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Coordination of Monetary and Fiscal Policies from a Game Theoretic Perspective

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Abstract: Under the backdrop of a highly intricate international environment and sluggish recovery of the global economy, it is crucial to delve into methods for bolstering national economic prowess and promoting economic prosperity and stability. Monetary policy and fiscal policy, as two primary macro-control tools, play a pivotal role in national progress, with their effective coordination becoming a significant issue. Game theory, a tool to mathematically model decisions made by different individuals through logical analysis, provides a solid theoretical foundation and practical framework for studying the issue. This paper utilizes game theory to model the coordination among the two policy-makers, the central banks and the governments while establishing a payoff matrix that reflects their utilities. During normal or recovery periods, this paper views it as a cooperative game, and the cooperative equilibrium will be that both policy-makers choose expansionary policies. During financial crisis, this paper views it as a non-cooperative game, and the Nash equilibrium will be that both policy-makers choose contractionary policies. Additionally, this paper selects specific examples from Brazilian history to validate the rationality of the model while confirming that the short-term equilibrium aligns with the modeling conclusions.

Keywords: monetary policy, fiscal policy, game theory.

1. Introduction

In the current severe and complex international environment, every country or economy must face the issue of survival and development. A stable economic situation is the foundation of social development, and vigorous economic growth is one of the critical factors for the overall progress of a country. However, an economy's natural development is not always stable and robust. It is imperative to implement macroeconomic policies for regulating the speed, structure, and magnitude of economic growth in order to enhance resilience against external risks, forestall economic crises, and effectively respond to inevitable downturns [1].

The fiscal policy formulated by the government and the monetary policy formulated by the central bank are two important macro-control methods to maintain economic stability and promote economic development [2]. These two macroeconomic policies coexist and are closely interrelated within an economy [3]. In general, fiscal policy directly impacts economic activity through mandatory transfer measures such as taxation and government spending, while monetary policy indirectly influences the economy through mechanisms such as interest rates and exchange rates [2, 3]. They are subject to

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their respective constraints while also exerting mutual influence on each other [2, 3]. Therefore, good coordination is crucial to avoid policy ineffectiveness and strengthen the effectiveness of macroeconomic regulation. However, since the two policymakers have different goals in various aspects and use different tools, coordination becomes a topic every economy needs to focus on [4]. In this article, game theory, a highly effective method for analyzing the strategic choices of multiple agents and the interact results, will be used to build a model to deal with the challenges of well-coordinated monetary and fiscal policies [5].

Game theory provides a theoretical framework for analyzing individual strategic decisions using mathematical calculations and logical reasoning [6, 7]. In non-cooperative scenarios, the Nash equilibrium in the game theory can be employed to analyze how decision-makers from various backgrounds achieve a state of equilibrium, where no player can improve their outcome by unilaterally altering their strategy [6, 7]. In cooperative scenarios, other game theoretical analysis can be applied to identify optimal outcomes for the decision-makers, through concepts like the core or Shapley value, which help determine efficient and mutually beneficial agreements. This theory is highly applicable for studying the coordination of monetary and fiscal policies, as in reality, the central bank, the monetary policy-maker, and the government, the fiscal policy-maker, are relatively independent to each other [2]. The two policy-makers have their own independent goals and priorities, but when they make their own decisions, their effects work together on the economy [2]. A set of theories are required to analyze how the two can achieve balance and obtain their respective dominant strategies in both cooperative and non-cooperative situation.

2. Construction of Policy Coordination Model

2.1. Theoretical Framework

This article aims to establish a game model to identify the equilibrium in different situation. The model involves two key participants: the central bank (referred to as CB) and the government (referred to as G). Each participant has two strategic choices: expansionary policy (denoted by E) and contractionary policy (denoted by C). By the choices of these two participants in these two strategies, the policies will jointly affect the economy and yield different macroeconomic regulatory outcomes.

Both the central bank and the government aim to achieve the macro-control objectives of fostering economic growth, managing inflation, and mitigating unemployment. However, their objectives are different in their primary focus. For CB, it focuses more on controlling inflation, maintaining currency value, and promoting financial system stability through monetary policy. For G, it focuses more on promoting economic growth, improving social welfare, and achieving income redistribution through fiscal policy.

Considering the distinct objectives, responsibilities, and roles of the two policy-makers, although they all have two strategic choices, they have their own methods of adopting strategies in the “game”. CB primarily employs monetary policy, wherein expansionary measures encompass lowering interest rates, purchasing government bonds, and reducing reserve requirements, etc., while contractionary measures encompass raising interest rates, selling government bonds, increasing reserve requirements, etc. G primarily employs fiscal policy, wherein expansionary measures include increasing government spending, reducing taxes, expanding social welfare, etc., while contractionary measures include reducing government spending, increasing taxes, cutting social welfare, etc.

2.2. Model Construction

Assuming that the utility of CB is represented by U_{CB} and the utility of G is represented by U_G. Based on different strategy combinations, the established payoff matrix is shown in Table 1.

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Table 1: The payoff matrix between CB and G based on game theory.

	G: E	G: C
CB: E	(U_{CB-E}, U_{G-C})	(U_{CB-E}, U_{G-C})
CB: C	(U_{CB-C}, U_{G-E})	(U_{CB-C}, U_{G-C})

When the economic environment varies, the utilities of different strategies also varies. This article primarily considers the normal or recovery period and the financial crises period. The financial crises period refers to a situation where a country or economy experiences a crisis due to improper policies or the impact of external financial crises, resulting in significant abnormalities in various key economic indicators, rather than a typical economic downturn. This payoff matrix only considers short-term utilities. In order to better understand and apply this model, specific figures are used in Table 2 and Table 3 to clarify the specific situation of payoff matrix under the two period.

Table 2 shows the normal or recovery period. When both G and CB adopt E, they will jointly promote economic development and achieve good results (3,3). When CB adopts E and G adopts C, the main driving force of the economy is CB, and government spending is relatively low, resulting in a higher U_G and a lower U_{CB} since CB will face more pressure. The payoff is thus (1,2). When G adopts E and CB adopts C, U_G is lower and U_{CB} is higher which can be represented as (2,1). When both G and CB adopt C, they both weaken the external spending of utilities. In this case, although it cannot promote the vigorous development of the economy, it can still generate a certain level of utilities in a stable manner which can be represented as (2,2).

Table 2: The payoff matrix in the normal or recovery period.

	G: E	G: C
CB: E	(3, 3)	(1, 2)
CB: C	(2, 1)	(2, 2)

This article assumes that under normal or recovery period, CB and G play a cooperative game. In the case of cooperative game, the equilibrium in Table 2 is (U_{CB-E}, U_{G-E}) with a payoff (3,3) and (U_{CB-C}, U_{G-C}) with a payoff (2,2). The most reasonable choice for maximizing overall utilities is (U_{CB-E}, U_{G-C}) and (3,3).

Table 3 shows the financial crises period. When both G and CB adopt E, as there may be malignant inflation or fiscal deficits, the expansionary fiscal or monetary policies are not conducive to national development and may have serious negative consequences; the utilities are represented as (-1, -1). When CB adopts E and G adopts C or when CB adopts C and G adopts E, the utilities are represented as (1, 0) and (0, 1). The participant that employs E can alleviate crisis situations such as inflation or fiscal deficits to a certain extent, while the other would not have a significant effect on promoting economic development, but can instead increase the burden on the first participant and lead to a decrease in its utility. When both G and CB adopt C, both policies will be beneficial for the country to control the overall situation during a crisis. Although the economic development speed temporarily slows down, it avoids further impacts on society, environment, etc. caused by the financial crisis, so the utilities are represented as (2, 2).

Table 3: The payoff matrix in the financial crises period.

	G: E	G: C
CB: E	(-1, -1)	(0, 1)
CB: C	(1, 0)	(2, 2)

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This article assumes that under financial crises period, CB and G play a non-cooperative game, since the overall situation in a crisis is even more critical and two policy-makers are more likely to prioritize their own situation. In the case of non-cooperative game, the Nash equilibrium in Table 3 is ($U_{CB\text{-}C}$, $U_{G\text{-}C}$) with a payoff (2,2).

3. Take Brazil as an Example to Test the Model

Brazil, the largest economy in Latin America and a promising emerging market, has undergone periods of prosperity as well as crises throughout its history, making it an excellent case study. This paper aims to examine the appropriateness of the equilibrium in the game theory model mentioned above by analyzing the corresponding monetary and fiscal policies implemented during stages of economic prosperity, recovery, and crisis in Brazil's developmental history.

For the "prosperous development" and "recovery" phase, this paper selects the period of Luiz Inacio Lula da Silva, a pivotal figure in Brazil's history. The period from 2003 to 2014, encompassing both President Lula's and his successor, Dilma Rousseff's administration, is widely recognized as "the Golden Decade of Brazil" [8]. During this period, Brazil achieved remarkable advancements across economic, social and environmental domains, and successfully attained an "investment grade" status, which was not even changed by the 2008 global financial crisis [8, 9]. In terms of policy, although the central bank adopted a relatively contractionary monetary policy to control high inflation in the early days of Lula's administration, it began to lower interest rates as the economy stabilized, boosting growth [8]. Concurrently, the government augmented investments in public services such as education and healthcare, and implemented credit subsidies and tax incentives to foster economic growth [8, 9]. Thus, it can be argued that this phase culminated with an adoption of "expansionary" monetary and fiscal policies. This period corresponds to the game matrix for "the normal or recovery period" in the model. The selection of the prosperous development stage aims to demonstrate that under regular economic operations stage, coordinating expansionary fiscal and monetary policies promotes economic progress while maximizing overall benefits and the policy makers' benefits ultimately forming an optimal game equilibrium in the short term.

For the financial crisis phase, this article selects the stage in the 1990s when Brazil tried to adjust to improve the country's high inflation, especially the "Real Plan" in 1994. Brazil had endured a prolonged period of high inflation spanning 34 years (1960-1994), characterized by fiscal deficits, inadequate monetary policy responses, and constraints on debt financing [10]. The Real Plan led to a significant improvement in Brazil's hyperinflation crisis by reducing its inflation rate from 2,240% in 1994 down to 4.9% by 1998, according to the World Bank. It also made Brazil's monetary system more stable, attracting foreign investment and paving the way for the subsequent economic recovery. In the Real Plan, contractionary monetary and fiscal policies played an important role. The central bank raised the benchmark interest rate significantly and reduced the money supply to curb the inflation. The government cut spending and raised taxes, implemented public spending reforms to try to reduce the fiscal deficit. With the well-coordinated monetary and fiscal policy, Brazil's economic situation stabilized and laid a foundation for future economic transformation. This example shows that in solving financial crises (referring to the situation which has extremely abnormal economic indicators and the economy is in a highly unhealthy state), it is necessary for the central bank and the government to adopt simultaneously contractionary fiscal policies to prevent the situation from worsening, so as to achieve the maximum benefit of both interests and achieve overall economic prosperity. This also corresponds to the equilibrium found in the game theory model in the financial crises period above.

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4. Conclusion

This article employs game theory to model and analyze the current hot macroeconomics research topic on the coordination between monetary policy and fiscal policy. A payoff matrix is established based on the utilities generated by different strategy combinations of the central bank and the government, considering two distinct backgrounds, the normal or recovery period and the financial crises period. The paper finds that in normal or recovery period, the two policy-makers tend to be in a cooperative state, and the equilibrium of the cooperative game is achieved when both of them choose expansionary policies. In financial crises period, the two policy-makers tend to be in a non-cooperative state, and the Nash equilibrium in this case is achieved when both of them choose contractionary policies. The paper then selects different historical stages in Brazil as cases to verify the reliability of the model, and the model established in the paper is found to be consistent with the real situation.

This paper only divides the strategies of the two policy-makers into two categories, without further refining the specific implementation policies. Future research can further expand fiscal policy and monetary policy and conduct more in-depth research on the game among more specific policies. Additionally, this paper mainly focuses on theoretical analysis rather than empirical analysis. In the future, empirical analysis can be conducted based on the current theoretical model which requires gathering more information and data to further verify the validity of the model.

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