is therefore very useful since it aims to fill this gap by proposing a multiple-index model for the evaluation of central banking performance internationally, which should offer new suggestions for scholars and policymakers interested in an area of economic policy, which is still not fully explored.

1.2 Objective of the study

- To methodically examine how social and religious beliefs, the informal economy, and political stability affect the efficacy of monetary policy in many settings.
- To create a quantitative measure that gives economists and politicians an empirical tool to help them make better decisions when formulating national policies.
- To determine whether social, political, and economic factors have a major impact on central bank effectiveness and investigate how using these findings could improve economic resilience.

2. LITERATURE REVIEW

Factors that affect Monetary Policy effectiveness have earlier been discussed in previous literature (Bamford & Grant, 2020; Lister, 2024). The Independent variables involved in this study are Political Stability, Informal Economy and Social and Religious Attitudes.

Many arguments have been made on the object that the political instability in Pakistan has been a major impediment to growth and development in the country through blurred policies, high rate of leadership changes, and governance crises that have impacted negatively on key economic fundamentals including trade, FDI and domestic currency. This persistent instability, not only affects the current economic performance but also hinders long-term development by aggravating inflation, increasing poverty, and discouraging investors leading to the creation of a vicious cycle of economic and political instability (Hussain et al., 2024). Backed by such findings, Hielscher and Markwardt (2012) have stressed the significant importance of political stability in enhancing an appropriate CBI to pursue the anti-inflation monetary mandate mandated by the constitution. This, therefore, highlights political stability as a core determinant in the feasibility of good governance and stability of economic systems as a direct key to the ability of the central bank to achieve sound monetary policies and stability of the general prices.

Among the emerging markets and developing countries, the informal sector provides significant employment and contributes to the GDP. However, this sector is usually characterized by low productivity and has issues with capital such as lacking easy access to loans, which is a major challenge to economic growth in this context (World Bank, 2019). According to Govindharaj (2023), informal businesses, mainly unregistered organizations are disproportionately hit with any changes in monetary policy since most of them cannot borrow from the formal banking sector. This exclusion from the mainstream financial channels is an indication that their cost of production is not influenced by changes in interest rates allowing them achieve operation stability amidst interest spikes

Social and religious factors also affect firm and consumer economic decisions, resulting in the returns generated from commerce and the efficacy of economic mechanisms of exchange being influenced depending on the society .For instance, Islamic finance's prohibition of riba (interest) complicates the use of interest-based tools central to traditional monetary policy (International Monetary Fund, 2015). In more basic terms, social and religious philosophies may become ‘economized’ in a country's MPC, which measures its ability to change consumption in response to changes in disposable income. Sokolova (2023) notes that MPC is a decisive measure when it comes to monetary interventions due to a direct connection with demand stability in the process of economic adjustment. In the case of specific population groups, having a higher MPC can strengthen the ability of monetary policy to respond to fiscal changes through immediate spending. The combination of cultural motives and MPC as a reaction indicator indicates that the sociocultural factor plays an important role when the central banks develop related policies for efficient economic outcomes in the relevant countries.

That said, the current state of literature holds a major blind spot: the lack of an aggregate index that standardizes these variables to assess the efficiency of monetary policy. We therefore intend to address this gap in knowledge, through developing a merged index of the many-faceted impact of the Political Stability, Informal Economy and Social and Religious Attitudes. This research therefore contributes to the

existing body of knowledge on the effectiveness of monetary policy particularly in emerging markets where these indicators are most acute.

3. METHODOLOGY

The paper examined factors that affect the functioning of the monetary policy by integrating archival data on interest rate fluctuations and their effect on GDP growth in the subject country. This data supported and extended the findings related to the variables under investigation, showing how economic agents respond to changes in monetary policy. The study was influenced by the Gini coefficient, which provides an answer range between 0 and 1. Just as the Gini coefficient measures two extremes of income equality (Joe Hasell, 2023), this study measured two extremes of central bank effectiveness.. A value of 0 indicated that none of the economic agents in the economy was sensitive to fluctuating interest rates; they continued normal economic activities. On the other hand, a value of 1 meant all economic agents: from a child rushing to buy an ice cream at a nearby shop to high profile traders in stock markets, were influenced by changes in interest rates. For it was almost imprecise to achieve these extremes, they formed a comparison by which the results could be measured. All the variables were involved in individual equations wherein the rules for arriving at the results were different. In the end, the study summed up all these equations and then took the average of them to come up with the result. Following the method described by Mehar (2022) for this type of study that sought to assess the efficiency of monetary policy in stimulating the economy, the study compares the monetary policy impact of the economy to the changes in aggregate demand as measured by GDP.

To measure political instability this study relied on a World Bank's measure of Worldwide Governance Indicators (WGI). Developed by World Bank researchers, the WGI compiled data from 1996 and provided a rating from 0 to 100 for countries based on six topics related to political stability: Voice and Accountability, Political Stability and No Violence/Terrorism, Government, Regulation, Order, Legal, and Residential Corruption. With this concept the study considered the indicator as an independent variable perhaps in the middle of developing an equation that is shown in the research article by Kaufmann, D., Kraay, A., & Mastruzzi (2010) but used the mean rating of these six categories where the effectiveness of the central bank was the dependent variable.

To express the informal economy in arithmetic form, the study used the following equation, where E represented the effectiveness of the central bank, ranging from 0 to 1, and S was the percentage share of GDP contributed by the informal sector:

$$E=1-S$$

Through the Informal Economy Database of the World Bank, it was possible to get more detailed numerical estimates of the size of the informal economy based on aggregate data from 196 countries for the period from 1990 to 2020. Of all variables that are possible to track – from the rates of self-employment and pension coverage up to child labor statistics – the database also featured the DGE model, which was recognized as the most accurate one for formal evaluation of the informal economy's effects on economies. This approach applied the macroeconomic modeling methodology to capture the complexity of the informal sector (World Bank, 2024). If S equal to zero meaning that no economy is represented by the informal sector then E would equal to one and if S is equal to one meaning that wholly informal economy then E would equal to zero. This approach in line with the research indicating that due to cash dominated nature of the informal economy, efforts at demonetization and digital transformation had distorted impacts on the efficacy of monetary policy and practices. Alberola and Urrutia (2019) went further and specified that "the presence of the informal sector cuts the sensitivity of ulc to changes in the interest rate": since informal firms have neither much formal credit access nor borrowed for working capital needs, as opposed to the formal ones who used credit for working capital thus, they felt much more the impact of a variation in interest rates.

However, it emerged that in the policy effectiveness analysis, the informal sector share coefficients were not as strong as some other variables that were mentioned in the research paper. For instance, even in a country where a large number of people are engaged in the informal sector, the rates of interest could impact on the behavior of consumers. Probably if higher rates were set they would have helped in encouraging saving as opposed to spending, and therefore this would have a roundabout effect on the informal sector because it would have reduced the overall demand in the economy (Economics Help, 2023). Furthermore, fluctuations in interest rates could have influenced export and import fluctuation that in turn affected the competition levels received by the informal firms. Therefore, to make the equation more practical, the study proposed introducing a constant to adjust for these indirect influences. The revised equation would be:

$$E=1-AS$$

Where A stood for that constant. In fact, it was understood that the constant could vary over time, however, within the framework of this research paper, it was decided that the constant was 0.8.

Regarding quantifying social and religious attitudes, it proved helpful to study their correlation with the Marginal Propensity to Consume commonly used for large population behavior assessment across the nation. According to Sokolova (2023), MPC was central to the effectiveness of monetary interventions as it affected the probability of demand fluctuations during the course of economic changes. A higher MPC among specific demographic groups would further help the central banks retain macroeconomic stability since it could encourage timely spending responses to fiscal measures through relevant policies. The interplay between cultural values and MPC as an adjustment metric underscored the need for central banks to incorporate socio-cultural considerations into policy development to achieve effective economic outcomes in culturally diverse economies

Economics Online (2024) defined the marginal propensity to consume (MPC) as the portion of additional income that a household spent on consumption rather than saving. It reflected the relationship between changes in disposable income and consumer spending. It further provided an equation to calculate MPC:

$$MPC=\Delta Y/\Delta C$$

ΔC was the change in consumption, and ΔY was the change in disposable income. The data for the MPC was provided by the World Bank Database Indicators of 'Final consumption expenditure (constant 2015 $)' for ΔC and 'Adjusted net national income (constant 2015 $)' for ΔY (World Bank, n.d.). Though it was noted that different demographics spent their income differently—where the rich consumed more than the poor—the research focused on the national level, taking the average MPC for the country. Nevertheless, the equation above helped determine the MPC of a country, which was then used as a key factor in the final equation. Therefore, the equation was as follows:

$$MPC=E$$

Where E stands for the effectiveness of the central bank. By extension, an economy with a MPC of 0 would have remained virtually immune to changes in the monetary policy while an economy that boasted of a MPC of 1 would have been sensitive.. This was however only true where it related to expansionary monetary policy, where a lowering of interest rates would have tended to help a consumption led economy such as the US (which has a much higher MPC closer to 1) compared to a savings led economy such as Japan with a MPC close to 0.

In contrast, contractionary monetary policy had the opposite effect. In this instance, a savings-based economy (APC near 0) would have benefited more from it than a consumption-based economy (APC near 1). In order to rectify this imbalance and properly represent the consequences of contractionary policy in various economic contexts, the study made a small adjustment to the equation.

$$1-MPC=E$$

4. RESULTS

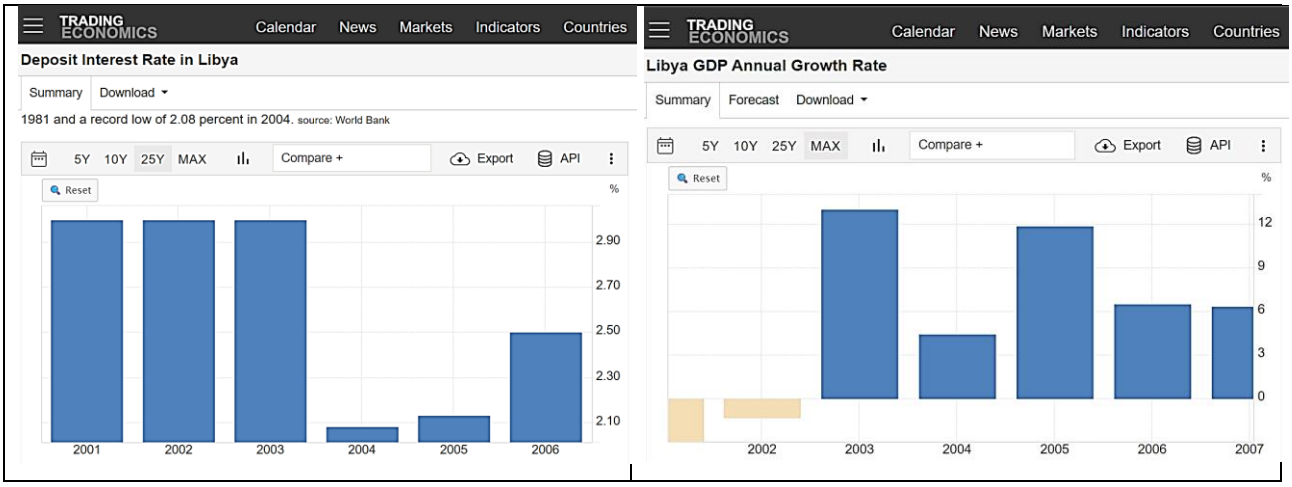
4.1 Political Stability

The study used the example of Libya from the year 2003- 2004 to test the impact between the dependent variable Central Bank Effectiveness with the change in independent Variable Political Stability.

Table 1: *World Governance Indicator (Libya)*

WGI Aggregate Indicators (Libya)	2003	2004
Voice and Accountability	3.48	2.40
Political Stability and Absence of Violence/Terrorism	48.24	58.25
Government Effectiveness	19.46	20.90
Regulatory Quality	3.78	7.46
Rule of Law	21.39	19.23
Control of Corruption	20.63	19.70
Mean	19.50	21.32

Figure 1: Interest Rate and Economic Growth (Libya)



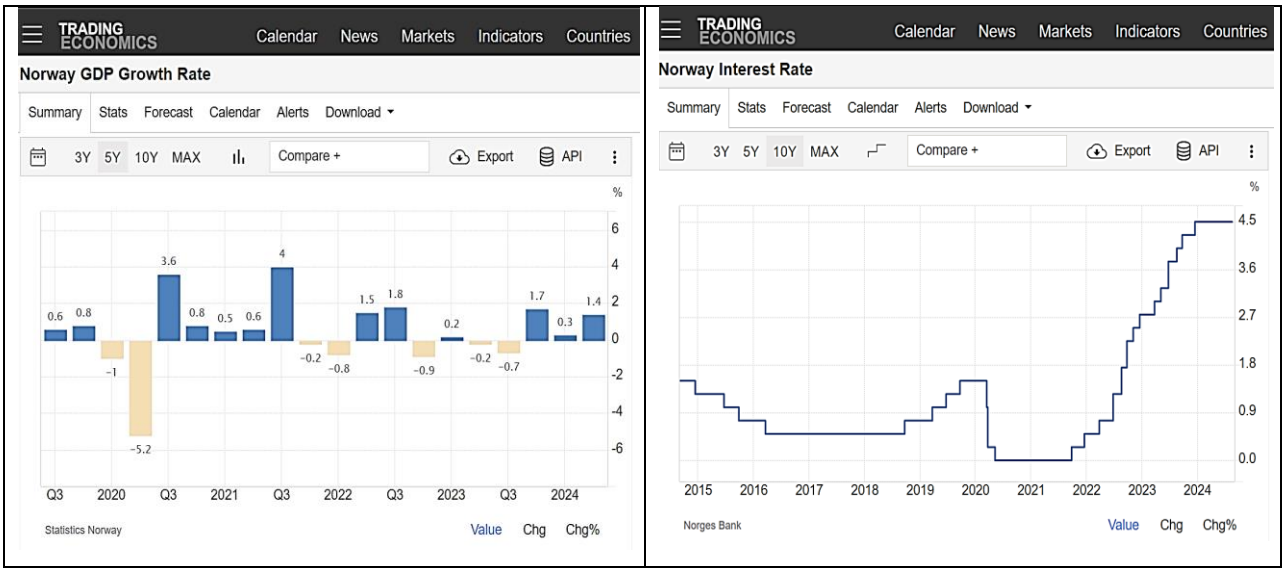
In WGI indicators Libya was below average and gave poor performance in the years 2003-2004. Averaging all the indicators, it was 19.5 (in 2003) and 21.32 (in 2004), or 0.195 (in 2003) and 0.2132 (in 2004). Deposit interest rates decreased from 3 percent in 2003 to 2.08 percent in 2004 to reflect the central bank's desire to boost aggregate demand spending and investment. However, during the same period, the economic activity declined and the economic growth rates, having shown 13 % in 2003 were further down to 4.46% in 2004 (Trading Economics, n.d.). This implied an inadequate link between the two figures, and, therefore, the population had no confidence in the government and was not concerned with the monetary policy.

The study also took another example of Norway from the year 2021-2022 to show a correlation with the variable Political Stability

Table 2: *World Governance Indicator (Norway)*

WGI Aggregate Indicators (Norway)	2021	2022
Voice and Accountability	100	100
Political Stability and Absence of Violence/Terrorism	88.68	76.42
Government Effectiveness	97.62	98.11
Regulatory Quality	95.24	91.98
Rule of Law	99.52	98.11
Control of Corruption	98.10	98.11
Mean	96.53	93.79

Figure 2: *Interest Rate and Economic Growth (Norway)*



All the WGI indicators for Norway were positive in their assessments. When the mean of these indicators was calculated the respective values were 96.53, for 2021 and 93.79 for 2022 or 0.97 (2021) and 0.93 (2022). Thus indicating that, there seemed to be a close relationship with the central bank's actions in the period of 2021 to 2022. This was evidenced by the following statistics about the national interest rate of the economy of Norway, which was 0% in 2021 and 2.75% in 2022. The above change in behavior had the effect of lowering the rate of expenditure by consumers and by firms, which decreased the GDP growth rate from 4 percent per annum in 2021 down to -0.9 percent per annum in the last quarter of 2022. (Trading Economics, n.d.). This showed a strong correlation between the two figures and consequently hinted towards the fact that people had confidence in the government and were affected by Monetary policy.

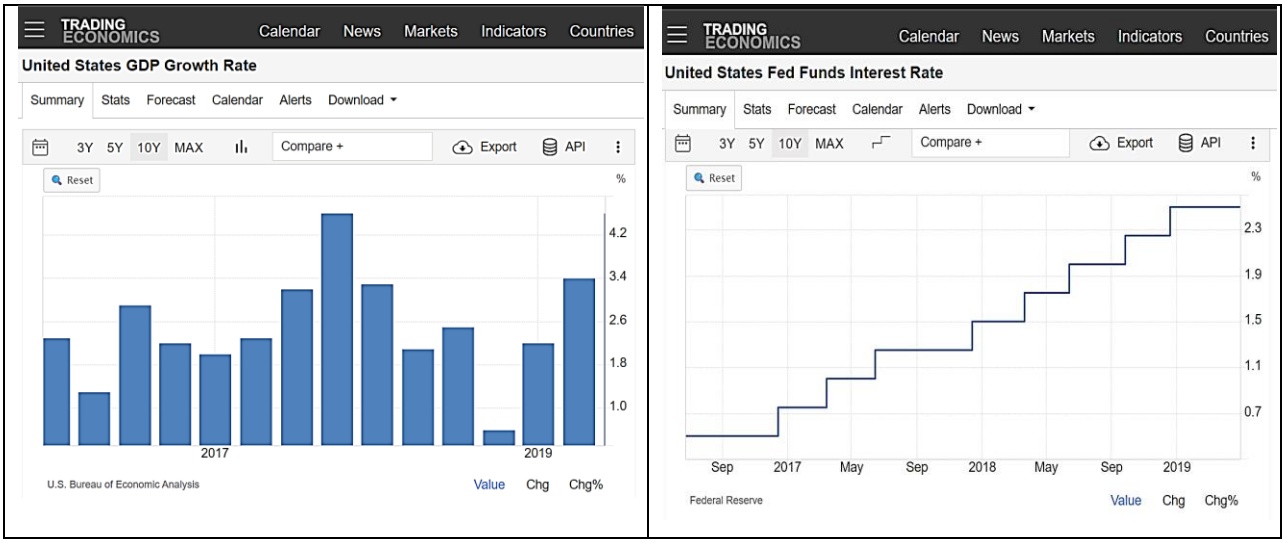
4.2 Informal Economy

The Study used the Example of the USA from 2017-2018 to test the impact of the size of the Informal sector on Central Bank Effectiveness using World Bank's metric of Dynamic General Equilibrium to estimate the size of Informal output as a percentage of Total GDP

Table 3: *Dynamic General Equilibrium (USA)*

Detail	2017	2018
Dynamic General Equilibrium	8.10	8.10
Central Bank Effectiveness	0.93(52)	0.93(52)

Figure 3: *Interest Rates and Economic Growth (USA)*



Overall, the study established that, relative to the Years 2017-2018, the USA's informal economy share stood at about 8.1 percent derived from the dynamic general equilibrium World Bank Indicator. The study then entered the value in the formula mentioned above and got the last answer E as 0.93 for both years. This was observed to be a value closer to 1 and inferred towards the American Federal Reserve as being more effective. Further, this strong relationship became apparent in the period starting from 2017- 2018, when the interest rates were raised from 0.75% to 2.5% by the Federal Reserve. In this period, the gross domestic product growth rate also adjusted from 2.0% in 2017, to 0.6% in 2018 (Trading Economics, n.d.). This proved that the minimal contribution of the informal sector to the total GDP makes monetary policy more effective.

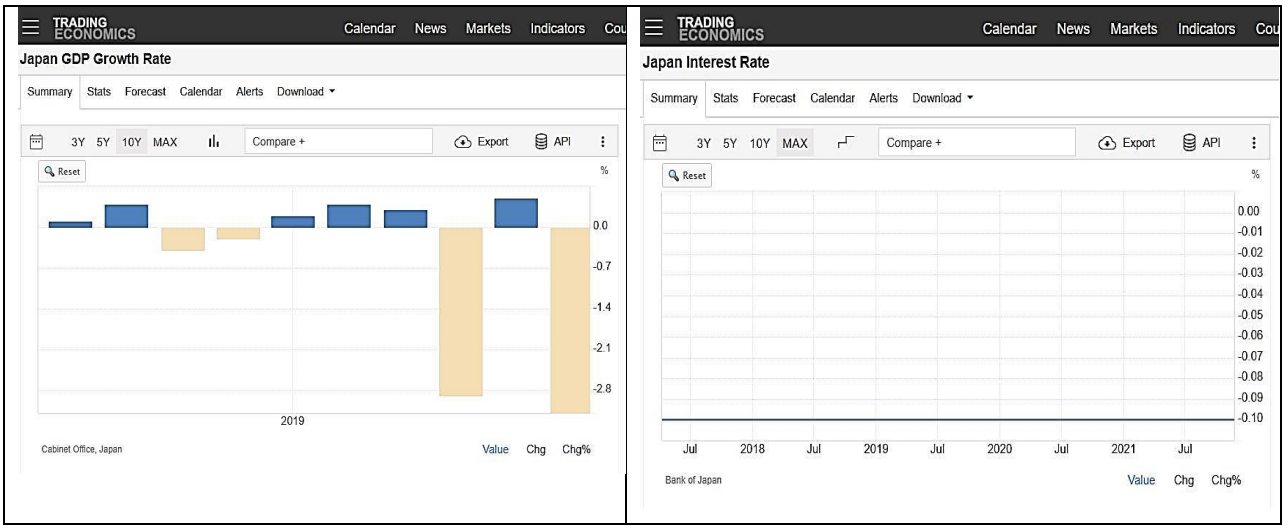
4.3 Social and Religious Attitudes

The study used the example of the Japanese central bank from the period 2019-2020, to test the impact of Consumer spending patterns on central Bank Effectiveness. Using the World Bank Indicators of Final consumption expenditure (constant 2015 $) for change in consumption and Adjusted net national income (constant 2015 $) for change in income, the study was able to derive Marginal Propensity to consume (MPC) from which it compared Central Bank Performance.

Table 4: *Marginal Propensity to Consume (Japan)*

Detail	2019-2020 Change
Adjusted net national income (constant 2015 $)	190,000,000,000
Final consumption expenditure (constant 2015 $)	90,000,000,000
MPC ($\Delta C/\Delta Y$) / Central Bank Effectiveness	0.47(3)

Figure 4: *Interest Rates and Economic Growth (Japan)*



Thus, the study established that using Adjusted net national income (constant 2015 $) and Final consumption expenditure (constant 2015 $) of the World Bank indicator, Japan has got the MPC of 0.47 in the region of the year 2019-2020. This proved to be a figure closer to 0 and pointed towards the Japan Central Bank's being less efficient. From the period between 2019 and 2020, the Japan Central Bank kept Interest rates at a Negative figure of -0.1% and the economic growth rate did not rise as much as was expected. It rose from 0.3% in 2019 to 0.5% in 2020 (Trading Economics n.d.). This thus showed that MPC has an impact on Monetary Policy efficiency.

5. DISCUSSION

To sum up, the study accomplished the above-mentioned three objectives by constructing a preliminary tool to measure the effectiveness of the monetary policy. Using coefficients like Political Stability and quantifying how each is affiliated with economic growth (Mehar, 2022), the study established that these variables affect monetary policies. The tool provides a framework for future researchers to further refine it, by incorporating previously discussed variables (e.g., Hielscher and Markwardt, 2012; Govindharaj, 2023).

Through this tool, policymakers can get an overview of how changes in the interest rate impact GDP growth with ease, greatly helpful for decisions made for the fiscal year. However, by introducing more variables the researchers can enhance its effectiveness regarding more variables and can be used in other economic systems more accurately.

5.1 Limitations Assumptions

Some of the assumptions implicit in the study are anticipated limitations that may affect the generalizability of the results. For example, assuming that expenditure and income are positively related distorts real life situations where the two may be completely differ giving negative values of MPC. Likewise, excluding Micro finance banks from the informal sector analysis could lead to an underestimate value for effectiveness of monetary policy should Microfinance banks be significant economic agents. Another assumption made was that upon discussing impact of informal sector on interest rates, the study assumed that the informal sector are completely immune to interest rate change while in reality they may be affected indirectly as it may raise the spending in the economy thus affecting sales of informal sector Future research should be able to capture these complexities by using more inclusive data ,utilising dynamic modeling frameworks and encompassing more variables

6. CONCLUSIONS

The study successfully identified and proved the impact of various variables on monetary policy and then it successfully quantified such variables into a tool that helps to evaluate the potential impact of a specific policy. The study offered a multifaceted view on the hurdle that policy makers might face when implementing a policy. The study also provided empirical evidence to show how the results of the tool correlated with real life changes in interest rates and gdp growth rate for different countries. The study filled a research vacuum in economic monetary policy research and provided a framework for other researchers to further build upon this tool to improve its accuracy.

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Conflict of Interest

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ORCID iDs

Khawaja Muhammad Umar [1] https://orcid.org/0009-0002-4809-853X
Abdul Wahab Shah Bukhari [2] https://orcid.org/0009-0005-4352-1142

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