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Game Theory and Strategy in Currency War Interactions

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Abstract
This research article seeks to provide an in-depth examination of the application of game theory and strategic interaction models in elucidating the complex dynamics underlying international currency wars. It aims to analyze how rational, strategic decision-making processes influence the behaviors of sovereign states as they engage in competitive and cooperative monetary policies within the interconnected global economic system. By integrating advanced economic terminology and providing comprehensive explanations, this paper aims to illuminate the strategic incentives, equilibrium outcomes, and potential policy implications that characterize these covert yet significant financial conflicts.

Keywords: Game Theory, Currency War, Prisoner's Dilemma, Nash Equilibrium

Introduction:

This research article conducts a comprehensive analysis of game theoretic applications in the context of strategic interactions among nation-states involved in currency wars—coordinated or competitive devaluations and revaluations aimed at achieving competitive trade advantages. By employing formal models of strategic games, incorporating asymmetric information, commitment problems, and dynamic move structures, the study elucidates the underlying decision-making processes of policymakers, chiefly central banks and executive governments. It examines the payoff matrices that influence their strategic choices and explores the equilibrium concepts—particularly Nash equilibrium and subgame perfect equilibrium—that can function as credible deterrents against escalation into mutually destructive currency conflicts. The research further delineates the systematic phases of currency conflict escalation, de-escalation, and resolution, integrating insights from international political economy and monetary macroeconomics. Comparisons are drawn with trade wars, to contextualize their broader macroeconomic implications, including effects on exchange rate regimes, capital flows, and global financial stability.

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Literature Review:

This research paper employs the concept of Nash Equilibrium (Nash, J. F., 1950) as the primary analytical framework within our theoretical assumptions rooted in game theory. The analysis considers an N-player strategic interaction, which may offer valuable insights into recent economic phenomena. The study initially models the situation as a non-cooperative game, following by the (Nash J. F., 1951) formulation. When the game is played repeatedly, the likelihood of reaching an equilibrium outcome increases, as players' strategies adapt over multiple iterations, potentially reaching a stable solution characterized by Nash Equilibrium.

Research Methodology:

In this research paper, we will utilize the Nash equilibrium as an analysis tool to estimate the selection approach among nations and players. The analysis of game theory and strategy in the currency war actions between countries is always one of the main concerns of officials and economists. In this paper, interactions between G8 and individual central banks, between central banks and speculators, and between speculators and individual citizens are modeled using game theory. By introducing a Nash equilibrium as a modeling and analyzing tool, we can analyze the possible outcomes that may lead to insights and potential solutions.

Discussion:

Currency wars, can be conceptualized as competitive devaluations, occur when nations intentionally manipulate their exchange rates—often through monetary policy interventions or direct market operations—to achieve a competitive advantage in international trade. By devaluing their currencies, these countries aim to make their exports cheaper and more attractive on the global market, thereby boosting domestic production and stimulating economic growth. However, such strategic currency depreciation can provoke a series of retaliatory measures, leading to a cycle of competitive devaluations that can undermine the stability of the international monetary system. This phenomenon can distort relative prices, generate trade imbalances, and erode global economic stability. Game theory, particularly concepts like strategic complementarities and Nash equilibrium, offers valuable analytical frameworks for understanding these interactions, highlighting how policymakers' choices are interdependent and how such strategic behaviors can escalate into a currency conflict with wide-reaching macroeconomic repercussions.

Game Theory and Currency Wars

Game theory offers a rigorous and formalized analytical framework for examining strategic interactions among rational agents operating within competitive and cooperative environments. It systematically incorporates four fundamental components: players, which represent decision-makers; strategies, denoting the available choice sets; payoffs, reflecting the utility or benefits derived from strategic outcomes; and information, encompassing the knowledge and signals available to agents at the point of decision-making. This theoretical construct models how agents formulate and select optimal strategies by forming expectations about the behaviors and

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responses of other participants, thereby enabling the analysis of equilibrium concepts such as Nash equilibrium and subgame perfection. Especially, in real economic applications, game theory facilitates a nuanced understanding of strategic decision-making processes under conditions of strategic interdependence. It focus on the complexities of bargaining, pricing strategies, and cartel formation, among other phenomena. Its utility extends across fields like industrial organization, behavioral economics, and political economy, providing insights into the strategic behavior of firms, consumers, policymakers, and other economic agents. In the context of international relations and macroeconomic policy, game theory is instrumental for analyzing strategic interactions among nations, central banks, and financial market participants, especially when decisions are interconnected and outcomes depend heavily on mutual expectations and anticipated responses under uncertainty and asymmetric information.

In reality, game theory is typically applied in central banks and among speculators' strategies in currency trading. In the zero-sum game, it seldom involves interactions between nations. However, recently these strategic strategies became much more complex since they involve more than one dominant player. This makes the situation more complicated, as each player seeks to gain more and cause the other player to lose. Regardless of whether these players are central banks, nations, or speculators, they all aim to maximize their own interests. Some nations serve their people, hoping to trade more goods (export more), while others focus on employment rates or inflation rates. Each player has different goals, but one thing remains the same: they all want to maximize their gains.

Typically, sovereign states and their central banking authorities actively participate in currency wars, also known as competitive revaluations. These actions are often motivated by macroeconomic objectives such as improving export competitiveness, managing trade imbalances, and stimulating economic growth. In this context, governments may engage in strategic interventions in foreign exchange markets, utilizing tools like direct currency purchases, manipulation of monetary policy, and sometimes coordinated efforts with other nations to influence exchange rates. Central banks, as the authoritative institutions responsible for implementing a nation's monetary policy, play a crucial role by adjusting interest rates, conducting open market operations, or intervening directly in foreign exchange markets to devalue or appreciate their respective currencies. These measures are typically part of a broader economic strategy aimed at gaining a competitive advantage in international trade, though they can also introduce volatility and undermine global financial stability. Possible strategies include currency devaluation, protectionism (tariffs), negotiation, or accusations.

The main reason for adopting strategic games in currency strategies is that some nations focus on economic growth, trade balance, and political stability, which motivates players.

So, currency wars can be conceptualized as strategic interactions analogous to classical game-theoretic models such as the Prisoner's Dilemma or the game of Coward. In these scenarios, nations engage in competitive devaluation of their currency to gain trade advantages, but mutual devaluation leads to negative spillover effects, such as inflationary pressures and loss of

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purchasing power, which ultimately diminish collective welfare. The dilemma arises because while unilateral currency devaluation can confer short-term competitive advantages, it carries significant risks, including triggering a currency race to the bottom, reciprocal retaliations, and undermining long-term economic stability. These dynamics highlight the tension between individual rationality and collective welfare, illustrating the strategic considerations underpinning policy decisions in open macroeconomic environments. At last, since it will be developed as a repeated game, so Nash equilibrium will occur. [1][2]

This situation can be explained in the Nash equilibrium, in the Nash equilibrium, it states that when it is in the repeated game, strategic outcomes occur where no player benefits from unilateral changes. That means, in the Nash equilibrium, no one will win everything; a winner-takes-all game cannot be sustained in the Nash equilibrium. Instead, everyone gets some payoff, and conversely, the game will reach a stage where no one wins or loses. At that stage, it is the equilibrium point, where any possible strategy becomes useless as long as the market remains free. In the long run, the equilibrium will develop in the best way through this formation. [1][2]

Modeling Currency Wars as a Strategic Game

Thinking about Currency War as a Strategic Game can make understanding the complex dynamics a lot more approachable. It helps us see the various moves and countermeasures involved, making the entire situation clearer and more engaging.

So, let's simulate the model case below:

(1) Polymorphism
It is stated that the currencies of different countries, meaning the exchange rates, fluctuate with different values (prices) every day, every hour, every minute.

(2) Learn from Each other
Learn from each other involves everyone experiencing gains and losses in currency exchange battles. Sometimes hedge funds come out ahead, while other countries face losses, like during the Asian financial crises of 1992 and 1997. Conversely, at times, countries win and hedge funds incur losses, such as when the Hong Kong government intervened in August 1998. Therefore, it is important to learn from each other and stay transparent about actions taken by either side.

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(3) Split Strategies Game

Resides in the development of a model (see Figure 1).

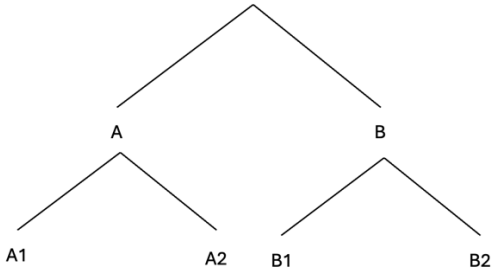

Figure 1: Split Strategies

Split Strategies describes each phrase of maternal behavior in currency decision-making, involving decision processes and responses with terms like 'utility maximization,' 'opportunity cost,' 'risk assessment,' and 'behavioral equilibrium.' This model formalizes hypotheses on maternal incentives and constraints within currency economics and decision behavior.

(4) Multi-stage game involving observation and incomplete information.

Therefore, when addressing the equilibrium, the concept of a refined Bayesian equilibrium within a complete information dynamic game should be employed, R1-R3...

Polymorphism in Monetary Game Theory

Simply put, factors that influence currency exchange rates include many aspects, such as PPP, trade balances between the two countries, international competitive advantages, and so on. However, from a gaming perspective, it can be divided into four main forces, specifically the four forces of currency discussed in this article, which involve the G8 countries, speculators, central banks, and local citizens.

Table 1: Game Theory in decision box

Speculator	G8
Central Bank	Local Citizen

For example, whether banks in each country use free-floating or fixed exchange rates, they will soon set an optimal rate (for instance: USD 1.00 to HKD 7.80), but this rate might not be accepted by the market.

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A speculator sells currency if they believe the exchange rate is too high, while the Central Bank buys back local currency to maintain a stable exchange rate, and vice versa.

Each country will set its exchange rate based on its own needs. Some exchange rates are high, while others are low. Similar to a repeated game in game theory, speculators and central banks continuously learn from each other, with speculators punishing or benefiting from their actions, and central banks reciprocating. That is, the government intervenes in the market, causing speculators to incur losses, or speculators may short-sell the currency to make profits. Through this ongoing process, everyone determines an appropriate exchange rate. In other words, the Nash points of different countries are inherently diverse, with many potential Nash points. Each country's Nash point is like a parent game, and the overall exchange rate is the perfect equilibrium of the sub-games.

This article assumes that the currency market is an incomplete information market, with the nature of this incompleteness reflected in the types of players involved. It first employs staged gaming to explain fluctuations in exchange rates, then examines how players' decision-making evolves—using models like Cournot and Stackelberg—to determine whether the optimal exchange rate strategy is non-attack (Non-Attack "NA") or attack (Attack "A") to maximize profits. The development of the profit function will be elaborated through a detailed mathematical model.

Types of games:

(1) The first game (first stage game)

Participants in this game include international speculators and local central banks. The clear strategic choice for the central bank is whether to intervene in the exchange rate. The clear strategic choice for the speculator is whether to attack the exchange rate. It is assumed that everyone operates with incomplete information and considerable uncertainty in the market.

Table 2: First Stage currency game matrices

		Speculators	
		Attack	Non Attack
Central Bank	Intervent	(I, A)	NA (I, O)
	Non Intervent	(O,A) NI	(O,O) NI NA

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(2) The second game (second stage game)

The second stage of the game involves the eight major industrial nations (G8) along with their local central banks. The G8's pure strategy is to either intervene or refrain from intervention, while each local central bank chooses to either resist or not resist.

Table 3: Second stage currency game matrices

		G8	
		Intervent	Not Intervent
Local Central Bank	Fight Back	(F,I)	(F,O)
	Not Fight Back	(O,I)	(O,O)

The first and second stages are set because speculators compare them to the eight major industrial countries, whose combined economic and military strength surpasses any hedge fund or international speculator. These countries' intervention in exchange rates depends on factors like national strength, politics, geography, and military power, and may be influenced by relative weakness or strength. The local central bank can counteract these interventions, marking the final speculation stage. The ultimate goal is reaching a perfect market equilibrium through mutual learning in an environment with incomplete information.

The interactions among the major G8 currencies—namely Canada, France, Germany, Italy, Japan, Russia, the United Kingdom, and the United States—can be viewed as a strategic game similar to a "threat game,' which is a subset of the classic prisoner's dilemma. In this framework, each country that issues currency employs a strategy of credible threat to revalue or devalue their currency competitively, aiming to improve their trade balance or economic standing. However, these strategies carry significant risks: if all parties escalate their threats simultaneously, it could result in mutually harmful outcomes, including disruptive exchange rate volatility, loss of monetary policy control, and increased financial instability. These interactions form a strategic dilemma where each player must balance the potential benefits of competitive devaluation against the danger of triggering a costly escalation. Such escalation could lead to a currency rush or a collapse of exchange rate norms, undermining economic stability and international monetary cooperation. Therefore, this strategic interplay is a key factor in understanding the dynamics of global currency markets and the potential for conflict or cooperation under various geopolitical and economic conditions.

So, why will the above situation happen? To answer this, we need to understand the currency manipulation behind it. There are four main reasons. First, opponents of the currency nation cause manipulation. An opponent of currency manipulation opposes practices that artificially influence a nation's currency to gain trade advantages, often through government interventions like central bank actions or policy measures to devalue or inflate the currency. Critics say it distorts competition, causes trade imbalances, and disrupts global monetary stability. Opponents support free-market principles, transparency, and multilateral organizations like the IMF to maintain exchange rate stability and prevent devaluations.

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Secondly, the reason for currency competitiveness. The currency's efficiency and external valuation in international markets determine its ability to maintain purchasing power and competitiveness, impacting overall economic stability. This involves assessing real exchange rate dynamics, comparative price levels, and macroeconomic policies affecting exchange rates and price parity.

Thirdly, currency speculators cause manipulation by intervening in foreign exchange markets to profit, often violating market norms. Such actions can distort market balance, undermine stability, and attract regulatory attention. They exploit macroeconomic imbalances to generate abnormal returns, causing currency misalignment and affecting inflation and competitiveness. Authorities may act to detect and counteract these speculative activities to maintain market integrity and stability.

Fourthly, citizens involved in currency activities. A citizen participating in currency exchange or transactions, demonstrating involvement in currency markets, trading, or investments. This indicates interaction with monetary policies, forex markets, or the financial system, influenced by economic incentives and market signals.

Implication:

This research article examines the application of game theory as a framework for determining a country's exchange rate and its optimal equilibrium. A nation's exchange rate is shaped by competing factors. Through an evolutionary process using Repeated Game (or evolutionary game), this mutual learning leads to a Nash equilibrium characterized by two main points: (1) The Local Central Bank and Speculators either punish or benefit each other, guiding the choice of the best exchange rate for the country, while strong government intervention can cause losses to speculators. (2) Countries learn from one another; for example, some maintain high exchange rates, while others keep low rates. For instance, the British pound to HKD is 1.00 to 14.00 because the UK relies less on exports and more on imports, making a high exchange rate beneficial. Over time, through mutual learning and cooperation, exchange rates tend to align across nations, resulting in a more consistent and naturally coordinated global currency system.

The well-known "Prisoner's Dilemma" in game theory shows that in multi-party situations, individuals or countries pursuing their own interests often fail to maximize the collective good. If each tries to prioritize their own advantage without considering others' reactions, then punishment will act as a hurdle, so as long as it is a repeated game, the Nash equilibrium will be encountered. If the country's currency doesn't appreciate against the dollar, it may impact trade deficits or surplus in the foreign trade. This research model approach may be the best way to predict the actions between countries and speculators. Game theory is useful for explaining complex situations simply, but Nash equilibrium usually prevents reaching the best overall outcome for individual countries. Progress in efficiency only happens when all parties cooperate, allowing everyone's interests to benefit and the overall good to be achieved. [1][2]

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Findings:

This research paper suggests that ongoing currency tensions could eventually lead to a global currency conflict. When countries implement strategic currency policies, it can cause dissatisfaction and ripple effects. Over time, this could result in a currency rivalry, especially during periods of devaluation. These competitive devaluations may spread quickly worldwide, increasing the risk of a global economic downturn. Additionally, this paper proposes that we might resolve the currency conflict through negotiation within the framework of the Nash equilibrium, since there will be only an equilibrium from either side. From that perspective, negotiation strategies might offer a viable solution to reach a final resolution.

Conclusion:

In conclusion, applying game theory to currency wars provides deep insights into the strategic choices and interactions of sovereign states involved in international monetary competition. Analyzing payoff matrices and the credibility of threats helps clarify when currency conflicts may occur, escalate, or resolve peacefully. Cooperative approaches, such as negotiated currency stabilization agreements and shared policy commitments, can promote macroeconomic stability. Conversely, defection or non-cooperation might lead to a "Crisis of the Commons" scenario, resulting in increased volatility, currency devaluations, and potential macroeconomic instability.

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