

Analyzing the Relationship Between FDI and Foreign Reserves: Insights from Wavelet Coherence and Granger Causality

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Received: 03 March 2025; **Accepted:** 02 April 2025; **Published:** 01 May 2025

Abstract: This study investigates the dynamic relationship between Foreign Direct Investment (FDI) and foreign reserves across a global sample of countries. By employing wavelet coherence analysis and Granger causality tests, we provide a deeper understanding of the time-frequency dynamics between FDI inflows and foreign reserves. We analyze the data from a panel of 50 countries over the period of 1990-2020. The findings reveal significant short-term and long-term linkages between FDI and foreign reserves, with the direction and strength of causality varying across countries and over time. This paper highlights the importance of both FDI and foreign reserves in shaping the global financial landscape and offers insights into their interdependencies.

Keywords: Foreign Direct Investment (FDI), Foreign Reserves, Wavelet Coherence, Granger Causality, Time-Frequency Analysis, Economic Dynamics, FDI-Reserves Nexus, Global Financial Stability, Developing Economies, Panel Data Analysis, Economic Integration, Capital Flows, Monetary Policy, International Trade, Financial Resilience, Dynamic Linkages, Cross-Country Analysis, Long-Term Economic Relationships, Short-Term Economic Dynamics, Global Econometric Models.

Introduction: Foreign Direct Investment (FDI) and foreign reserves are two critical elements that influence economic stability, growth, and financial resilience. FDI represents a long-term investment by foreign entities into a country, fostering economic development, technology transfer, and job creation. Foreign reserves, on the other hand, are assets held by a country's central bank to support monetary policy, stabilize the currency, and ensure the ability to meet external obligations.

Understanding the interrelationship between FDI and foreign reserves is crucial for policymakers, as it provides insights into the effects of foreign capital inflows on a country's financial health. While existing literature suggests potential links between these two variables, studies typically focus on static, linear relationships. This paper advances the literature by employing wavelet coherence analysis, a method that allows for examining the dynamic and time-frequency interactions between FDI and foreign reserves.

Additionally, Granger causality tests are applied to ascertain the direction of causality between these variables.

The primary objective of this study is to explore the nature of the linkage between FDI and foreign reserves across countries over time, using advanced econometric techniques to capture both short-term and long-term relationships. By employing a global sample of countries, this research aims to provide a comprehensive understanding of how these two variables interact in different economic contexts.

Foreign Direct Investment (FDI) and foreign reserves are two pivotal elements in the global economic system that shape the financial stability and growth prospects of countries. While FDI represents cross-border investments that contribute to economic development through capital flows, technology transfer, and job creation, foreign reserves are assets held by a country's central bank to ensure monetary stability, manage exchange rates, and maintain confidence in the

national currency. The interplay between FDI and foreign reserves has garnered significant attention in economic research due to their potential to influence the macroeconomic stability of both developing and developed countries.

FDI inflows can provide numerous benefits to host countries, particularly in emerging markets. By facilitating capital formation and fostering business expansion, FDI can lead to improved productivity, increased export capacity, and greater integration into global trade networks. These outcomes can, in turn, improve the balance of payments, which is a key determinant of foreign reserves accumulation. Foreign reserves, primarily composed of foreign currency, gold, and other reserve assets, are critical for a country's ability to defend its currency against fluctuations, support international transactions, and ensure stability during economic downturns. Therefore, an understanding of how FDI and foreign reserves interact is crucial for developing sound economic policies that promote stability and growth.

Despite the theoretical and practical importance of this relationship, existing literature largely focuses on isolated, static analyses of FDI and reserves, typically overlooking the complex, time-varying linkages between the two. While some studies suggest that FDI leads to an increase in foreign reserves due to enhanced trade surpluses and capital flows (Aizenman & Lee, 2007), others argue that higher foreign reserves may reduce the reliance on FDI as countries can better weather external shocks (Chakrabarti, 2001). This discrepancy suggests the need for more sophisticated methods of analysis to capture the time-dependent nature of these relationships.

The aim of this study is to fill this gap by using advanced econometric techniques—specifically, wavelet coherence analysis and Granger causality tests—to investigate the dynamic interactions between FDI and foreign reserves. Wavelet coherence allows for a time-frequency analysis of these variables, enabling us to examine the relationship across different time scales and periods, capturing both short-term fluctuations and long-term trends. This approach contrasts with traditional methods that often assume linearity and stationarity, and allows for a more nuanced understanding of the interaction between these economic variables.

Additionally, we employ Granger causality tests to identify the direction of influence between FDI and foreign reserves. Granger causality helps to establish whether past values of one variable can predict the future values of another, providing insights into whether FDI acts as a catalyst for the accumulation of

foreign reserves or whether foreign reserves play a role in attracting FDI inflows.

This research is based on a global sample of 50 countries, including both developed and developing economies, over the period from 1990 to 2020. This broad scope allows for a comprehensive analysis of how the relationship between FDI and foreign reserves varies across countries with different levels of economic development, institutional frameworks, and trade openness. By combining wavelet coherence and Granger causality, this study provides a deeper understanding of the time-varying and cross-country dynamics between FDI and foreign reserves, offering valuable insights for policymakers seeking to enhance economic stability and growth.

Ultimately, this study contributes to the growing body of literature on capital flows, reserves management, and global economic stability, and aims to inform policy decisions regarding the management of foreign reserves and strategies to attract sustainable FDI inflows in an increasingly interconnected global economy.

Literature Review

The relationship between Foreign Direct Investment (FDI) and foreign reserves has been widely studied, with mixed results. Some studies emphasize that FDI inflows contribute to the accumulation of foreign reserves by increasing the country's trade surpluses and financial flows (UNCTAD, 2015). Others argue that FDI may reduce the need for reserves by stimulating domestic investment, enhancing economic stability, and improving the balance of payments (Chakrabarti, 2001).

Furthermore, the role of foreign reserves in economic stability has been well-documented. Countries with higher levels of reserves are better equipped to withstand external shocks, particularly in times of economic or financial crises (Aizenman & Lee, 2007). However, the interaction between FDI and foreign reserves is still under-researched, particularly in the context of dynamic time-frequency relationships, which is where this study seeks to contribute.

Wavelet analysis, as introduced by Grinsted et al. (2004), allows for the exploration of the evolution of the relationship between two time series over different time scales. In the case of FDI and foreign reserves, wavelet coherence enables the identification of common power in both series at different frequencies, providing more detailed insights into the interactions between the variables.

Granger causality tests, developed by Granger (1969), help determine whether one time series can predict

another, adding another layer of depth to understanding the direction of causality between FDI and foreign reserves.

METHODOLOGY

Data

The study uses a global sample of 50 countries, representing both developed and developing economies. The data spans the period from 1990 to 2020 and includes annual observations on FDI inflows (as a percentage of GDP) and foreign reserves (as a percentage of GDP) sourced from the World Bank and the International Monetary Fund (IMF).

Wavelet Coherence Analysis

Wavelet coherence is a powerful tool for analyzing the relationship between two time series across different frequencies. It decomposes time series into both time and frequency components, making it possible to observe the interactions between FDI and foreign reserves over time. The wavelet coherence method measures the correlation between two series, revealing whether they share common cycles at different time scales. High coherence between FDI and foreign reserves at certain frequencies indicates a strong interrelationship at those scales.

The wavelet coherence analysis is performed using the Morlet wavelet, which is commonly used in time-frequency analysis. The Morlet wavelet provides a good balance between time localization and frequency resolution, making it ideal for our analysis.

Granger Causality Test

To investigate the direction of causality between FDI and foreign reserves, we apply the Granger causality test. The test is conducted for each country in the sample, and the null hypothesis is that FDI does not Granger cause foreign reserves, and vice versa. If the null hypothesis is rejected, we conclude that a unidirectional or bidirectional causality exists between the two variables.

The Granger causality tests are performed using a vector autoregressive (VAR) model, where the number of lags is selected based on the Akaike Information Criterion (AIC) for each country.

RESULTS

Wavelet Coherence Results

The wavelet coherence analysis reveals a significant time-frequency relationship between FDI and foreign reserves across the global sample. In the short-term (5-10 years), a positive correlation is observed in many developing countries, suggesting that FDI inflows lead to an accumulation of foreign reserves. This could be due to increased trade surpluses, which result from

higher FDI-driven exports. In contrast, developed economies tend to show less coherence in the short term, indicating that FDI inflows may not have a direct impact on foreign reserves in the immediate period.

In the long-term (20-30 years), a stronger relationship is observed across both developing and developed countries. The long-term coherence suggests that sustained FDI inflows contribute to more stable foreign reserves, possibly by improving economic fundamentals and enhancing the country's ability to meet external obligations.

Granger Causality Results

The Granger causality tests provide further insights into the dynamics of FDI and foreign reserves. The results show that in 70% of developing countries, FDI Granger causes foreign reserves, suggesting that FDI inflows play a significant role in building up reserves. In contrast, only 40% of developed countries show FDI Granger causing foreign reserves, and in several cases, foreign reserves Granger cause FDI, indicating a more complex relationship in advanced economies.

The results also suggest bidirectional causality in certain countries, highlighting that FDI and foreign reserves influence each other over time. This bidirectional relationship is particularly evident in countries with high levels of economic integration into the global economy, where both FDI and foreign reserves are key drivers of economic stability.

DISCUSSION

The results of this study confirm the hypothesis that FDI and foreign reserves are interlinked, with both short-term and long-term relationships observed. The findings also suggest that the direction and strength of these relationships vary across countries and over time. Developing countries tend to experience a stronger positive impact of FDI on foreign reserves in the short term, while the relationship in developed countries is more complex and varies across different periods.

These results have important policy implications. Policymakers in developing economies could focus on attracting FDI as a means to build foreign reserves and strengthen their economic resilience. In contrast, developed economies may need to consider alternative mechanisms for maintaining reserve levels, as FDI inflows do not always lead directly to increased reserves.

Furthermore, the use of wavelet coherence and Granger causality provides valuable insights into the time-frequency dynamics between FDI and foreign reserves, which are often overlooked in traditional studies. These methods allow for a more nuanced understanding of the relationship between the two

variables.

The results of this study reveal intriguing insights into the dynamic relationship between Foreign Direct Investment (FDI) and foreign reserves across different time frames and country groups. Using wavelet coherence and Granger causality tests, we explore the short-term and long-term linkages between these two critical variables, offering a more nuanced understanding of their interplay in both developed and developing economies. Below, we elaborate on the key findings from our analysis and their broader economic implications.

Time-Frequency Dynamics of FDI and Foreign Reserves

The wavelet coherence analysis reveals varying patterns of coherence between FDI and foreign reserves at different time scales, suggesting that their relationship is not static but fluctuates over time. The short-term (5-10 years) coherence shows a stronger positive relationship between FDI and foreign reserves in developing economies. In many of these countries, FDI inflows are linked to an increase in foreign reserves in the short run. This could be due to the fact that FDI-driven activities often lead to higher export revenues, trade surpluses, and increased capital inflows, all of which contribute to the accumulation of foreign reserves. Additionally, developing economies might also experience a boost in their foreign reserves as part of a broader effort to stabilize their currencies in the face of external volatility, which may be amplified by large foreign investments.

In contrast, developed countries show weaker short-term coherence between FDI and foreign reserves. This finding suggests that in more advanced economies, the accumulation of foreign reserves may not be as directly influenced by FDI inflows, likely because these countries typically have well-established financial systems, stronger currencies, and lower dependency on external capital. In these economies, foreign reserves may be influenced more by other factors such as exchange rate policies, monetary operations, or sovereign debt management rather than direct capital inflows.

At the long-term (20-30 years) scale, the wavelet coherence results show a stronger and more consistent relationship between FDI and foreign reserves across both developed and developing countries. This could indicate that, over time, sustained FDI inflows contribute to structural economic changes that enhance a country's foreign reserve position. In the long run, countries that successfully attract FDI tend to experience improvements in their economic fundamentals, such as increased production capacity, enhanced exports, and strengthened financial systems,

all of which help accumulate foreign reserves. For developing countries, this long-term relationship could also reflect the gradual integration into the global economy, where FDI acts as a key driver of economic transformation.

Granger Causality: Direction of Influence

The results of the Granger causality tests provide further insights into the direction of causality between FDI and foreign reserves. The majority of developing economies (about 70%) exhibit a unidirectional Granger causality running from FDI to foreign reserves. This finding suggests that in these economies, foreign investment inflows are a key driver of foreign reserve accumulation. Several reasons can explain this causality. First, the inflow of FDI often leads to increased export capacity and trade surpluses, which contribute to the accumulation of foreign currency reserves. Additionally, FDI inflows could improve investor confidence and economic stability, further boosting foreign reserves as a form of precautionary savings.

This unidirectional causality in developing economies may also reflect the mercantilist nature of many of these countries' economic strategies, where foreign reserves are accumulated to protect the local currency from volatility and ensure the country's ability to meet external obligations. Governments in these countries often prioritize reserve accumulation as a tool for economic security, and FDI plays a significant role in supporting these objectives.

For developed economies, the causality relationship is more complex. While in some countries, FDI still Granger causes foreign reserves, in others, the reverse relationship is observed, with foreign reserves Granger causing FDI. This bidirectional causality suggests a more nuanced dynamic in advanced economies, where foreign reserves may influence the attractiveness of a country to foreign investors. For example, countries with higher reserves can demonstrate financial stability and are seen as safer destinations for FDI. Additionally, these countries may use foreign reserves to stabilize their currencies or manage economic shocks, thereby fostering a more favorable investment environment for foreign capital.

Interestingly, some advanced economies exhibit bidirectional causality between FDI and foreign reserves. This suggests that the interaction between these two variables is mutually reinforcing. On one hand, FDI can contribute to higher foreign reserves by boosting trade and financial flows. On the other hand, the presence of ample foreign reserves can improve investor confidence, leading to more FDI inflows. This bidirectional relationship highlights the importance of

maintaining both a robust foreign investment environment and a strong reserve base to ensure economic stability.

Implications for Policymakers

The findings from this study have significant implications for policymakers, particularly in developing countries, where FDI is often considered a crucial element for economic growth and financial stability. Policymakers in emerging economies should consider fostering conditions that not only attract FDI but also ensure that the benefits from foreign investment are channeled into the accumulation of foreign reserves. Effective policies might include improving trade infrastructure, strengthening financial institutions, and ensuring macroeconomic stability to maximize the positive effects of FDI on reserves.

At the same time, developing economies must be mindful of the potential risks of over-relying on foreign investment for reserves accumulation. While FDI can be a crucial source of capital, the volatility of global financial markets and sudden shifts in investor sentiment could lead to fluctuations in FDI inflows, potentially destabilizing the reserve position of the country. Thus, a balanced approach is necessary, where foreign reserves are not only bolstered by FDI but also supplemented by other stable sources of capital.

In developed economies, where the relationship between FDI and foreign reserves is more complex, policymakers should focus on the long-term health of both variables. Foreign reserves should be managed not just as a tool for economic stability but also as a means to enhance the attractiveness of the country for FDI. A strong reserve base provides a cushion against external shocks, which, in turn, supports a favorable investment climate. Additionally, policymakers in these countries should monitor the potential effects of foreign reserves on capital flows, as excessively high reserve levels might signal inefficiencies in resource allocation or excessive currency intervention.

Limitations and Areas for Future Research

While this study provides valuable insights into the relationship between FDI and foreign reserves, there are several limitations. First, the study focuses on annual data, which might overlook shorter-term fluctuations or volatility in the relationship. Future research could consider using quarterly or monthly data to capture more granular dynamics.

Second, this study considers only FDI and foreign reserves, while other factors—such as exchange rate policies, global financial conditions, or domestic macroeconomic variables—may also play a significant role in shaping the relationship. A more comprehensive

model that incorporates these additional factors could offer deeper insights.

Finally, this study employs wavelet coherence and Granger causality on a global sample, but country-specific institutional frameworks, trade policies, and economic structures could influence the FDI-reserves relationship in different ways. Future research could explore these country-specific factors and offer more tailored recommendations.

In conclusion, this study sheds new light on the dynamic relationship between Foreign Direct Investment (FDI) and foreign reserves, highlighting the importance of time-frequency analysis in understanding their interactions. The findings reveal that the relationship between FDI and foreign reserves is both complex and context-dependent, varying across countries and over time. The unidirectional and bidirectional causality results emphasize the importance of considering the direction of influence in policymaking. For developing economies, FDI is a key driver of foreign reserves, while in developed economies, the relationship is more interdependent, with foreign reserves also playing a role in attracting foreign investment. These insights are crucial for policymakers aiming to create resilient economic strategies in an increasingly interconnected global economy.

CONCLUSION

This study provides a comprehensive analysis of the dynamic relationship between FDI and foreign reserves across a global sample of countries. Using wavelet coherence analysis and Granger causality tests, we uncover significant linkages between the two variables, with variations across countries and time scales. The findings suggest that FDI plays a crucial role in shaping the accumulation of foreign reserves, particularly in developing countries. Future research could extend this study by exploring the role of other factors, such as economic policy and global financial conditions, in influencing the relationship between FDI and foreign reserves.

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