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The Optimization Model of the Phillips Curve using Shapiro-Stiglitz Model and the Kydland-Prescott Model for Fiscal and Monetary Policy Analysis

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ABSTRACT

Modern economic policy in many countries prioritizes short-run growth objectives. While such policies may generate immediate economic gains, they can also create long-run sustainability concerns through their effects on inflation and unemployment dynamics. Monetary economics proposes long-run equilibrium mechanisms that may mitigate these macroeconomic fluctuations. This study develops an analytical framework that integrates the Shapiro–Stiglitz efficiency wage model of unemployment with the Kydland–Prescott model of inflation setting and applies a Lagrangian optimization framework to estimate the optimal rate of economic growth subject to inflation targets set by the central bank of the Philippines. To examine the structural relationships implied by the theoretical framework, a Two-Stage Least Squares (2SLS) regression is employed, with results suggesting a significant disconnect between the policy objectives of the central government and those of the central bank. The predictive performance of the model is further evaluated using a quadratic ordinary least squares (OLS) regression comparing forecasted and observed output growth rates. The estimated model produces a higher coefficient of determination and statistically significant coefficients relative to regressions using Philippine GDP growth data, suggesting that the GDP optimization model may provide a useful analytical tool for informing macroeconomic policy design.

1. INTRODUCTION

The growth of an economy, whether developed or developing, is undoubtedly a delicate and complex balancing act. There is a complex interplay between factors of economic growth which are being pushed through by the fiscal government (Phullel, 2023) and factors of economic stability which are being pushed by monetary authorities around the world (Borio, 2003). Majority of people would think GDP growth should be a priority of the government as this shows how strong the economy is quantitatively; monetarists argue that price stability via inflation targeting is more suited to economic growth. This then begs the question, which between fiscal policy and monetary policy is better for the economy?

Whether classified as developed or developing economies, government intervention plays a pivotal role in charting a country's future trajectory. Contrary to the laissez-faire principles advocated by Adam Smith, contemporary governments worldwide embraced interventionist approaches in shaping their national economies. Over time, economic analysis has accounted for the governments' proclivity to prioritize specific facets of the macroeconomy, often emphasizing the enhancement of consumption to drive Gross Domestic Product (GDP) figures and signal economic prosperity (Stockhammer & Kohler, 2019).

The prevailing trend among governments globally revolves around prioritizing consumption, underscoring the markets' emphasis on sustaining consumption-focused economies (Christophers, 2011). This study examines these dynamics in the context of the Philippines, a developing economy where fiscal expansion and consumption-driven growth have been central features of economic policy. While some governments direct attention towards investments—be it domestic, exemplified by the Philippines, or international, as seen in China—the ultimate goal remains profit generation.

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Profitability, it is observed, hinges on the consumption patterns of the general public, thereby reinforcing the centrality of consumption spending in economic considerations (Lavoie, 2014).

Government spending serves as a guiding tool for the economy towards perceived improvements (Alesina & Ardagna, 2010). Some argue that such spending is strategically allocated to maintain power and the status quo (Scheve & Stasavage, 2012). Historical instances reveal a shift in government focus from agriculture to manufacturing, and in the contemporary era, towards the service sector. The underlying premise is that increased government projects or programs correlate with economic growth and elevated GDP figures. This rationale fuels governments' emphasis on fiscal policy globally, wherein short-term boosts in GDP and economic upswings during specific phases of the business cycle are pursued. Infrastructure projects, employment initiatives, and poverty alleviation programs contribute to these short-term economic fluctuations (Ramey, 2011). However, the term "short-run" prompts scrutiny, as classical and neo-classical economic theories, such as the Phillips Curve, highlight the potential long-term detriments of fiscal policies. Studies indicating the inflationary effects of such policies raise questions about the optimal approach to macroeconomics, prompting a reconsideration of the sustained reliance on fiscal policy.

Frederic Mishkin highlights another aspect of government policy-making which focuses on one important aspect of the economy: monetary policy. Monetary Policy focuses on the capacity of money to influence changes within an economy. Money as currency, which is originally known as fiat money is used as a medium of exchange to perform economic activities. This medium of exchange allows markets to operate via transactions; with other functions being a storage of wealth, and also used for emergencies.

Measurements such as interest rates, inflation and treasury bonds are used by governments to gauge the state of an economy. These then become closely related to the variables used in fiscal policy such as unemployment; which then gives one of the classic economic concept of the Phillips Curve. With this in mind, governments and researchers can observe and identify the different intricacies of the economic system via government intervention.

It is unavoidable however that the effects of monetary policy alone nor the effects of fiscal policy alone can be used to monitor and regulate economic progress. These two aspects of government intervention operate always in simultaneity and have different importance in various aspects of public policy. Various researches indicate the strengths and weaknesses of these to policy types: fiscal policy's inefficiencies stemming from political reasons or the fact that the whole focus of fiscal policy is provision of public goods which is by nature accounted as losses on the side of the government (Persson & Tabellini, 2005). Other researchers argue that monetary policy, although always leads to economic growth in the long-run highlights, this as its weakness: the lack of immediate effect (Friedman, 1961, Mojon, 2001, Cloyne, et al. 2020), which is as Keynes have stated is a misleading guide to current affairs which gave rise to the quote "In the long run we are all dead".

The Phillips Curve has been used for analysis relating the inverse relationship between the Unemployment Rate and the Inflation Rate. Over time, this relationship has been supported and challenged by empirical research. Subsequent developments in literature led to the formulation of the augmented Phillips Curve, which incorporates expectations and suggests a different dynamic relationship between unemployment and inflation.

Within this framework, monetary policy prioritizes controlling the inflation rate. Monetarists aim to achieve long-term price stability, characterized by a low general price level and a stable inflation rate. However, this objective involves a trade-off. Policies that stimulate short-term economic growth, which benefits society by creating jobs and boosting purchasing power, may simultaneously contribute to higher inflation.

Romer (2001) emphasizes the importance of the short run for social welfare. Economic growth during this period can stimulate the economy through the multiplier effect, resulting in job creation and increased purchasing power. At the same time, this growth can also fuel inflation as the economy expands (Barro, 1997, Ball, et al. 2019).

Consequently, both monetary and fiscal policies face a fundamental challenge: optimizing the economy. Policymakers must choose between two goals: long-term price stability or short-term economic growth (Walsh, 2010). Policies that prioritize pursuing price stability by minimizing inflation can lead to lower economic growth in the short run (Ball, 1994, Blinder, 2021),. Conversely, policies maximizing economic output which can boost growth, may result in higher inflation (Okun, 1962, Coibion, 2018) .

Kydland & Prescott (1990) showed the two possibilities: the incidence of two policymakers and the possible expectations of the economy with respect to the trade-offs of long-run and short-run monetary policy.

This study examines the interaction between the price stability objectives of monetary policy and the economic growth stimulus generated by fiscal policy in the Philippine economy. To address this relationship, the paper develops a Lagrangian optimization framework that derives the optimal level of output consistent with inflation targets set by the monetary authority. The structural relationships implied by the theoretical model are empirically estimated using a Two-Stage Least Squares (2SLS) approach in order to address potential endogeneity between fiscal policy variables and monetary policy instruments. To further evaluate the empirical validity of the proposed framework, the dataset generated from the optimization model is compared with observed macroeconomic data through a quadratic ordinary least squares (OLS) regression between the model-generated output growth rates and actual output growth rates. This additional estimation allows for an assessment of the predictive consistency of the optimization model relative to observed economic outcomes and provides insight into its potential usefulness as a tool for macroeconomic policy analysis.

2. LITERATURE REVIEW

2.1 Shapiro-Stiglitz Model for Unemployment

Shapiro & Stiglitz (1984) explores the role of unemployment on the market equilibrium between the sellers of labor and firms. Furthermore, Shapiro & Stiglitz (1984) identifies that there are variables which make market equilibrium unemployment rate either high or low. Wherein

there is a failure to account the consequences of monitoring and wages which firms must undertake to avoid shirking workers. Using Walrasian assumptions the model used by Romer (2001) utilizes the Shapiro-Stiglitz Model for the Matching models, utilizing the assumptions of heterogeneity of labor and dynamic programming, focusing on the variables of employment and the value of vacancy.

Expanding on these foundational theories, recent studies have further refined our understanding of efficiency wages. For instance, Katz (2002) provides a contemporary survey of efficiency wage theories of unemployment, offering insights into the persistence of unemployment despite seemingly competitive labor markets. Moreover, Gumata & Ndou (2017) delves into the effects of a positive minimum wage shock on labor productivity, employment, and GDP growth, reinforcing the efficiency wage hypothesis by demonstrating the potential for higher wages to enhance worker productivity and reduce unemployment.

Morant & Jacobs's (2018) unique contribution lies in its exploration of the social context of efficiency wages, emphasizing its significance from both economic and management standpoints. It traces the evolution of the concept from Adam Smith's initial ideas, through the classical and institutionalist perspectives, to modern empirical studies that challenge traditional Human Resource Management wage practices. This historical account is valuable for understanding efficiency wage theory as a tool for motivation and as a means to enhance social and economic well-being.

The study by Wilde (2017) revisits the Shapiro-Stiglitz model by incorporating technical progress and heterogeneity into the analysis. Wilde's (2017) work suggests that involuntary unemployment may not persist in the long run, even when efficiency wages are paid. This is particularly relevant when considering the reduction of real unemployment benefits and its ambiguous effects on employment levels. Wilde's (2017) approach aligns with Romer's (2001) utilization of the Shapiro-Stiglitz Model in matching models, where the heterogeneity of labor and dynamic programming play crucial roles in determining employment and the value of vacancies. Furthermore, the study by Wu & Ho (2017) addresses the theoretical limitations of the linear utility function traditionally used in the Shapiro-Stiglitz model. By introducing a nonlinear utility function, this paper links the Shapiro-Stiglitz model to Stiglitz's efficiency-wage paper, allowing for a more comprehensive analysis of factors affecting the secular unemployment rate. This modification is significant as it specifies conditions under which diminishing marginal utility can result in a trendless unemployment rate, providing a more accurate representation of real-world labor market dynamics.

2.2 Kydland-Prescott Model for Inflation Setting Monetary Policy

The study of Kydland & Prescott (1990) indicates that discretionary monetary policy gives rise to inefficiently high inflation. Furthermore, they show approaches as to how monetary policy should be determined by rules. Kydland & Prescott (1990) shows a model for the dynamic-inconsistency problem using a model of reputation showing the interaction of the monetary policy body and the agents of the economy reacting to the preferences of the policy maker. Wherein the model shows two possible policymakers, the first one prioritizing long-run inflation targeting, wherein the monetary body sets the expected inflation rate and assumes that the agents of the economy would follow. And the second showing the short-run objective of social welfare, wherein there is a high economic growth that benefits the society. Both the policies show drawbacks, wherein the tradeoff for setting the expected inflation rate for the economy assuming the agents of the economy works gains full information is that there is a low economic growth. Furthermore, if the policymaker then focuses on short-run economic growth, inflation rate rises higher, indicating an increase in the general price level. Romer (2001) then shows the instance of the optimal inflation rate and the existence of an equilibrium inflation rate wherein the policy maker chooses the optimal rate of inflation and the benefit of resulting higher output is positive. Ohanyan & Grigoryan (2021) contributed a methodological advancement in assessing the degree of discretion in monetary policy. Their approach, which estimates a Taylor-type rule with time-varying heteroskedasticity, offers a quantitative lens through which we can examine the dynamic inconsistency problem. This aligns with the Kydland-Prescott model's assertion that rule-based policies can better anchor inflation expectations, thereby stabilizing the economy.

Moreover, Klein (2018) delves into the time inconsistency problem's broader implications. It elucidates why policymakers may deviate from their commitments and how such deviations can lead to inflationary pressures. This discussion complements Romer's (2001) analysis of the optimal inflation rate and equilibrium inflation rate, where the policymaker balances the benefits of higher output against the costs of rising inflation.

2.3 Fiscal Policy and Economic Growth

Fiscal policy has been intensively studied over the past century, it has been used by governments to influence the economy either through the use of Expansionary Fiscal Policy which promotes or stimulates the economy, or through Contractionary Fiscal Policy which then influences economic growth. According to Canh (2018), Fiscal Policy is understood to encompass three aspects: (1) Government Expenditure; (2) Public Taxation; (3) and Public Debt. Alkasasbeh, et al. (2018) highlights that fiscal policy focuses on Government Spending and Taxation. Public Debt is defined as payments used to finance government expenditure outside the allotted government budget taken from taxation. This usually arises from the budget deficit by the government where a budget deficit (budget surplus) then entails high public debt (low public debt) in an economy. Economic growth can then be considered to be influenced by the government's structure, which determines budget expenditure, potentially leading to adverse effects on growth (Teles & Mussolini, 2013). Mirza et al. (2023) highlights the connection between fiscal policy and inflation. They explain that fiscal policy often depends on fiscal actions like subsidies and stimulus packages. These fiscal measures can lead to either a deficit or a surplus, based on the amount of tax revenue collected. In line with this, Hilton (2021) echoed that higher interest expenses on public debt can lead to inefficiencies in the allocation and utilization of budgetary resources.

As studies debated its impact on economic growth, Government Expenditure, standing as a key component of Fiscal Policy, has been extensively examined in economic literature. Theoretically an increase in the Government Expenditure lead to an increase in economic activity and in turn economic growth. Several studies have explored the

relationship between government spending and economic growth, with mixed results. For instance, research by Barua & Sakar (2023), Tan et al. (2020), Besos (2009), OECD (2023), Day & Yang (2010), Paparas et al. (2015), and Villanueva (2021) suggests that an increase in government expenditure may actually hinder economic growth. These papers argue that when the government spends more, it could potentially lead to inefficient allocation of resources, crowding out private investment, or increasing the tax burden, all of which can negatively affect the economy's growth potential. On the other hand, a study by Alves & Palma (2023) presents a contrasting view, indicating that government expenditure does not have a significant impact on economic growth. Some studies such as Bergh & Henrekson (2011), Di Mateo (2013), Grundler & Potrafke (2019) and Halkos & Paizanos (2015) argued that the larger the size of the government, the slower economic growth is. Min et al. (2021) also expounded that government spending shocks have no significant impact on aggregate investment or its components. This could then be due to the greater the size of the government. The less efficient government spending is therefore not necessarily associated with a better provision of pure public goods. Furthermore, studies such as Gatti et al. (2024), Halkos & Paizanos (2015), Paparas et al. (2015) and Zekkari (2024) emphasizes the importance of human capital to the effect of government expenditure for fiscal policy. Djellout et al (2014) re-assessed the role of government spending but suggesting long-term positive effects through infrastructure and human capital development. Daoudi (2023) explored fiscal policy impacts in Algeria, underlining the role of human capital and structural reforms in enhancing economic growth. This perspective posits that governmental fiscal augmentation, while contributory, is not the sole determinant of Gross Domestic Product (GDP) growth. The predominant influence rests with the agents of the economy, particularly through consumption activities, which constitute the bulk of GDP. This elucidates the amplifying effect of human capital on economic output. Furthermore, Halkos & Paizanos (2015) underscore the imperative of Research & Development, alongside Innovation, in fortifying the efficacy of fiscal expansionary measures. Some studies then provide caveats that policymakers should focus on investing in infrastructure, education and healthcare in the promotion of economic growth (Fay et al. 2019, IMF 2011, Calderon & Serven 2014). With studies indicating the emphasis on infrastructure investments as key to economic growth on the side of Government Expenditure (Halkos & Paizanos, 2015; Paparas et al., 2015; Kudrin & Knobel, 2017).

Taxation in general is another aspect of fiscal policy that is highlighted in previous studies. Taxation serves as a government mechanism for the collection of funds from various sectors of the economy to finance its budget; in Baiardi, et al. (2019), it is rather evident that the imposition of taxes can exert a negative influence on economic growth, echoing the findings of Gemmell, et al. (2014), Arnold et al (2011) and Romer & Romer (2010) which initially highlighted the adverse consequences of taxation to the economy in general. Higher tax rates can inadvertently discourage entrepreneurship, dampen investment enthusiasm, and stifle innovative undertakings—three critical drivers that fuel the engine of economic expansion. In concordance with recent empirical findings, direct taxes can have a substantial negative impact on economic growth (Balasoiu, et al. 2023); this aligns with the assertions of Muinelo-Gallo & Roca-Sagales (2013) who noted that distributive expenses as well as direct taxes can lead to marked decreases in GDP growth. Overall, these fiscal policy measures reflect the classic efficiency-equity trade-off, potentially resulting in a reduction of net income inequality. Poor and developing countries also rely significantly on international trade taxes as a crucial source of revenue, while income taxes gain prominence predominantly only within the fiscal frameworks of developed countries (Gnangnon, 2019).

As initially explored by Barro (2013) and Blanchard & Leigh (2013), fiscal policies are strategically designed to affect the marginal propensity to consume and invest; lbuquerque & Green (2022) corroborated this by emphasizing the impact of financial concerns on the marginal propensity to consume during the COVID-19 pandemic. The structure of the government is pivotal in all aspects of fiscal policy—a notion reinforced by Idrisov & Sinelnikov-Murylev (2015) and Pasichnyi (2017). Moreover, the governmental framework is instrumental in modulating economic volatility, as delineated by Marioli et al. (2024).

2.4 Monetary Policy to Economic Growth

Monetary Policy utilizes various tools to regulate the flow of money within an economy; these tools include (1) Open-Market Operations (OMO), which involve the trading of bonds; (2) Reserve Requirement Ratio, which dictates the amount of bank reserves; and (3) Discount Rate, which sets the cost of borrowing from the monetary authority. All of these tools operate through different mechanisms but converge on a singular objective: to modulate the money supply in circulation; this is achieved by influencing key economic levels such as interest rates and inflation rates (Mehar, 2022). As explored by Vasicek, et al. (2023), the efficacy of monetary policy is closely tied to the degree of autonomy possessed by the monetary authority relative to the central fiscal policy; this underscores Navarrete & Tatlonghari (2012)'s initial discussion as well as the prevailing view that an independent monetary authority is fundamental to the successful implementation of monetary policy measures.

In modern monetary theory the most common strategy by modern monetary authorities is referred to as inflation targeting. Inflation targeting is established by monetary authorities to target a certain level of inflation that is considered ideal; as studies like Furceri & Jalles (2019) contend that such targeting has no effect on GDP growth, Duong (2021)'s study supports this view, underscoring the importance of price stability within an economy, thus reinforcing the notion that the primary goal of inflation targeting may indeed be the maintenance of price stability rather than the stimulation of GDP growth.

Unlike fiscal policy, where empirical evidence often contradicts classical postulations, research on monetary policy consistently demonstrates a sustained and significant impact on economic growth. This correlation underscores the importance of monetary measures in shaping the trajectory of an economy's development (Khin et al., 2014; Ryan-Collins, 2016).Mehar (2022) reinforces the findings of Feldstein & Stock (1993) by demonstrating the enduring stability of the relationship between monetary policy and GDP growth, highlighting how strategic credit expansion to the private sector has contributed to a reduction in GDP variance; this aligns with Feldstein & Stock's assertion that the connection between Broad Money (M2) and economic growth, as measured by GDP, remains consistent. Abou & Elseoud (2014) highlights that while interest rates and inflation maintain a marginal relationship with

the GDP, it is the money supply that exerts the most substantial influence on economic growth; this corroborates Hameed (2010)'s findings, ultimately denoting the important role of money supply as a determinant of stability and progress. Tatlonghari (2002); Ejorcadas et al. (2023) reinforce the notion originally presented by Tatlonghari (2009), highlighting that while fiscal policy effects are promptly evident in the economy, monetary policy measures may initially manifest subdued impacts. However, these monetary interventions, particularly in the context of the Philippines, gradually build up over time. The cumulative influence of such policies, especially in the aftermath of significant economic disruptions like the COVID-19 pandemic, proves to be more potent and enduring than initially anticipated, ultimately steering the economy towards a stable and resilient trajectory. Building on this premise, research conducted by Mohamadpour et al. (2012), Agrawal & Bansal (2018), and Arai & Hoshi (2004) consistently reveal a positive correlation between money supply and GDP growth; highlighting the role of monetary expansion as a key factor in propelling economic progress. While some studies highlight a negative or inverse relationship between monetary policy and economic growth, others offer a more complex picture; works by Srithilat & Sun (2017) and Matres, et al. (2021) aligns with the earlier findings of Feldstein & Stock (1993), suggesting that over the long term, variables such as the money supply, interest rates, and inflation rates may adversely affect real GDP per capita. In contrast, these studies also reveal a positive correlation between the real exchange rate and GDP growth, highlighting its distinct contribution to economic development. This intricate interplay of monetary factors emphasizes the diverse effects that financial variables can have on a nation's economic vitality. Building on the insights of Kugler et al. (2005), it is underscored that a monetary policy overly concentrated on GDP growth, to the exclusion of inflation considerations, can precipitate an ineffective strategy (Mehar 2023). This approach risks not only elevating medium-term inflation rates but also exacerbating the volatility of GDP growth. The empirical evidence suggests that a balanced focus on both economic expansion and inflation control is essential for the formulation of an efficient monetary policy. Cafisco (2017) then states that private debt is a determinant of GDP Growth with responding to monetary shock is due to the variation of private debt. In line with these developments, innovation to monetary policy has been made such as in the paper of Cafiso (2017) which uses private debt in response to monetary shocks and in papers such as Bullard & DiCecio (2019) which shows the capacity of optimal monetary policy in repairing the credit market friction distortions inside an economy.

2.5 Fiscal Policy and Monetary Policy Interaction

Fiscal Policy and Monetary Policy have their different functions in an economy. Fiscal policy focuses on aspects of the economy more concerned with social welfare and provision of public goods and services, while monetary policy aims for price-stability. According to Tcherneva (2012), fiscal policy is pivotal in fulfilling three key functions: (1) Stabilization, (2) Allocation, and (3) Distribution. These roles are crucial in shaping a balanced and equitable economic landscape. Furthermore, as delineated in the preceding discussion, the primary objective of Monetary Policy is to mitigate inflation within an economy, thereby ensuring a stable financial environment conducive to growth. Building upon the framework established by Altar (2003), which examines the interplay between nominal interest rates and inflation, this discussion extends to the realm of fiscal policy (Woodford, 2011). It emphasizes the nuanced effects of distortionary taxation alongside productive government spending. The analysis delves into the Keynesian perspective of government expenditure multipliers, particularly under conditions where nominal rigidities and monetary policy constraints are present. This approach sheds light on the complex dynamics that govern the welfare of economic agents, highlighting the pivotal role of government interventions in shaping macroeconomic outcomes Wu et al. (2022) demonstrates, through a Dynamic Stochastic General Equilibrium model, that fiscal policies have a more pronounced effect on stabilizing output. In contrast, the study suggests that monetary policy should be primarily focused on combating inflation.

Recent studies strengthen the assertion that monetary policy is important in steering economic growth, overshadowing the influence of fiscal policy on investment and expansion. This view is substantiated by the findings of Younsi & Nafla (2017), who through comprehensive panel data analysis from 1993 to 2015 across 40 countries, demonstrated that monetary stability, coupled with trade openness and foreign direct investment, significantly propels economic development. Their research echoes earlier assertions by scholars such as Friedman & Meiselman (1963), Ajayi (1974), Elliot (1975), and Batter & Hafer (1983), confirming the critical role of monetary policy in shaping economic outcomes. Canh (2018) argues the importance of fiscal policy and how fiscal policy stimulates are crucial for economic growth. Mirza et al. (2023) states that inflation reduction goals such as inflation, growth and employment are largely influenced by monetary factors, which suggests using monetary policy as alternative or complement to inflation targeting.

The issue between these researches is that they do not take into account that fiscal policy and monetary policy always work simultaneously. Chen & Miao (2024) emphasizes that failing to take into account the interaction of monetary-fiscal policies in economic models might lead to incorrectly assessing the impact of monetary policy on commodity price fluctuations. De Grauwe & Froseti (2023) then presents us with three policy setups (1) Fiscal Dominance, (2) Monetary Dominance and (3) No Dominance, which illustrates the underlying government structure and indicates the strategic direction a country intends to pursue. Asada et al. (2023) reiterates the Mundell-Tobin Effect wherein nominal interest rates does not rise one-for-one with price levels and that Fiscal Policy plays a dominant role in current economies and that monetary authority's monetary policy only has a completely passive role to finance government expenditure. In the model, the active or inactive fiscal policy and high credibility or low credibility of inflation targeting are the stabilizing or destabilizing factors of the system. Lozano-Espitia & Arias-Rodriguez (2022) states that fiscal policy affects the country's sovereign risk during the period although not large, which then shows a lack of evidence for fiscal dominance. The correct policy mix setup can help enhance FDI inflows in Emerging Markets and Developing Economies (EMDE) (de Mendonca & Tiberto, 2024). Marioli et al. (2024) further supports this by stating that fiscal policy has been more volatile in emerging markets and developing economies than in advanced economies. This interaction between monetary policy and fiscal policy then results in the Phillips Curve interaction and determines the importance of monetary-fiscal coordination of monetary policy (Caramp & Silva, 2023). Caramp & Silva

(2023) further emphasizes that when monetary policy has fiscal consequences, monetary variables affect the timing of aggregate output while fiscal variables shape its present value and the wealth effect. Preising & Greiner (2023) adds to the discussion stating that sustainable debt policies detect that both monetary policy variables are positively correlated with the primary balance to GDP ratio. The study by Woodford & Xie (2021) shows the interdependence of this policy mix wherein fiscal transfers was a powerful tool to reduce the contractionary impact of an increased financial wedge during a crisis, and can even make possible complete stabilization of both aggregate output and inflation under certain circumstances, this once again however is dependent on the degree of monetary policy accommodation. Costa et al. (2021) adds then Fiscal Theory of the Price Level by Leeper (1991), wherein according to the study in a conventional monetarist world, the monetary authority succeeds in controlling inflation so long as the fiscal authority does its job that public debt does not grow too much and by contrast fiscal dominant, fiscal policy determines the price level and inflation in the short run, and the optimal monetary stance is holding policy rate constant, since if the monetary authority tries to fight back fiscally determined inflation, it will worsen fiscal sustainability and increase future inflation. Golpe et al. (2023) however, adds that monetary policy variables play a leading role in the resulting complex economic system. Furthermore, Golpe et al. (2023) finds evidence of the supporting role of Total Expenditure as a driver of economic growth. Afonso & Sousa (2024) states the roles of monetary policy as the controller of the stability of price level, while the government keeps public finances in good health ends up being confirmed. With regards to the monetary policy reaction function, inflation rate has a big impact over the monetary authority's decision making, meanwhile for fiscal policy, the cyclically adjusted primary balance reacts positively to increases in the level of government debt. Studies such as Liu et al. (2020) explores this interaction of fiscal and monetary dominance, according to the empirical results, China prefers a passive monetary coupled with an active fiscal policy regime. Moreover, unlike monetary policy shocks, fiscal policy shocks substantially affect inflation and output growth variations in both short and long run under the passive monetary and active fiscal setup. Mohseni & Cao (2020) shows that the impact of monetary policy on economic growth is ambiguous due to the fiscal policy intervention and public expectations play crucial roles for the effectiveness and transmission of monetary policy in economic growth models. Tule et al. (2020) further shows that using a Structured Vector Autoregression, expansionary monetary policy may have contemporaneous positive effects on the economy, expansionary fiscal policy however, does not automatically translate to growth. Fiscal surpluses rise following deficits, to repay accumulated debt, but surpluses do not respond to all values of unexpected inflation and deflation (Cochrane, 2021).

The dynamics of monetary and fiscal policy is a complex mix-match of different macroeconomic variables that eventually have backward and forward linkage effects. An example of this is in the paper of Dhital et al. (2021) wherein when the monetary authority follows an active policy regime, a unique stationary equilibrium exists regardless of how the supply of various nominal government bonds is specified. Consumption inequality, a fiscal variable, increases when the monetary authority pursues an expansionary monetary policy. Meanwhile, in contrast when fiscal authority pursues active policies, real indeterminants can exist. And when fiscal authority issues sufficiently few long-term (or short-term) bonds a unique steady state exists. And there are also cases wherein an expansionary fiscal policy leads to a decline in consumption inequality between monetary variables. Another study by Dhital et al. (2023) finds that expansionary monetary and government spending policy shocks systematically decrease income, disposable income and expenditure inequality and that there is evidence of time variation on effects and monetary policy and transfer payment shocks. Dhital et al. (2023) further elaborates that the responses of income and expenditures of households at different percentiles suggest that expansionary monetary and government spending policy have a larger positive impact on households with low income and expenditures relative to those at the top of the distribution. Buyukbasaran et al (2020) states the importance of the nature of these shocks in terms of the interaction between fiscal and monetary policies with the findings that these two are complementary in response to demand and supply shocks while they are substitute in response to shocks caused by each other. Bischi et al (2022) shows the need for the policy mix wherein findings in their study shows that fiscal rules alone, may not be enough to control the pattern of the debt ratio, and the adoption of a monetary policy in the form of an interest rate rule, is necessary to control the pattern of the debt ratio for assuring its sustainability over time.

Expanding on the insights of Cardia (1991), Chomicz-Grabowska & Orlowski (2020) acknowledge that macroeconomic activities are influenced by a spectrum of factors beyond the traditional scope of fiscal and monetary policies. It highlights the significance of financial market risks and macroeconomic stability variables, such as employment rates and market volatilities, which play a crucial role in shaping economic trends and patterns. Ascari et al (2023) states the importance of information in the economy wherein if information on government spending is symmetric becomes contractionary in monetary regimes, in contrast with the expansionary nature of government spending on implementation in both regimes. Another study by Apeti et al. (2024) shows the importance of Information Technology (IT) and by adopting IT, developing countries can discipline their fiscal behavior through constraining sustainability and efficiency and as such benefit of a lower fiscal policy volatility. Studies such Preising & Greiner (2023) presents the debt policies of the government, which is usually not emphasized in common literature, however once again Fiscal Dominance provides insufficient evidence for the countries' growth. Cao (2024) then shows the role of inflation which is a monetary policy variable in the effect on the maturity of government debt, a fiscal variable. No matter how the government thinks of it, fiscal policy and monetary policy will always interact with each other and various studies, and it is important to recognize that variables such as inflation are always brought upon by the effects of the interaction of fiscal-monetary policy mix (Cao 2024). Reynolds (2001) argues that tax rate and money growth simultaneously leads to stagflation thus the Government could choose either fiscal and monetary policy stimulus for the pursuit of economic growth. While the economic system is heavily complex, while some policies play a leading role over the other, there is still significant evidence of the role of the other policy type as a driver of economic growth (Golpe et al, 2023).

2.6 Synthesis

Monetary and Fiscal Policy both have their own respective scopes in policy making. Various studies have highlighted the benefits of both while at the same time showing us the drawbacks of using one over the other. Phillip's Curve shows us a framework as to how to analyze both monetary and fiscal policy simultaneously. The classical inverse relationship of unemployment and inflation rate has been discussed and scrutinized by various authors such as Parkin (1973). There are instances wherein the inverse relationship are then inconsistent in the modern economy due to complexities in modern policymaking.

Fiscal Policy has played a key role in the discussion of economic growth, with its own tools of stimulating the economy. With the fiscal policy's resources Teles & Mussolini (2013) places high emphasis on the government expenditure with its budgets leading to either economic growth or contraction. Various authors such as Barua & Sakar (2023), Tan et al. (2020), Besos (2009), OECD (2023), Day & Yang (2010), Paparas et al. (2015), and Villanueva (2021) shows an inverse relationship between government expenditure and economic growth contrary to theoretical expectations of this relationship. Some researches such as Alves & Palma (2023) goes as far showing that these two indicators have no significant relationship. Fiscal Policy, however, is multifaceted as the whole point of fiscal policy is not only economic growth but social welfare in general. With the authors such as Gatti et al. (2024), Halkos & Paizanos (2015), Paparas et al. (2015) and Zekkari (2024) highlighting the importance of human capital to the efficacy of government expenditure, with authors such as Djellout et al. (2014) and Daoudi (2023) reinforcing the long-term effects of human capital development together with infrastructure projects.

Monetary Policy, the same as fiscal policy, has its own tools which focus on the regulation of currency inside an economy affecting interest and inflation rates inside the economy. Authors such as Vasicek et al. (2023) and Navarrete & Tatlonghari (2012) emphasize the importance of the autonomy of a central bank for the success of monetary policy inside and economy. It is also evident from researches that the relationship between monetary policy (Feldstein & Stock (1993), Abou & Elseoud (2014), Tatlonghari (2009), Ejorcadas et al. (2023) and Tatlonghari, 2009), money supply (Mohamadpour et al. (2012), Agrawal & Bansal (2018), and Arai & Hoshi (2004), and GDP growth is a subdued but consistent one.

While these two policy tools have different functions and objectives inside an economy, the importance of these two tools cannot be disregarded. All the more studies and literature cannot ignore the fact that fiscal and monetary policy works simultaneously and not individually in an economy. Fiscal policies and monetary policies interact either directly or indirectly based on expansionary or contractionary policies by both sides such as in the work of Altar (2003), Woodford (2011) and Chen & Miao (2024). A number of studies emphasize the correct policy mix between the two with various countries preferring one over the other where countries prefer a more passive monetary policy such as China (Liu, 2020). On the other hand, studies such as Tule et al. (2020) then emphasizes the effectiveness of an expansionary monetary policy as compared to an expansionary fiscal policy.

Various contrasting studies regarding Fiscal and Monetary Policy have spun decades of analysis on this interaction of policies. While the majority of the literature focuses on either fiscal policy or monetary policy alone, there are only a limited number of studies that focus on both. As both policies prioritize their own objectives and variables, this isolated policy focusing still has implications for the other.

2.3 Research Objectives

1. Statistically examine the relationships among the variables included in the constraint function and the objective function.

2. Determine what interaction of the fiscal policy and monetary policy has within the Philippine economy.

3. Develop a model integrating both fiscal and monetary objectives into an optimized model.

2.4 Research Hypothesis

1. Fiscal Policy Variables have no significant relationship to Monetary Policy Variables
2. Monetary Policy Variables have no significant relationship to Fiscal Policy Variables

2.5 Theoretical Framework

2.5.1 Phillips Curve

The Phillips Curve has evolved over time, reflecting different outcomes of the economy: the relationship between Unemployment and Inflation. Initially the Phillips Curve (1959) reflected the negative relationship between Unemployment and Inflation in the United Kingdom. However, subsequent empirical studies have questioned this traditional negative relationship. For example, Parkin (1973) provided evidence against it. More recently, Bharadwaj & Dvorkin (2020) discussed the complexities in estimating the Phillips curve's slope, noting that changes in monetary policy and the relative importance of supply and demand shocks could lead to mis-estimations of this relationship. This view is supported by data from European countries, where instances of high unemployment have coexisted with significant disinflation, as observed by Stock & Watson (2010) and Meier (2010). This is due to the outcome of studies for non-linearity of the Phillips curve resulting in the development of an augmented Phillips curve showing the new possible relationship of the two variables.

2.5.2 Shapiro-Stiglitz Model for Unemployment

The Shapiro-Stiglitz Model for Unemployment focuses on the equation for the Matching Function for the Value of Vacancy in the economy representing relationship of Labor and Firms in the following equation (1):

$$rVv = -C + \left(\frac{\alpha}{a + \alpha + 2b + 2r}\right) A \quad (1)$$

Wherein:

A = Rate of Output Production
C = Cost of Capital
α = Rate at which jobs are filled
a = Rate per unit time that unemployed workers find jobs.
b = Probability per unit time of a capital loss at VE-VU.
Vv = Value of Vacancy
VE = Value of Employment

VU = Value of Unemployment

2.5.3 Kydland-Prescott Model for Inflation Setting Monetary Policy

The Kydland-Prescott Model for Inflation Setting Monetary Policy defines equilibrium inflation in equation (2) as follows:

$$\pi^{EQ} = \pi^* + \frac{c}{d}(y - \bar{y}) \quad (2)$$

Wherein:

π^{EQ} = Equilibrium Inflation wherein actual inflation is equal to expected inflation.
π^* = Optimal Level of Inflation.
c = Reflects the relative importance of Output and Inflation in Social Welfare.
d = Coefficient of the difference between actual inflation and expected inflation.
y = log of output
$\bar{y}$ = log of flexible price level

3. RESEARCH METHODOLOGY

3.1 Research Design

This paper employs a quantitative research design utilizing the Lagrange Multiplier Method, as discussed in Borwein & Zhu's (2016) work from a variational perspective, to address a theoretical optimization problem in an economic context. Using the Shapiro-Stiglitz Model for Unemployment and the Kydland-Prescott Model for Inflation from Romer (2001), this study aims to identify the marginal gains of an economy's output function minimizing unemployment with a set specific real interest rate. This study employs the Shapiro-Stiglitz Model for Unemployment to analyze wage setting and job security dynamics in the labor market. It examines how efficiency wages can cause involuntary unemployment as a disciplinary mechanism, as described in the Shapiro-Stiglitz theory. The Kydland-Prescott Model for Inflation Setting Monetary Policy will also be used to explore the effects of time inconsistency in monetary policy, which can lead to suboptimal inflation outcomes. Overall, these models will be used to analyze the complex relationship between unemployment, monetary policy, and inflation.

This study seeks to estimate the optimal rate of economic growth by deriving the Value of Vacancy from the Shapiro–Stiglitz model of unemployment under a monetary policy framework constrained by inflation targeting, as described in the Kydland–Prescott model. In line with this objective, the study employs a quadratic Ordinary Least Squares (OLS) regression using the dataset generated from the derived GDP growth optimization model. The resulting estimates are then compared with those obtained from a quadratic OLS regression based on the actual GDP growth data in order to evaluate the empirical validity of the proposed GDP growth estimation framework.

Furthermore, to evaluate the interaction between the variables in the constraint function and the objective function a Two-Stage Least Squares regression was employed by the author to estimate the interaction of the monetary policy variables inside the fiscal objective function, and the interaction of fiscal policy variables inside the monetary constraint function.

3.2 Data

This study focuses on the Philippine macroeconomic indicators to represent theoretical components of the Shapiro-Stiglitz and Kydland-Prescott models in the estimated growth rate model. The dataset utilized was retrieved from various agencies, such as the World Bank, Philippine Statistics Authority (PSA), Bangko Sentral ng Pilipinas (BSP), and Public Employment Service Office (PESO) job vacancies with the annual time series from the year 2002-2022. The Philippines is an ideal scope of study as it provides a well-defined institutional inflation targeting framework and observable fiscal-monetary interactions making it a suitable empirical setting for analyzing fiscal and monetary policy behavior.

3.3 Models

3.3.1 Lagrange Optimization Model

For the Shapiro-Stiglitz model and the Inflation Setting Monetary Policy Model to have common factors, the following assumptions will be applied. The variable y which is the log of output will be converted into *A* which is the rate of output growth, as the logarithmic form of output is just the growth rate of output. And lastly *y* which is the logarithm of flexible price level will be converted to *w* which is wage, since flexible price levels indicate that the long run production costs of firms at full employment would be equal to the wage of labor. When prices are fully flexible, any divergence from full employment is corrected as wages adjust to match the marginal product of labor, effectively aligning production costs with labor compensation (Grieve, 2017). Another assumption to be applied would be for the Equilibrium Inflation to be converted to its *fisher identity* which is $\pi = i - r$ wherein inflation is equal to the difference between nominal and real interest rates.

The revised Inflation Setting Monetary Policy Model would then become equation (3):

$$(i - r) = \pi^* + \frac{c}{d}(A - w) \quad (3)$$

Similarly the Shapiro-Stiglitz model will be converted to equation (4) by dividing both sides of the equation with r.

$$Vv = -\frac{C}{r} + \frac{\alpha}{ar + \alpha r + 2br + 2r^2}\, A \quad (4)$$

The Lagrange Optimization Model theoretically would come out as a minimization model as shown in equation (5), wherein the policymakers would aim to minimize the value of vacancy to promote economic growth subject to the inflation level set by the Central Bank.

$$L = -\frac{C}{r} + \frac{\alpha}{ar + \alpha r + 2br + 2r^2} A - \lambda\left[\pi^* + \frac{c}{d}(A - w) - (i - r)\right] \quad (5)$$

Getting the partial derivatives in terms of λ, A and r, yielding equations (6), (7), and (8), respectively:

$$\frac{\partial L}{\partial \lambda} = \pi^* + \frac{c}{d}(A - w) - (i - r) \quad (6)$$

$$\frac{\partial L}{\partial A} = \frac{\alpha}{ar + \alpha r + 2br + 2r^2} - \frac{\lambda c}{d} \quad (7)$$

$$\frac{\partial L}{\partial r} = -\frac{A\alpha(4r + \alpha + 2b + a)}{(2r^2 + \alpha r + 2br + ar)^2} + \frac{C}{r^2} + \lambda \quad (8)$$

Solving for λ from equation (7) gives equation (9):

$$\lambda = \left(\frac{d}{c}\right)\left(\frac{\alpha}{ar + \alpha r + 2br + 2r^2}\right) \quad (9)$$

Solving for λ from equation (8) gives equation (10):

$$\lambda = -\frac{A\alpha(4r + \alpha + 2b + a)}{(2r^2 + \alpha r + 2br + ar)^2} + \frac{C}{r^2} \quad (10)$$

Equations (9) and (10) represent the two expressions for λ. Equating equations (9) and (10) produces equation (11):

$$-\frac{A\alpha(4r + \alpha + 2b + a)}{(2r^2 + \alpha r + 2br + ar)^2} + \frac{C}{r^2} = \left(\frac{\alpha}{ar + \alpha r + 2br + 2r^2}\right)\left(\frac{d}{c}\right) \quad (11)$$

Solving for A in equation (11) gives equation (12):

$$-A\left(\frac{\alpha(4r + a + 2b + a)}{(2r^2 + ar + 2br + ar)^2} = \left(\frac{a}{ar + \alpha r + 2br + 2r^2}\right)\left(\frac{d}{c}\right) - \frac{C}{r^2}\right. \quad (12)$$

Simplifying equation (12) gives the final derived optimal output growth equation (13):

$$A = \left[\left(\frac{\alpha}{ar + \alpha r + 2br + 2r^2}\right)\left(\frac{d}{c}\right) - \frac{C}{r^2}\right]\left[-\frac{(2r^2 + ar + 2br + ar)^2}{4ar + \alpha^2 + 2\alpha b + \alpha a}\right] \quad (13)$$

The final equation would be the optimal level of output minimizing the Value of Vacancy subject to inflation set by the monetary body. The assumption then for real interest rate or r is that the government would be setting the level of interest rate and therefore is assumed to be exogenous in the model. The optimal rate of output growth will be indicated by the model, wherein the goal of the policymaker is the long-run price stability and wherein there is low inflation.

However, it can be observed that there is a negative value for growth of output when subjected to the Lagrange Minimization, which is consistent with both the assumption of the classical Phillips curve wherein an increase in output growth would lead to an increase in inflation, and the assumption of long-run monetary policy growth wherein the opportunity cost for the policymaker if he/she aims for a stable price level and a low inflation rate, is the short-run social welfare condition wherein there is a low economic growth.

3.3.2 Econometric Model

For the evaluation of the computed rate of output growth the author will be utilizing the derived objective function and constraint function as the Stage 1 and Stage 2 regression models. The estimated quadratic OLS regression is presented in equation (14) and the actual quadratic OLS regression in equation (15).

a. Estimated Quadratic OLS Regression

$$Vv = \delta_1(GDP^*)^2 + \delta_2(GDP^*) + \delta_0 + \varepsilon_1 \quad (14)$$

Wherein:

Vv	=	Value of Vacancy
GDP*	=	estimated optimized GDP growth

b. Actual Quadratic OLS Regression

$$Vv = \sigma_1(GDP)^2 + \sigma_2(GDP) + \sigma_0 + \varepsilon_2 \quad (15)$$

Wherein:

GDP	=	GDP growth

c. Stage 1 TSLS Regression

Equation (16) is based on the Kydland-Prescott Model representing the monetary policy variables together with GDP Growth and Social Expenditure representing the fiscal policy components, together with Real Interest Rate as the endogenous variable in the model.

$$RI = \gamma_0 + \gamma_1 IT + \gamma_2 GDP + \gamma_3 FE + \gamma_4 CPI + \gamma_5 SOCEXP + \varepsilon_3 \quad (16)$$

Wherein:

RI	=	Real Interest Rate
IT	=	Inflation Target
GDP	=	GDP growth
FE	=	Central Bank Forecast Error
CPI	=	Consumer Price Index (Inflation Rate)
SOCEXP	=	Logarithm of Social Expenditure

d. Stage 2 TSLS Regression

$$GDP = \beta_0 + \beta_1 FR + \beta_2 VV + \beta_3 RIF + \beta_4 CCAP + \varepsilon_4 \quad (17)$$

Wherein:

GDP	=	GDP Growth
FR	=	Fill Rate
VV	=	Value of Vacancy
RIF	=	Forecasted Real Interest Rate
CCAP	=	Cost of Capital

Equation (17) is based on the Shapiro-Stiglitz Model representing the fiscal policy variables such as Fill Rate,

Employment Rate, Value of Vacancy and Cost of Capital together with Forecasted Real Interest Rate from the first stage regression with GDP Growth included as the endogenous variable in the equation.

Both models were estimated using Ordinary Least Squares (OLS) regression procedures and the results were both presented. However, due to the endogenous variables GDP (GDP Growth) and RI (Real Interest Rate) appear as predictors in each of the other's equation, simultaneity will be taken into account, employing TSLS procedure.

3.4 Statistical Treatment of Data

The data were statistically treated and processed utilizing Microsoft Excel and E-Views at 0.05 level significance. To ensure statistical soundness of the data, the Unit Root test for the stationarity of the data to be used in the regressions, the Johanssen Cointegration Test was utilized to examine the long-term equilibrium relationships of the variables utilized, the Jarque-Bera test for normality was employed to ensure that the residuals of the model are normally distributed, the Breusch-Pagan-Godfrey test for heteroskedasticity and the White's Test for heteroskedasticity was employed to ensure the constant variance across regressions, and the Breusch-Godfrey test for Autocorrelation was utilized to ensure that the variables are not correlated with each other.

4. RESULTS AND DISCUSSION

4.1 Two-Stage Least Squares Regression Results

Table 1 presents the first stage regression results for the Two-Stage Least Squares (TSLS) model, showing the interaction between the real interest rate and the monetary and fiscal policy variables.

Table 1. First Stage Regression Results

	Coefficient	Probability
Constant	5.762847	0.0833
Inflation Target	-0.452756	0.0115
GDP Growth	-3.472279	0.4580
Forecast Error	-0.913113	0.0000
Consumer Price Index	0.018023	0.3472
Ln(Social Expenditure)	-0.185779	0.2144
R-squared	0.822370	
Adjusted R-squared	0.758930	
F-statistic	12.96308	0.000077
Durbin-Watson	1.552350	

Table 2 presents the second stage regression results, showing the interaction of GDP growth with labor market variables and the forecasted real interest rate.

Table 2. Second Stage Regression Results

	Coefficient	Probability
Constant	-0.042692	0.2903
Fill Rate	0.032134	0.0018
Value of Vacancy	1.06E-11	0.0173
Forecasted Real Interest Rate	-0.004569	0.3350
Cost of Capital	-1.11E-13	0.0244
R-squared	0.660580	
Adjusted R-squared	0.570068	
F-statistic	7.298264	0.001800
Durbin-Watson	2.031631	

Table 3 shows the diagnostic test results for the second stage TSLS regression, confirming the statistical validity of the model.

Table 3. Two-Stage Least Squares Stage 2 Diagnostic Tests

Diagnostic Test	Value	Interpretation
Johanssen Cointegration Test	Trace test indicated 2 cointegrating equations at 0.05 level	There is a long-term equilibrium relationship among the variables
Jarque-Bera Normality Test	0.609931	Residuals are normally distributed
Breusch-Godfrey Serial Correlation Test	0.8766	No Autocorrelation
Breusch-Pagan-Godfrey Heteroskedasticity Test	0.1674	Homoskedastic

4.2 Regression Results

This paper utilizes the Kydland-Prescott Model for Inflation Setting Monetary Policy represented by first stage regression and the Shapiro-Stiglitz Model for Fiscal Policy was represented by the second stage regression. The first stage regression represents the constraint function of the Lagrange Multiplier Method utilized while the second stage regression utilizes the objective function of the model. Translating the original variables from both models to its modern equivalent in the Philippines, the TSLS model gives us a very important insight into the dynamics of how the Philippine Government pursues its economic policies.

The first stage regression shows the interaction of the real interest rate with monetary policy variables together with social expenditure and GDP growth, which are fiscal policy variables. It is evident in the regression that monetary policy variables related to price stability are significant to real interest rate (Mishkin, 2007) with the exception of CPI. However, both fiscal policy variables of social expenditure and GDP growth are both insignificant in the first stage regression indicating that both have no effect on real interest rate. This is contrary to the findings of Golpe et al. (2023) and Afonso & Sousa (2024), indicating that fiscal policy objectives such as social welfare and GDP Growth have a low priority for the Bangko Sentral ng Pilipinas.

The second stage regression then shows the interaction of GDP Growth to labor market variables related to employment and the exogenous variable Real Interest Rate. In the second stage regression a forecasted real interest rate from the first stage regression was utilized as a predictor in the second stage. Consistent with the stage 1 results, fiscal variables related to GDP Growth which were related to employment are highly significant to the second stage regression. Variables such as fill

rate increase GDP growth in the Philippines by 0.032134 per unit increase. A 1 unit increase in value of vacancy increases GDP growth by 1.06E-11 units and a 1 unit increase in cost of capital decreases GDP growth by 1.11E-13 units which all matches macroeconomic theory. The forecasted value from the real interest rate from the first stage regression however is insignificant indicating that monetary policy variables have no significant effect to Philippine GDP growth. In line with this a 1 unit increase from the forecasted real interest rate decreases GDP growth by 0.004569 which further supports traditional studies showing there is an inverse relationship between the monetary body and the fiscal government in the Philippines however significant. Contrary to the findings of Costa et al. (2021) fiscal policy has no significant relationship with inflation in proxy with the real interest rate.

4.3 Dataset of the Optimization Model

To test the viability of the model, data from World Bank, and various Philippine government organizations such as BSP, PSA, PESO job vacancies were utilized to provide actual data for the variables proposed in the theoretical optimized output growth rate A. The corresponding symbols and the variables they represent are summarized in Table 4.

Wherein:

Table 4. Symbols per Variable in the Derived Equation

Symbol	Variable Represented	Data Utilized
A	Rate of Output Production	Result of the model
α (alpha)	Fill Rate - Rate at which jobs are filled	$\frac{Total\ Employed_t - Total\ Employe}{Job\ Vacancies_t - Job\ Vacancies_t}$
a	Rate per unit time that unemployed workers find jobs	Employment Rate
b	Probability of capital loss at VE-VU	Probability of 1 indicating a 100% probability of experiencing a capital loss.
c	Reflects the relative importance of Output and Inflation in Social Welfare	Social Expenditure as percent of GDP
d	Coefficient of the difference between actual inflation and expected inflation	Forecast Error of BSP for inflation rates.
r	Real Interest Rate	The literature on inflation targeting suggests that optimal inflation is positive and low, with empirical policy frameworks—particularly in emerging markets—typically adopting target ranges around 2–4%, reflecting structural rigidities, macroeconomic volatility, and policy credibility constraints (Mishkin, 2000; Fraga et al., 2003; Ball, 2014)

Utilizing the derived equation from the Lagrange Multiplier, we estimate the optimal growth rate of the GDP in the Philippines per year. The resulting actual versus estimated GDP growth values are presented in Table 5.

Table 5. Actual vs Estimated GDP Growth

Year	GDP Growth	Estimated GDP
2003	0.05087	11.99486
2004	0.065692	-9.49076
2005	0.049424	-12.3482
2006	0.053164	-9.8809
2007	0.065193	0.286602
2008	0.043447	-0.40202
2009	0.014478	-0.05735
2010	0.073352	0.061827
2011	0.038582	0.005314
2012	0.068969	0.24145
2013	0.067499	0.204962
2014	0.06348	0.056021
2015	0.063486	0.407898
2016	0.071497	0.152047
2017	0.06931	0.01465
2018	0.063414	-0.12718
2019	0.061187	0.106411
2020	-0.09519	0.184579
2021	0.057151	0.071288
2022	0.075809	0.0252

It is noted that there is a significant difference in the actual GDP growth vs the estimated GDP growth from 2003-2006 to 2007 onwards. This is due to the implantation of the Pantawid Pamilyang Pilipino Program (4Ps) a government social welfare program aimed to assist the "poorest of the poor" households with its pilot launch beginning in 2007 and official launch in 2008, in addition to this per-capita spending on education and health sectors declined with education spending declining by around 20% between the year 2001 and 2006. This was due to the Philippine government addressing high public debt by reallocating social services budget to prioritize the issue of high public debt.

4.4 OLS Estimation of the Estimated GDP Growth vs Actual GDP Growth

An Ordinary Least Squares regression was utilized by the author to examine the reliability of the estimated GDP values provided by the optimization model presented in equation (15). The regression results are shown in Table 6.

Table 6. Quadratic OLS Regression for Actual GDP and Value of Vacancy Growth Rate vs Estimated GDP and Value of Vacancy Growth Rate

	Actual GDP	Estimated GDP
Constant	23.44255	23.94051
Constant (p-Value)	0.0000	0.0000
GDP coefficient	2.423774	0.000750

GDP coefficient (p-Value)	0.1850	0.9503
GDP squared coefficient	73.98956	-0.003428
GDP squared (p-Value)	**0.0519**	**0.0084**
R-squared	**0.225207**	**0.370767**
Adjusted R-squared	0.134055	0.296739
F-statistic	2.470670	5.008504
Prob (F-statistic)	**0.114309**	**0.019494**

Figure 1 illustrates the comparison between the actual and estimated GDP growth rates over the study period.

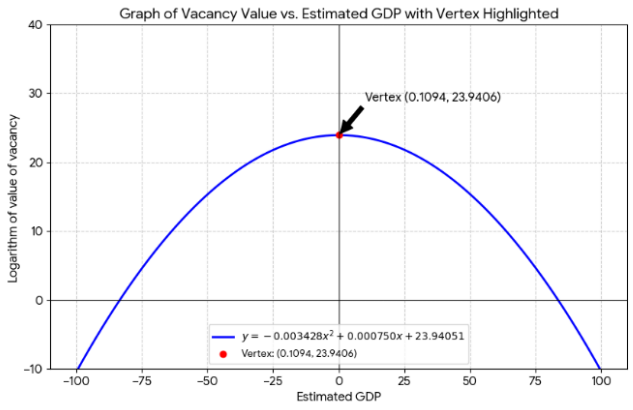

Fig. 1. Graph of the Estimated GDP

Table 7 presents the diagnostic test results for both the actual and estimated GDP quadratic OLS regressions.

Table 7. Diagnostic Tests for actual and estimated quadratic OLS regression

Diagnostic Test	Actual GDP	Interpretation	Estimated GDP	Interpretation
Jarque-Bera Normality Test	0.793969	Normally Distributed	0.641185	Residuals are Normally Distributed
Breusch-Pagan-Godfrey Heteroskedasticity Test	0.4632	Homoskedastic	0.2401	Homoskedastic
White's Test for Heteroskedasticity	0.4533	Homoskedastic	0.2693	Homoskedastic
Ramsey RESET	0.7586	No Misspecification Error	0.4988	No Misspecification Error

4.5 Discussion on OLS Estimation of Estimated GDP Growth vs Actual GDP Growth

A quadratic OLS regression was utilized using Value of Vacancy as the endogenous variable and the Estimated GDP Growth and its squared values as the predictors to make the quadratic equation. In line with this the second OLS regression utilizes the same Value of Vacancy as the dependent, however it utilizes the actual GDP growth as a point of comparison against the estimated GDP growth.

With the exact same formula, it is shown that the p-value of the regression for the actual GDP Growth is insignificant, which means that the predictor of Actual GDP Growth has no relationship to the dependent variable, value of vacancy. Thus, it could be concluded that statistically, the estimated GDP Growth model is a more dependable model in predicting the value of vacancy in the country.

While in the OLS regression model, the level values of estimated GDP growth is insignificant with a p-value >0.05, the squared values of estimated GDP growth remains significant indicating that the model follows a concave parabolic shape with the natural logarithm of value of vacancy increases in the short run then decreases in the long run after a certain value of the estimated GDP growth. This shows that in the short-run the value of vacant jobs increases, however after reaching a certain threshold of GDP growth the value of vacant jobs becomes lower showing the short-run and long-run trend of monetary policy-based economic growth.

5. Conclusion and Recommendation

5.1 Conclusion

This paper examines the integration of fiscal and monetary policy as dual instruments for stabilizing and enhancing economic growth. While these policy tools traditionally pursue distinct and often contrasting objectives, this paper aims to combine and integrate fiscal and monetary policy utilizing the Lagrange multiplier method. The Lagrange process provides us with two models, the objective fiscal policy function and the constraint monetary policy function. From the Lagrange process resulting in equations to solve for the values of GDP Growth A and Real Interest Rate r. However, due to the inflation targeting real interest rate r is set as a set value 0.04 to represent the 4% optimal real interest rate targeted by central banks. Utilizing this value the author utilizes the GDP Growth A equation utilizing the set 0.04 real interest rate to solve for GDP Growth providing the table of the estimated GDP per year in the Philippines. This estimated GDP growth dataset is then examined utilizing a quadratic OLS regression utilizing Value of Vacancy as the dependent variable and estimated GDP Growth and squared values of estimated GDP growth as the independent variable. The same regression format was utilizing replacing the estimated GDP growth with actual GDP growth and its squared values as a point of comparison for the estimates provided by the Lagrange Multiplier based estimated GDP growth. The results of the estimated GDP growth regression yielded a more statistically significant model in contrast to the actual GDP growth indicating that statistically, the estimated GDP growth value is a more dependable predictor for the value of vacancy as compared to the actual GDP growth. The model is proven to be a statistically effective model for the GDP growth to be targeted by the government integrating both economic growth goals of the fiscal policy and economic stability objectives by the monetary policy.

A TSLS regression was also employed by the author to examine the relationship of the variables utilized by the Shapiro-Stiglitz model and the Kydland-Prescott model utilized in the Lagrange Multiplier method. The result of the first-stage regression and the second-stage regression reveals an

interesting relationship between fiscal policy and monetary policy; statistically, in the Philippines, variables of both fiscal and monetary policy have no significant relationship with one another. The result of this study furthermore reinforces this concept wherein in both stages of the TSLS Regression the monetary policy variable inside the fiscal policy equation and the fiscal policy variable inside the monetary policy equation are insignificant in both of each other's equations suggests a lack of interaction and coordination between these two important government bodies. While literature such as Chen & Miao (2024) highlight the importance of integrating both fiscal and monetary policy and that ignoring the interaction between the two leads to misleading assessments, contrary to this study, statistically the fiscal policy and monetary policy in the Philippines have no significant effect on each other possibly indicating that the Bangko Sentral ng Pilipinas and the Philippine central government have little to no coordination and interaction with each other.

5.2 Recommendations

5.2.1 Government

While the findings of this paper indicate a lack of interaction between fiscal and monetary policy authorities, this result pertains specifically to the Philippine context. The literature consistently emphasizes that effective macroeconomic management requires close coordination among government institutions. However, the empirical evidence presented in this study suggests that such coordination between fiscal and monetary policy bodies in the Philippines remains limited.

This paper then recommends for the Philippine central government to collaborate with the Bangko Sentral ng Pilipinas to employ policies which are holistically better not only in their respective scopes but for the whole economy. The findings of this study indicate a lack of interaction between fiscal and monetary policy bodies, though this conclusion is specific to the Philippine context. Existing literature underscores the critical importance of collaboration among various government agencies for Philippine policymakers. The empirical evidence presented in this paper, however, reveals a significant deficiency in such cooperation. Therefore, this paper recommends that the Philippine government and the Bangko Sentral ng Pilipinas enhance their collaboration to implement policies that are holistically optimized, not merely within their respective domains, but for the entire economy.

Furthermore, this paper provides a new tool for the Philippine government to experiment with its policies with the proposed tool integrating a holistic policy which provides economic growth and economic stability at the same time.

5.2.2 Private Sector

For the private sector this paper provides a possible metric for domestic and international investors to view the Philippine economic policies with a new policy tool. This paper provides a dataset that could indicate the potential of the Philippine economy which has still not been reached. This expectation of the Philippine economy's potential could bring Foreign Direct Investments (FDI) which could further thrust Philippine GDP closer to its optimal growth rate.

5.2.3 Direction for Future Research

For future researchers, the statistical findings of this paper highlights the disconnect between fiscal and monetary policy in the Philippines, however this is only true for the Philippines. This study recommends examining the interactions of other countries as the government policies of different countries vary depending on internal and external conditions.

Furthermore future researchers could explore other variables derived from other economic models. In addition, the variables inside the optimization model could be explored upon and tested for the relationships between one another. Other more comprehensive datasets besides those used by the author could be explored as these data are only utilized in the Philippines and other countries could have a more complete dataset which is closer to the original design of the theoretical models.

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