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Analyzing and Extending the Capital Market Line: Implications for International Trade

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Highlights

- **This study using game theory analyzes the equilibrium in the game between investors and governments using risk and return parameters.**
- **This paper provides a more realistic and dynamic interpretation of the CML by integrating macro-financial and geopolitical dimensions.**
- **The equilibrium analysis shows that the investor's decision is highly sensitive to relative returns and external risk, while the host country's utility is most affected by the degree of hostility and its relative economic power.**
- **The results confirm that minimizing political antagonism and enhancing institutional cooperation significantly increases domestic utility and stabilizes capital inflows.**

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Abstract

This paper extends the classical Capital Market Line (CML) framework by incorporating strategic interactions between international investors and host countries through a game-theoretic model. The extended model introduces key behavioral and institutional variables, notably the degree of hostility (ρ), economic power asymmetry, and relative risk-return dynamics across domestic and foreign markets. The investor seeks optimal capital allocation based on expected return and perceived risk, while the host country aims to retain capital by enhancing domestic market attractiveness and minimizing political hostility. The equilibrium analysis shows that the investor's decision is highly sensitive to relative returns and external risk, while the host country's utility is most affected by the degree of hostility and its relative economic power. The results confirm that minimizing political antagonism and enhancing institutional cooperation significantly increases domestic utility and stabilizes capital inflows. Ultimately, this paper provides a more realistic and dynamic interpretation of the CML by integrating macro-financial and geopolitical dimensions, and it suggests that peaceful economic diplomacy and sound macroeconomic policies are crucial for sustainable investment and trade flows.

1. Introduction

The Capital Market Line (CML) constitutes a key principle in modern portfolio theory, depicting the balance between risk and return for optimal portfolios that integrate risk-free assets with the market portfolio (Jarrow, 2019). Traditionally, the CML is studied in a domestic context, but globalization has

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made international investment an integral part of portfolio management. Cross-border capital flows are shaped not only by financial variables but also by political, institutional, and strategic interactions between countries and investors (Lewis, 2011). Understanding how the CML extends in the international sphere requires incorporating these multifaceted factors, highlighting the importance of game-theoretic approaches to model strategic behaviors influencing risk and return.

International investments are inherently more complex than domestic ones due to factors like exchange rate risk, political uncertainty, and regulatory heterogeneity (Bekaert & Harvey, 2017). These complexities influence the shape and position of the CML when applied globally. Investors must weigh both market and non-market risks, while countries simultaneously compete or cooperate to attract foreign capital. Consequently, international investment can be viewed as a strategic game where investors and sovereign states act as players with interdependent payoffs, reshaping classical portfolio theories to fit dynamic, strategic international contexts (Michie, 2010).

Game theory serves as a crucial and powerful framework for examining and understanding strategic interactions in international finance, especially those occurring between investors and nations (Rapoport, 2012). This approach captures how countries design policies to attract or deter foreign investment and how investors respond to risks and incentives in their portfolio allocation decisions. The dynamic interplay between regulatory frameworks, market signals, and geopolitical considerations can be modeled as repeated or dynamic games, offering insights into equilibrium outcomes in capital allocation and risk assessment (Meyer & Habanabakize, 2018).

Recent studies emphasize the behavioral components of international investment decisions, such as experience-based learning and cognitive biases that deviate from classical rational expectations. Investors' past experiences shape their expectations about foreign markets, affecting home bias and portfolio retrenchment during crises (Nakov & Nuño, 2015). Integrating these behavioral insights into the CML framework is crucial to more accurately model risk-return profiles and understand international capital flow volatility.

The international capital market is often segmented due to institutional differences, capital controls, and asymmetric information (Bekaert & et al., 2016). Such segmentation challenges the assumption of perfect capital mobility underlying the classical CML. Game-theoretic models can help elucidate how these frictions arise from strategic interactions, such as regulatory competition or cooperative treaties, and their effects on the shape of the international CML and portfolio diversification strategies (Bellalah & Dammak, 2019).

Exchange rate risk is a pivotal factor influencing international portfolio returns and the CML's international extension (Apergis & et al., 2011). Currency fluctuations introduce additional volatility and correlation effects that impact the risk-return frontier for global investors. Countries' monetary policies and macroeconomic conditions affect these risks, which interplay strategically with

investor expectations and capital movements. Incorporating exchange rate dynamics into the CML requires a comprehensive game-theoretic approach that captures the strategic interdependence between investor behavior and country policies.

Political risk, including expropriation, policy instability, and geopolitical conflicts, substantially influences foreign direct investment and portfolio decisions (Brink, 2017). Countries often engage in strategic behavior to balance attracting investment with maintaining sovereignty and domestic interests. Investors, in turn, assess and price these risks, resulting in a strategic game framework that shapes international capital allocation. Integrating political risk into the CML expands its relevance to real-world conditions faced by global investors.

The increasing importance of sustainable and ESG (Environmental, Social, Governance) factors has introduced new strategic dimensions to international investments (Aouadi & Marsat, 2018). Countries that develop favorable ESG policies can attract long-term investors seeking to mitigate non-financial risks. This introduces additional layers of strategy, where investors and countries interact over reputation, regulatory commitment, and social responsibility, reshaping the CML to account for evolving investor preferences and policy frameworks.

This article aims to analyze and extend the Capital Market Line within the context of international investment by modeling the strategic game between investors and countries. Incorporating game theory, behavioral insights, political risks, and ESG factors, the study develops a more comprehensive framework to capture the complexities of global capital markets. This integration addresses gaps in classical portfolio theory and provides practical insights for policymakers and investors navigating an increasingly interconnected and strategic investment landscape.

This article is organized into five sections. The first section presents the introduction to the topic. The second section reviews the literature, while the third section discusses the application of game theory in social sciences, with a particular focus on capital markets. The fourth section provides the analysis of the findings in two sub-sections, and finally, the last section offers conclusions and policy recommendations.

2. Research background

Albulescu et al., (2010), explored the impact of globalization on FDI flows, focusing on its growing importance for developing countries, especially in Central and Eastern Europe. They emphasized that EU accession boosted investor confidence and economic development. While traditional FDI determinants include host country policy, macroeconomic performance, and national economic attractiveness, the study introduced financial stability as a new determinant. Using panel data from 1998 to 2008 and a financial stability index, they found that financial system stability significantly increases FDI inflows. These results

highlight the critical role of macro-financial stability alongside conventional FDI factors.

Salimian & Almasifard (2020), conducted a study exploring the economic foundations of peace through the lens of game theory. They developed a static game model involving players specifically investors and countries, to examine their strategic behavior based on the available options for each player. Initially, they analyzed a scenario where two countries were indifferent toward one another. In the second scenario, the two countries were considered adversaries, and in the third scenario, a triadic relationship was modeled in which one country was indifferent and the other was a rival. Based on the Nash equilibrium outcomes in all three cases, the researchers concluded that the optimal outcome for both the investor and the host country is achieved when the investor diversifies their portfolio across markets and the host country fosters cooperation and peace. This interaction leads both sides to reach the Nash equilibrium, representing a stable and mutually beneficial strategic balance.

Malmendier et al., (2020), offered a novel theoretical explanation for several longstanding international macroeconomic puzzles related to capital flows and portfolio allocation, grounded in macro-financial models of experience-based belief formation. Their study emphasized that individuals' personal experiences with past macroeconomic conditions significantly shape their expectations about future outcomes, thus influencing portfolio decisions—particularly the preference for domestic over foreign equity investments. These experience effects explain stylized facts in international investment behavior, such as home bias, retrenchment during domestic crises, and fickleness during foreign crises. The model also suggested that the strength of these behaviors depends on the business cycle and market participants' demographics. Empirical evidence supported these predictions, underlining the key role of behavioral learning in shaping global capital flows.

Salem & Younis (2020), conducted a study investigating the impact of country risk on Foreign Direct Investment (FDI) inflows to Egypt during the period from 2005 to 2015. Utilizing multiple regression analysis, the study examined the relationship between selected macroeconomic and risk-related variables that influence FDI flows. The findings revealed that economic risk indicators exert the most significant effect on FDI inflows, while financial risk showed no statistical relevance, and political risk was found to be associated with variations in FDI.

Hassan (2022), examined how country risk influences foreign direct investment (FDI) inflows in the Visegrád Four countries (Czech Republic, Hungary, Poland, and Slovakia) from 1991 to 2020. The study applied the dynamic common correlated effects (DCCE) estimator to address cross-sectional dependence, structural breaks, and varying slopes among countries, and further utilized country-specific fully modified least squares (FMOLS) regressions to verify the robustness of the findings. The empirical findings demonstrated that country risk significantly deters FDI inflows in these economies, with economic

and political risks exerting negative impacts, while financial risk exhibited weak and mixed effects across the panel and individual country estimations

Damodaran et al., (2022), examined the concept of country risk and its implications for international investment and the valuation of multinational corporations. Their study provided a comprehensive analytical framework for assessing and adjusting for country risk from two perspectives: bond investors via credit ratings and credit default swap (CDS) spreads and equity investors through the estimation of country-specific equity risk premiums. The authors emphasized that exposure to country risk should be evaluated based on the location of a firm's operational activities, rather than its place of incorporation or stock listing. They proposed that this operational exposure approach should be integrated into both the valuation of multinational firms and international capital budgeting decisions. Additionally, they warned that currency mismatches in risk assessment may lead to significant miscalculations in strategic investment decisions.

Salimian et al., (2022), investigated the role of investment in shaping equilibrium within the international political economy using a game-theoretic approach. By constructing a strategic game between players and defining payoff functions for each, they analyzed how different variables influence outcomes. Their findings revealed that lower external risk and higher economic power lead to increased risk and return in both domestic and foreign markets, and vice versa. Ultimately, the study concluded that when the degree of hostility between countries is reduced to zero, nations achieve the highest possible positive outcomes, a result that is further amplified when domestic economic power is relatively low, underscoring the strategic importance of cooperation under asymmetrical conditions.

Sun et al., (2023), examined the role of public and private investment, along with globalization, in fostering economic growth across 34 Asian countries, while accounting for investment risk and demographic pressures. Utilizing the two-step Generalized Method of Moments (GMM) and panel data covering the period from 2001 to 2019, the study compared the effects of these variables across economies at different levels of development. The findings indicated that private investment exerts a significantly positive effect on economic growth in emerging Asian economies. Additionally, economic globalization was found to accelerate growth in these countries. The study further suggested that policies aimed at reducing investment risk and strengthening institutional frameworks could enhance the attractiveness of these economies to both domestic and foreign investors.

Huang & Li (2024), conducted a study examining the impact of international trade on global peace and inter-state relations, from the perspective of the World Trade Organization (WTO). Utilizing data on intergovernmental conflicts spanning from 1950 to 2000, they assessed how trade integration influences the likelihood and intensity of military disputes. Their findings indicate that participation in the WTO-based international trade framework significantly reduces the probability and severity of inter-state conflicts, thereby playing a crucial role in fostering and maintaining global peace. However, the magnitude

of this effect varies depending on geographic distance between countries, the extent of tariff concessions granted by member states, and institutional changes within the WTO's framework.

Kaya et al., (2024), investigated the relationship between investors' risk appetite and country risk, with a particular focus on Credit Default Swap (CDS) spreads as a proxy for sovereign risk. Employing asymmetric Hatemi-J cointegration and causality tests, the study analyzed the dynamic interactions between domestic and foreign investors' risk appetite and sovereign CDS premiums over a specified time horizon. The findings revealed a cointegrated relationship between these variables, indicating long-term equilibrium. Moreover, an increase in investor risk appetite both domestic and international, positively affects CDS spreads, signaling heightened perceived risk. Conversely, a decrease in CDS spreads was shown to have asymmetric effects on investor risk appetite, potentially exerting either positive or negative influences depending on the broader economic and geopolitical context.

In recent years, the expansion of international capital flows and the growing interdependence among national economies have revealed the limitations of classical financial models such as the Capital Market Line (CML). While the traditional CML is grounded in a frictionless, single-country context assuming perfect capital mobility and uniform risk preferences, real-world investment decisions are increasingly influenced by geopolitical frictions, institutional asymmetries, and country-specific risks. In this context, several scholars have highlighted the importance of incorporating strategic interactions between investors and host countries (particularly through a game theory approach) to better capture the complexities of global investment behavior. Key variables such as relative economic power, perceived hostility between countries, and the political or institutional environment have been shown to significantly shape both investor demand and national policy responses. These insights underscore the need to revise and extend the classical CML framework by integrating such critical variables. Therefore, the present study builds upon this emerging literature and aims to develop an enriched CML model that accounts for strategic behavior and inter-country hostility, providing a more accurate representation of international investment dynamics.

3. Game Theory

The application of game theory extends beyond economics into political science, sociology, and international relations, offering profound insights into human behavior, institutional dynamics, and collective decision-making processes (Maschler et al., 2020). This theoretical foundation enables scholars to capture complexities inherent in real-world interactions, especially under uncertainty and asymmetric information, thus fostering more precise policy designs and institutional reforms.

In the context of international investment, game theory elucidates the strategic interdependence between sovereign states and investors, where each

party's decisions influence capital flows, regulatory policies, and geopolitical risks (Khan & Akbar, 2013). Investors strategically allocate capital by weighing expected returns against political risks such as expropriation, regulatory changes, and geopolitical tensions, while host countries design policies that either incentivize foreign direct investment or impose restrictions to protect domestic interests (Daude & Stein, 2007). Game-theoretic models in political economy reveal how credibility, signaling, and reputation impact investment decisions, with mechanisms such as investment treaties or multilateral agreements serving to mitigate risks and facilitate cooperation (Sikka, 2011). Consequently, understanding these strategic dynamics is essential for explaining capital mobility patterns and policy responses in the globalized economy.

The interaction between foreign investors and host countries is commonly conceptualized as a strategic game characterized by asymmetric information and divergent objectives, where both parties aim to optimize payoffs under uncertainty (Pandya, 2016). Investors seek to maximize returns while mitigating political and economic risks, whereas countries endeavor to attract capital without compromising sovereignty or domestic stability. Game-theoretic frameworks such as signaling games and principal-agent models are employed to capture the mechanisms through which countries communicate credible commitments—like legal protections or policy stability—to influence investor expectations (Seyoum, 2011). Similarly, investors' decisions convey market confidence or skepticism, impacting a country's economic trajectory. These models highlight the strategic importance of transparency, contract enforcement, and institutional quality in fostering stable investment environments. Moreover, they show how opportunistic behaviors and commitment problems can lead to suboptimal equilibria, including capital flight or investment withholding, underscoring the value of robust governance and international cooperation.

Contemporary advancements in behavioral game theory have enriched traditional models by incorporating cognitive biases, bounded rationality, and social preferences into the analysis of investor-country interactions (Camerer, 2003). Recognizing that agents do not always act in purely rational or self-interested ways, these models account for fairness concerns, reciprocity, and reputation beyond immediate economic payoffs. Such behavioral insights explain phenomena like persistent cooperation despite short-term incentives to defect, or heightened sensitivity to perceived fairness in regulatory environments (Barberis & Thaler, 2003). In international investment contexts, this perspective clarifies why countries might adopt investor-friendly policies not only for economic returns but also to signal commitment to fairness and legitimacy. Additionally, investors may exhibit herd behavior or overreact to political signals, affecting capital flows and market volatility. Incorporating behavioral factors thus improves predictive accuracy and policy relevance of game-theoretic frameworks in complex geopolitical and financial environments.

4. Game Modeling

Suppose that countries and investors engage in a strategic, non-cooperative game concerning cross-border capital allocation. From the perspective of the domestic country, the strategic objective is to retain investment capital within its borders, thereby enhancing internal economic growth and minimizing exposure to foreign economic or political influences. This preference is shaped by the relative return R and risk Y associated with the domestic market, as well as the corresponding values in the foreign market (R_f and Y_f) respectively. Notably, risk in this context includes both financial volatility and country-specific factors such as political instability. On the opposite side of the game, foreign investors act as rational agents who allocate capital across borders in pursuit of higher risk-adjusted returns, responding to shifts in profitability and risk perception across markets. These opposing interests result in a strategic interaction wherein both players optimize their respective utility functions. Countries strive to reduce capital outflows and attract domestic investment, while investors seek the optimal portfolio mix given international constraints. The model developed in this paper captures these dynamics by integrating the effects of economic strength (G), Degree of hostility (ρ), and relative market performance into an extended formulation of the Capital Market Line (CML) thereby bridging portfolio theory with game-theoretic principles.

The modeling process starts by defining the investor's utility function, which is then followed by the specification of the utility functions of the participating countries. To derive the investor's utility and ultimately fulfill the main aim of this study, modifying and extending the Capital Market Line (CML), a thorough analysis and expansion of the traditional CML framework is first conducted. Conventionally, the CML is depicted as a linear relationship between expected return and risk (standard deviation), as shown in the accompanying figure. For clarity and conciseness, the discussion below focuses solely on the most essential components of this framework.

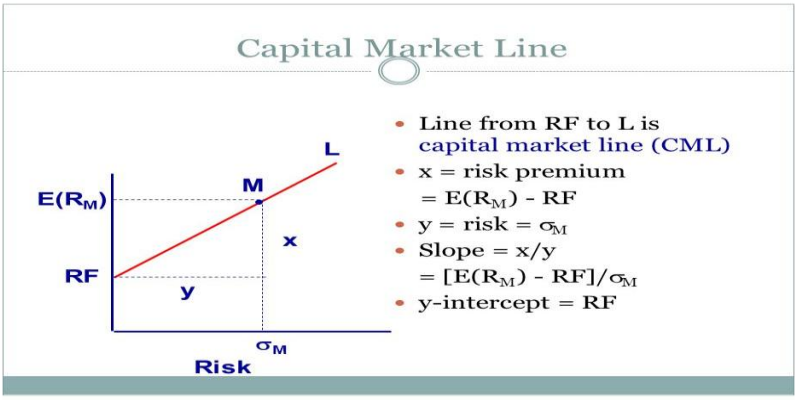

Figure.1. Capital Market Line (CML)
Source: *researcher's findings*

According to this diagram, the equation of the Capital Market Line (CML) is expressed as follows:

$$E(R_p) = RF + \frac{E(R_M - RF)}{SD(R_M)}\ SD(R_p)$$

In the above equation,

$E(R_p)$ is the expected return of each efficient portfolio for the capital market line (CML)

RF is the risk-free asset rate of return

$E(R_M)$ is the expected return of the market portfolio M

$SD(R_M)$ is the standard deviation of the market portfolio return

$SD(R_p)$ is the standard deviation of the efficient portfolio.

Moreover, the slope of the Capital Market Line reflects the market's price of risk. In addition, according to conventional portfolio theory, the following relationship holds:

$$E(R_i) = \sum X_i\ p(X_i) \qquad (1)$$

As can be seen, the traditional Capital Market Line (CML) captures the risk return relationship within a single market, typically the domestic market. To extend this framework to incorporate both domestic and international (foreign) markets, the model is expanded as follows:

$$E(R_p) = (RF_d + RF_f) + \frac{E(R_{M_d} + R_{M_f}) - (RF_d + RF_f)}{SD(R_M)}\ (1 - W_{RF})SD(R_X) \qquad (2)$$

In which W shows the probability values. Also. Since:

$$R_{it} = a_i + b_i R_{Mt} + e_{it} \Rightarrow Var\ (R_i) = b_i^2 var\ (R_M) + var\ (e_i) \qquad (3)$$

The first component of this equation, $b_i^2 var\ (R_M)$, represents systematic risk, while the second component, $var\ (e_i)$, reflects unsystematic risk. The sum of these two terms constitutes the total risk associated with the asset. So we have:

$$E(R_p) = (RF_d + RF_f) + \frac{E(R_{M_d} + R_{M_f}) - (RF_d + RF_f)}{\sqrt{b_i^2 var\ (R_M) + var\ (e_i)}}\ (1 - W_{RF})SD(R_X) \qquad (4)$$

$$Var\ (R_M) = Var\ \left(R_{M_d} + R_{M_f}\right) = Var\ \left(R_{M_d}\right) + Var\ \left(R_{M_f}\right) + 2\ Cov(R_{M_d} + R_{M_f}) \qquad (5)$$

Since markets are independent (in terms of financial laws in each country), we have:

$$SD(R_p) = \left(1 - W_{RF_d}\right)SD(R_X) + (1 - W_{RF_f})SD(R_X) \qquad (6)$$

$$\Rightarrow E(R_p) = (RF_d + RF_f) + \frac{E(R_{M_d} + R_{M_f}) - (RF_d + RF_f)}{SD\left(R_{M_d}\right) + SD(R_{M_f})}\ \left(1 - W_{RF_d}\right)SD(R_X) + (1 - W_{RF_f})SD(R_X) \qquad (7)$$

Therefore, the desirable function of investors will be as follows:

$$U_I = \begin{cases} (RF_d) + \frac{E(R_{M_d}) - RF_d}{SD(R_{M_d})}\left(1 - W_{RF_d}\right)SD(R_X) & Investment\ in\ the\ Country \\ (RF_f) + \frac{E(R_{M_f}) - RF_f}{SD(R_{M_f})}\left(1 - W_{RF_f}\right)SD(R_X) & Investing\ abroad \\ (RF_d + RF_f) + \frac{E(R_{M_d} + R_{M_f}) - (RF_d + RF_f)}{SD(R_{M_d}) + SD(R_{M_f})}\left(1 - W_{RF_d}\right)SD(R_X) + \left(1 - W_{RF_f}\right)SD(R_X) & Combined\ Investment \end{cases} \quad (8)$$

Given that both risk and return are fundamental parameters influencing the strategic behavior of investors and nations within the investment game, the theory can be revised in a more simplified yet conceptually robust manner. Specifically, Equation (9) can be interpreted as the probability or proportion of investment allocated abroad (or equivalently, the probability of not investing domestically). This expression can be substituted for the standard deviation (risk) component in Equation (1), thereby yielding a revised and more intuitive representation of investor behavior under uncertainty.

$$\frac{R_f Y}{R_f Y + R Y_f} \quad (9)$$

It should be noted that the above probability term is not a dimensional replacement of σ but a normalized behavioral proxy capturing relative perceived risk between domestic and foreign markets. This transformation preserves the monotonic relationship between expected return and risk while aligning with behavioral portfolio theory (Barberis, 2013, Shefrin, 2016). Therefore, the proposed substitution remains theoretically consistent as a bounded measure of risk-weighted investment probability.

This is because the primary portion of the Capital Market Line (excluding the segment associated with investment in risk-free assets offering a fixed return) typically yields low returns. Given that most investors seek higher-return assets, the risky component of Equation (8) can be revised accordingly. To model this behavior, Equation (9) is presented, where R_f represents the return in the foreign market, Y denotes the risk in the domestic market, R indicates the return in the domestic market, and Y_f corresponds to the risk in the foreign market. Since the second segment of the CML is derived based on investors' expectations, Equation (9) as a proposed substitute, retains this property and is constructed based on investor expectations regarding the relative risk and return of both domestic and foreign markets. It thus reflects the expected probability (or proportion) of investment in foreign markets, or equivalently, the probability of not investing domestically. As noted earlier, Equation (9) quantifies the likelihood or percentage of capital an investor allocates to foreign assets, simultaneously incorporating both markets. It effectively expresses the proportion of investment assigned to either the domestic or international market. The properties of this equation indicate that:

- If foreign market returns increase or domestic market risk rises, the proportion of foreign investment (or disinvestment from the domestic market) increases.

- Conversely, if domestic returns rise or foreign market risk increases, the proportion of foreign investment decreases.

Therefore, this equation can be used as a substitute for the risk component in Equation (8), allowing for a modified formulation of the Capital Market Line (CML). Accordingly, Equation (8) can be reformulated as follows, resulting in the revised Equation (10):

$$U_I = \begin{cases} (RF_d) + \frac{R\,Y_f}{R\,Y_f + R_f\,Y} & \text{Investment in the Country} \\ (RF_f) + \frac{R_f\,Y}{R_f\,Y + R\,Y_f} & \text{Investing abroad} \\ (RF_d) + \frac{R\,Y_f}{R\,Y_f + R_f\,Y} + (RF_f) + \frac{R_f\,Y}{R_f\,Y + R\,Y_f} & \text{Combined investment} \end{cases} \quad (10)$$

To derive the utility function of countries within the strategic interaction with investors, the primary factor considered is the country's level of economic development or strength, denoted by G. The variable G represents the economic capacity or power of a country and is defined on a scale between 0 and 1. A value of $G = 1$ indicates that the country is at the highest level of economic development, whereas lower values of G reflect weaker economic conditions. As G decreases, the country's concern with retaining capital domestically increases significantly. Moreover, a country's top priority is to ensure that investment remains within its domestic economy. However, if capital outflow is inevitable, countries prefer that such capital be directed toward foreign economies with lower levels of hostility or adversarial relations, that is, to countries with which they maintain more cooperative or neutral relations. In this context, geopolitical alignment and economic diplomacy become critical factors shaping the country's strategic preferences in the investment game.

Based on the considerations outlined above, the utility function of countries is defined as follows (Equation 11):

$$U_G = \frac{R\,Y_f}{R\,Y_f + R_f\,Y} G - \rho \frac{R_f\,Y}{R_f\,Y + R\,Y_f} G_f \quad , \quad 0 < G \leq 1 \quad \text{and} \quad 0 \leq \rho \leq 1 \quad (11)$$

In this utility function, U_G denotes the utility of the country; R represents the return in the domestic market, while R_f refers to the return in the foreign market. Similarly, Y and Y_f indicate the level of risk in the domestic and foreign markets, respectively. The parameters G and G_f reflect the economic strength or development level of the domestic and foreign countries, respectively.

The variable ρ represents the degree of hostility (or geopolitical tension) between the two countries and is defined over the interval [0,1]. If $\rho = 0$, the countries are considered friendly, and both markets are viewed as equally acceptable investment destinations. Conversely, if $\rho = 1$, the countries are in a state of full antagonism or strategic rivalry. As ρ approaches zero, bilateral relations are considered increasingly cooperative, while values of ρ approaching one indicate rising levels of hostility and conflict between the two nations.

The investor seeks to allocate capital in a way that maximizes return while minimizing risk. Accordingly, the demand function of the investor for foreign investment or equivalently, the probability of not investing in the domestic market is defined as follows:

$$P_f = \frac{R_f Y}{R_f Y + R Y_f} \quad , \quad P_d = 1 - P_f = \frac{R Y_f}{R_f Y + R Y_f} \tag{12}$$

The variables affecting the investor demand function and the intensity of each factor's impact are shown in the table below:

Table 1. Key Determinants and Their Effects on Investor Demand

Variable	Symbol	Partial Effect On P_f	Explanation	Approx. Sensitivity
Foreign return	R_f	$\uparrow \Rightarrow \uparrow P_f$	More attractive foreign return increases foreign allocation	High ($\uparrow$ > 20%)
Domestic return	R	$\uparrow \Rightarrow \downarrow P_f$	Strong local return deters capital outflow	High ($\downarrow$ ~20–25%)
Domestic risk	Y	$\uparrow \Rightarrow \uparrow P_f$	Higher local risk pushes investment abroad	Medium ($\uparrow$ 10–15%)
Foreign risk	Y_f	$\uparrow \Rightarrow \downarrow P_f$	Unsafe foreign markets reduce investor interest	Medium ($\downarrow$ 10%)

Source: *researcher's findings*

The results derived from the table above indicate that the investor's demand for foreign investment is directly proportional to foreign return and domestic risk, and inversely proportional to domestic return and foreign risk.

On the other hand, the host country prefers that capital remains within its domestic economy. The utility function of the country is defined as follows:

$$U_G = \frac{RY_f}{RY_f + R_f Y} G - \rho \frac{R_f Y}{R_f Y + R Y_f} G_f \tag{13}$$

The variables affecting the country's utility function and the intensity of each factor's impact are shown in the table below:

Table 2. Key Determinants and Their Effects on Country Utility

Variable	Symbol	Partial Effect On U_G	Explanation	Approx. Sensitivity
Domestic return	R	$\uparrow \Rightarrow \uparrow U_G$	Raises domestic attractiveness	High ($\uparrow$ > 20%)
Foreign return	R_f	$\uparrow \Rightarrow \downarrow U_G$	Increases outflow pressure	Medium ($\downarrow$ 10%)
Domestic risk	Y	$\uparrow \Rightarrow \downarrow U_G$	Reduces internal retention capacity	Medium ($\downarrow$ 15%)

Foreign risk	Y_f	$\uparrow \Rightarrow \uparrow U_G$	Encourages capital to stay local	Medium ($\uparrow$ 10%)
Country power	G	$\uparrow \Rightarrow \uparrow U_G$	Enhances weight of domestic flows	Very High ($\uparrow$ > 50%)
Foreign power	G_f	$\uparrow \Rightarrow \downarrow U_G$	Increases cost of losing capital	High ($\downarrow$ 25%)
Degree of hostility	ρ	$\uparrow \Rightarrow \downarrow U_G$	Penalizes foreign-directed capital	Very High ($\downarrow$ > 50%)

Source: *researcher's findings*

The findings presented in the table above suggest that a country's utility function is positively influenced by its domestic market returns, the degree of risk in foreign markets, and the country's overall economic capacity. Conversely, it is inversely related to the foreign market return, domestic market risk, the economic power of the foreign country, and the degree of hostility between the two nations. Moreover, the country's utility function exhibits the greatest sensitivity to the hostility index and the relative economic strength of both countries. Therefore, managing these strategic variables is of critical importance for the country. In contrast, the relative return profile remains the most influential factor guiding the investor's decision-making process.

On the other hand, the investor's demand function and the country's utility function are simultaneously and strategically influenced by four common key variables: domestic risk Y, foreign risk Y_f, domestic return R, and foreign return R_f. While the investor is primarily motivated by the pursuit of higher returns, the country is mainly concerned with capital outflows and the political relationship with the destination country of investment.

The investor allocates capital to the domestic market when the expected utility of investing domestically exceeds the utility of investing abroad, i.e., when ($U_I^{Domestic} > U_I^{Foreign}$). Accordingly, the investor's indifference condition the threshold point between the two investment decisions, can be expressed as follows:

$$(RF_d) + \frac{R\,Y_f}{R\,Y_f + R_f\,Y} = \left(RF_f\right) + \frac{R_f\,Y}{R_f\,Y + R\,Y_f} \tag{14}$$

If this equality holds, the investor may allocate capital across both markets in a mixed investment strategy. However, if one of the options yields a higher utility, the investor will direct the entire capital toward that more favorable market.

The host country, likewise, seeks to maximize its utility by reducing capital outflows and improving domestic returns. In this utility function, the only policy-controllable variable available to the country is the degree of hostility (ρ). By differentiating the utility function with respect to ρ, the country's optimal strategy can be assessed analytically.

$$\frac{\partial U_G}{\partial \rho} = -\left(\frac{R_f\,Y}{R_f\,Y + R\,Y_f}\right) G_f \tag{15}$$

Since the derivative is always negative, it follows that the country's optimal strategy is to minimize the hostility parameter, i.e., $\rho^* = 0$. In other words, the more cooperative and friendly the relationship between countries, the higher the utility for the host country. This is because the likelihood of capital flowing to rival or hostile nations diminishes, increasing the probability that investment will remain within the domestic economy.

4.1. Formal Game Structure and Equilibrium Derivation

The Nash equilibrium in this game is defined as follows:

$$\left(P_d^* = \frac{R\,Y_f}{R_f\,Y + R\,Y_f}\ ,\ \rho^* = 0\right) \tag{16}$$

Define the two players (Investor I and Country C), their strategy spaces $S_I = \{s_d, s_f\}$, $S_C = [0,1]$, and payoff functions U_I and U_C. Then show that the investor's best response yields $P_d^* = \frac{R\,Y_f}{R_f\,Y + R\,Y_f}$ and that $\frac{\partial U_C}{\partial \rho} < 0$ implies $\rho^* = 0$. Conclude that the unique Nash equilibrium is $(P_d^*, \rho^* = 0)$.

This implies that the country should reduce hostility to zero (i.e., establish full cooperation), while the investor allocates a portion of capital to the domestic market based on the relative risk–return profile of the two markets.

4.2. Modeling the Hostility Parameter (ρ) as a Function of Economic Variables

In this model, the degree of hostility is not an exogenous variable but an endogenous function of economic and political factors. The following relationship is defined for it:

$$\rho = 1 - \theta.\left(\frac{G}{G_f}.\frac{R\,Y_f}{R_f\,Y + R\,Y_f}\right) \quad , \quad 0 < \rho \leq 1 \tag{17}$$

This relationship is designed logically and behaviorally:

- If the domestic country's economic power (G) is sufficiently high and its market becomes more attractive, the degree of hostility decreases.
- Conversely, if the foreign country's economic power (G_f) is greater and its market is more appealing, the degree of hostility increases.

Table 3. Key Determinants of Hostility Degree ρ

Variable	Symbol	Partial Effect On U_G	Explanation	Approx. Sensitivity
Policy Sensitivity Factor	θ	$\uparrow \Rightarrow \downarrow \rho$	Increases institutional moderation	Parametric
Domestic Economic Power	G	$\uparrow \Rightarrow \downarrow \rho$	Improves bargaining position	High ($\downarrow$ 25%)
Foreign Economic Power	G_f	$\uparrow \Rightarrow \uparrow \rho$	Raises foreign economic asymmetry	High ($\uparrow$ 25%)
Domestic Return	R	$\uparrow \Rightarrow \downarrow \rho$	Enhances domestic market attractiveness	Medium ($\downarrow$ 15%)

Foreign Return	R_f	$\uparrow \Rightarrow \uparrow \ \rho$	Intensifies fear of capital outflow	Medium (↑ 15%)
Domestic Risk	Y	$\uparrow \Rightarrow \uparrow \ \rho$	Raises domestic market risk	High (↑ 25%)
Foreign Risk	Y_f	$\uparrow \Rightarrow \downarrow \ \rho$	Lowers foreign market risk	High (↓ 25%)

Source: *researcher's findings*

A higher ratio of $\frac{G}{G_f}$ – where G represents the economic strength of the domestic (host) country and G_f that of the foreign country– signifies a relatively stronger foreign economy and a weaker domestic market. In such cases, the host country, recognizing its weaker position, is more inclined to adopt a conciliatory stance and reduce the level of hostility in international interactions. Additionally, when domestic market returns increase or the foreign market exhibits elevated risk, the perceived threat of capital flight diminishes, thereby reducing the host country's strategic hostility. Within this framework, the parameter θ functions as an institutional or political coefficient that reflects the level of mutual trust, international policy alignment, or the credibility of bilateral commitments. The closer θ is to unity, the more responsive the level of hostility becomes to economic variables. In essence, a higher θ amplifies the moderating influence of economic fundamentals on strategic behavior, reinforcing the role of market-based incentives in reducing geopolitical tensions.

$$\frac{\partial \rho}{\partial G} = -\theta . \frac{1}{G_f} . \frac{R\,Y_f}{R_f\,Y + R\,Y_f} < 0 \tag{18}$$

The partial derivative of the hostility function with respect to domestic economic power (G) shows that an increase in G leads to a reduction in hostility. This inverse relationship stems from the fact that a stronger domestic economy has less need for hostile behavior to attract capital investment.

$$\frac{\partial \rho}{\partial G_f} = \theta . \frac{G}{G_f} . \frac{R\,Y_f}{R_f\,Y + R\,Y_f} > 0 \tag{19}$$

Conversely, the partial derivative of the hostility function with respect to the foreign country's economic power (G_f) demonstrates that as the rival country (the investment destination) grows stronger, the source country experiences heightened strategic anxiety, leading to an increase in hostility.

At this stage, we derive the partial derivatives of the hostility function with respect to four key variables: domestic market return (R), foreign market return (R_f), domestic market risk (Y), and foreign market risk (Y_f):

$$\frac{\partial \rho}{\partial R} = -\theta . \frac{G}{G_f} . \frac{Y_f R_f Y}{(R_f Y + R Y_f)^2} < 0$$

$$\frac{\partial \rho}{\partial R_f} = \theta . \frac{G}{G_f} . \frac{Y R Y_f}{(R_f Y + R Y_f)^2} > 0$$

$$\frac{\partial \rho}{\partial Y} = \theta . \frac{G}{G_f} . \frac{R_f R Y_f}{(R_f Y + R Y_f)^2} > 0$$

$$\frac{\partial \rho}{\partial Y_f} = -\theta . \frac{G}{G_f} . \frac{R R_f Y}{(R_f Y + R Y_f)^2} < \tag{20}$$

The above results demonstrate that:

1. Higher domestic returns reduce hostility as capital naturally flows to the domestic market ($\frac{\partial \rho}{\partial R} < 0$).
2. Higher foreign returns increase source-country anxiety, elevating hostility ($\frac{\partial \rho}{\partial R_f} > 0$).
3. Higher domestic risk increases hostility due to capital flight risk ($\frac{\partial \rho}{\partial Y} > 0$).
4. Higher foreign risk reduces hostility by deterring foreign investment ($\frac{\partial \rho}{\partial Y_f} < 0$).

Departing from the classical Capital Market Line (CML) framework that focuses exclusively on risk-return tradeoffs, our extended model incorporates three critical dimensions: (1) relative national economic power, (2) political risk factors (operationalized through the hostility parameter ρ), and (3) strategic interactions among sovereign actors (modeled using game-theoretic principles). The methodological innovation lies in replacing the traditional standard deviation (σ) measure of risk with a behavioral investment probability function. This enhanced framework more accurately captures real investor decision-making in high-risk international environments by endogenizing geopolitical considerations while preserving the CML's fundamental structure. The resulting model demonstrates more realistic predictive power in forecasting capital flows under conditions of strategic uncertainty.

The mathematical analysis and derivation of optimal responses reveal that a rational country will always prefer to maintain hostility at its minimum level (ρ=0) to maximize its utility, except when domestic economic variables become critically weak. Investors, meanwhile, allocate capital between domestic and foreign markets based on effective risk-adjusted returns (Variables R, R_f, Y, Y_f). A Nash equilibrium emerges when: (1) the country refrains from hostile policies, and (2) investors allocate partial capital to the source country - contingent upon maintaining sufficient relative advantage in the domestic market. This equilibrium point reflects the real-world balance between economic policymaking and investment behavior in competitive international markets, where ρ becomes endogenously determined through strategic interaction.

A concrete example of this is the growing cooperation between China and Taiwan, which is discussed by liberal scholars in the context of international economic cooperation. China and Taiwan have had political tensions and differences for more than 7 decades (since 1949), but the existence of common economic grounds has pushed the two countries towards greater convergence, so that China is now Taiwan's largest trading associate.

5. Conclusions and Policy Recommendations

The Capital Market Line (CML), a fundamental element of Modern Portfolio Theory, illustrates the optimal trade-off between risk and return for a fully diversified portfolio in a frictionless market. It is based on the assumption that investors can both borrow and lend at the risk-free rate and freely allocate investments in the global market portfolio, thereby achieving the highest possible returns for a specified level of risk. However, in today's globalized and geopolitically complex environment, these assumptions fall short. Capital mobility is often constrained by institutional, political, and regulatory frictions, while investment decisions are increasingly shaped by the strategic behavior of both private investors and sovereign nations. Foreign direct investment (FDI), for example, is not merely a function of return expectations but is also sensitive to factors such as country risk, economic power disparities, and international relations. As such, the classical CML fails to capture the nuances of real-world capital allocation across borders.

This paper proposes an extension of the CML framework by incorporating game-theoretic interactions between two key agents: the international investor and the host country government. By modeling their strategic decisions under conditions of asymmetric information, risk heterogeneity, and political hostility, the study seeks to provide a more realistic depiction of global investment behavior. In particular, we introduce a new variable—the degree of hostility (ρ)—which captures the geopolitical tension or cooperation between nations, significantly influencing investment flows. Moreover, the model accounts for differences in economic strength, institutional credibility, and expected market performance. Through this lens, the traditional one-dimensional CML is expanded into a multidimensional framework that reflects both economic fundamentals and strategic international dynamics. The proposed model not only improves theoretical accuracy but also offers practical insights for policymakers aiming to attract and retain foreign investment under uncertain geopolitical conditions.

The extended model demonstrates that an investor's capital allocation decision between domestic and foreign markets is a function of four key variables: domestic return (R), foreign return (R_f), domestic risk (Y), and foreign risk (Y_f). However, the core innovation of this study lies in introducing the strategic behavior of the host country through a utility function and incorporating the concept of "hostility level" (ρ) as a policy control variable. The Nash equilibrium analysis shows that as the hostility level increases, the attractiveness of the domestic market declines, prompting capital flight. Thus, investor utility is inversely affected by political tension and directly influenced by relative return-risk tradeoffs.

By differentiating the country's utility function with respect to ρ, the model demonstrates that the derivative is consistently negative, indicating that the optimal approach for any rational host country is to minimize hostility ($\rho^* = 0$). From an institutional economics perspective, this suggests that aggressive or

conflict-prone international policies, especially by economically weaker countries, significantly reduce their internal utility and investment attractiveness. Moreover, the model confirms that when the host country has lower economic power, it is more inclined to adopt cooperative foreign policy strategies, recognizing that hostility under asymmetric conditions is counterproductive.

According to results governments should focus on improving domestic return and reducing macroeconomic risk through stable fiscal, monetary, and institutional frameworks. Also international diplomacy and trust-building efforts are crucial, as the hostility parameter (ρ) plays a central role in shaping investor behavior. The equilibrium analysis shows that the investor's decision is highly sensitive to relative returns and external risk, while the host country's utility is most affected by the degree of hostility and its relative economic power. The results confirm that minimizing political antagonism and enhancing institutional cooperation significantly increases domestic utility and stabilizes capital inflows.

Author Contributions

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