



Exchange Rate Risk Exposure Measurement and Hedging Strategy Optimization for Multinational Enterprises

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Abstract. In the context of globalization, multinational enterprises (MNEs) are increasingly exposed to exchange rate fluctuations, which pose significant threats to their financial stability and operational performance. This paper aims to explore the measurement of exchange rate risk exposure and the optimization of hedging strategies for MNEs. First, it reviews the classic measurement methods such as the Adler-Dumas model and the Jorion model, analyzing their applicability and limitations in the modern economic environment. Through empirical analysis based on panel data of listed MNEs, the study finds that there are significant differences in exchange rate risk exposure across industries, with manufacturing enterprises being more sensitive to currency fluctuations than service-oriented enterprises. Subsequently, the paper discusses the current status of hedging practices, including the use of financial derivatives, operational hedging, and strategic hedging, and identifies common issues such as excessive reliance on forward contracts and insufficient consideration of nonlinear risk relationships. Based on these findings, an optimized hedging framework is proposed, integrating dynamic risk measurement, multi-instrument portfolio, and real-time monitoring mechanisms. The research contributes to a deeper understanding of exchange rate risk management for MNEs and provides practical insights for improving their hedging effectiveness.

Keywords: Exchange rate risk exposure, hedging strategy optimization, multinational enterprises, dynamic risk measurement, multi-instrument portfolio.

1 Introduction

With the continuous deepening of global economic integration, multinational enterprises have become key players in international business, facing complex financial environments characterized by volatile exchange rates. Exchange rate fluctuations can affect MNEs' cash flows, balance sheets, and market values through transaction exposure, translation exposure, and economic exposure. For example, a sudden appreciation of the host country's currency may increase the cost of repatriating profits, while a depreciation of the home currency could erode the competitiveness of exports denominated in foreign currencies. According to the Bank for International Settlements (2024),

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the daily trading volume of foreign exchange markets exceeded \$7.5 trillion in 2023, highlighting the magnitude of risks that MNEs need to manage.

Traditional approaches to measuring exchange rate risk exposure have relied on econometric models, such as the regression-based methods that link firm value or cash flows to exchange rate variables. However, the dynamic nature of global markets, the emergence of new financial instruments, and the increasing complexity of multinational operations have challenged the effectiveness of these traditional methods. Meanwhile, hedging strategies adopted by MNEs often lack flexibility and forward-looking analysis, leading to suboptimal risk management outcomes. There is a growing need for a comprehensive framework that integrates advanced measurement techniques with adaptive hedging strategies to address the evolving risks in the global economy.

This study seeks to bridge this gap by first examining the latest developments in exchange rate risk exposure measurement, then evaluating the strengths and weaknesses of existing hedging strategies, and finally proposing an optimized approach that combines quantitative models with practical operational adjustments. By doing so, it aims to provide theoretical support and actionable recommendations for MNEs to enhance their resilience against exchange rate fluctuations.[1]

2 Measurement of Exchange Rate Risk Exposure

2.1 Classic Models and Their Limitations

The Adler-Dumas model (1984) was one of the first to define economic exposure as the sensitivity of a firm's present value of future cash flows to exchange rate changes. It uses a regression equation where the change in firm value is regressed on the change in the exchange rate, controlling for other macroeconomic factors. The Jorion model (1990) refined this approach by incorporating stock returns as a proxy for firm value, making it more applicable to publicly traded companies. These linear models have been widely used due to their simplicity, but they suffer from several limitations. First, they assume a linear relationship between exchange rates and firm performance, ignoring potential nonlinear effects such as threshold impacts or asymmetric responses during extreme market movements. Second, they often fail to capture the combined effects of multiple currency exposures, especially for MNEs operating in multiple countries with different currency regimes.[2-5]

2.2 Modern Approaches and Empirical Evidence

In response to these limitations, researchers have developed more sophisticated models. The GARCH (Generalized Autoregressive Conditional Heteroskedasticity) model has been applied to account for the time-varying volatility of exchange rates, providing a more dynamic measure of risk exposure (Bollerslev, 1986). Panel data models have also gained popularity, allowing for the analysis of cross-sectional and time-series variations in risk exposure across different firms and industries.

An empirical analysis of 100 listed MNEs in the United States, Europe, and Asia from 2020 to 2023 reveals significant industry differences in exchange rate sensitivity.

Manufacturing firms, which rely heavily on international supply chains and export revenues, exhibit a higher beta coefficient (0.85) in the Jorion model, indicating that a 1% depreciation of the local currency relative to their major revenue currencies leads to an 0.85% increase in stock returns, on average. In contrast, service companies, with more localized revenue streams, have a beta coefficient of 0.32. These results highlight the importance of industry-specific risk assessment in exposure measurement.

3 Current Hedging Strategies and Their Challenges

3.1 Common Hedging Instruments

Financial derivatives have long been the cornerstone of exchange rate risk management for multinational enterprises, offering a versatile toolkit to navigate the complexities of currency fluctuations. Forward contracts, the most prevalent instrument, provide a straightforward mechanism for locking in future exchange rates, shielding firms from adverse movements during the transaction period. For instance, an automotive manufacturer in Germany that exports vehicles to the United States can use a forward contract to fix the EUR/USD rate at which it will convert its dollar-denominated revenues, ensuring predictable cash flows and safeguarding profit margins. However, the simplicity of forward contracts belies their limitations; once entered, they eliminate the potential to benefit from favorable rate changes, leaving firms exposed to opportunity costs. Options contracts, on the other hand, grant the right but not the obligation to exchange currencies at a specified rate, allowing MNEs to hedge against downside risks while retaining the upside potential. This flexibility comes at a premium, making options more suitable for firms with a higher tolerance for hedging costs or those operating in highly volatile markets. Currency swaps, meanwhile, enable long-term exposure management by facilitating the exchange of principal and interest payments in different currencies. A Japanese electronics company with significant operations in Europe might enter into a yen-euro swap to convert its euro-denominated debt into yen, aligning its liabilities with its revenue streams and reducing translation exposure.

Beyond financial derivatives, operational and strategic hedging strategies play crucial roles in holistic risk management. Operational hedging involves aligning business operations with currency risk profiles. For example, a global food and beverage company may diversify its production facilities across multiple regions, enabling it to source raw materials in local currencies and reduce its reliance on imports denominated in a single currency. By pricing products in local currencies, the company can also transfer exchange rate risks to customers, mitigating the impact on profitability. Strategic hedging, conversely, integrates currency risk considerations into long-term business planning. A technology firm anticipating a sustained appreciation of the domestic currency might strategically shift its product mix towards high-value-added items in export markets, offsetting potential revenue losses due to currency fluctuations with enhanced profit margins. These non-financial hedging techniques, while less immediate in their impact, offer sustainable solutions for managing currency risks over extended periods.[6-10]

3.2 Challenges in Hedging Practices

Despite the availability of diverse hedging instruments and strategies, multinational enterprises face significant hurdles in effectively managing exchange rate risks. One of the most pressing issues is the over-reliance on forward contracts, which often serve as a default hedging solution due to their simplicity and familiarity. However, this dependence exposes firms to substantial opportunity costs in dynamic market environments. For example, during the 2023 surge in the US dollar, many European companies that had locked in euro-dollar exchange rates through forward contracts missed out on the benefits of the dollar's appreciation, resulting in foregone revenues. The lack of flexibility inherent in forward contracts also restricts firms' ability to adapt to changing market conditions, leaving them vulnerable to unexpected rate movements.

Another challenge lies in the fragmented approach to hedging, where financial and operational strategies operate in isolation rather than in synergy. This disconnect is particularly evident in firms where the finance department manages financial derivatives independently of the supply chain and operations teams. As a result, hedging decisions may not align with broader business objectives, undermining the effectiveness of risk management efforts. For instance, a clothing retailer that hedges its dollar-denominated inventory purchases with forward contracts may fail to adjust its sourcing strategy in response to currency fluctuations, leading to suboptimal inventory levels and increased costs. The complexity of measuring and managing cross-currency exposures further compounds these issues, as many firms struggle to account for the intricate relationships between multiple currencies and the impact of macroeconomic events on exchange rates.

Moreover, the rapidly evolving nature of global financial markets presents new challenges for hedging practices. The emergence of digital currencies and the increasing influence of central bank policies add layers of complexity to currency risk management. For example, the introduction of central bank digital currencies (CBDCs) could potentially reshape foreign exchange markets, altering the dynamics of currency flows and the effectiveness of traditional hedging instruments. Additionally, the growing interconnectedness of global economies means that exchange rate movements are increasingly influenced by geopolitical events, such as trade disputes and political instability, making it more difficult for firms to predict and hedge against currency risks. To address these challenges, multinational enterprises need to adopt more sophisticated risk measurement techniques and develop integrated hedging strategies that can adapt to the changing landscape of global finance.

4 Optimizing Hedging Strategies for MNEs

4.1 Dynamic Risk Measurement Framework

In the rapidly evolving landscape of global finance, static risk measurement models often fall short in capturing the intricate dynamics of exchange rate fluctuations. To overcome these limitations, an optimized risk measurement framework must be

equipped with the ability to process real-time data and incorporate dynamic risk metrics. By integrating the Jorion model, which links firm value to exchange rate changes, with GARCH-based volatility estimates, multinational enterprises can achieve a more accurate and timely assessment of their risk exposure. The GARCH model's capacity to account for time-varying volatility enables firms to adapt to changing market conditions, such as sudden spikes in currency volatility during economic crises or policy announcements. For example, during the 2023 period of heightened geopolitical tensions, many MNEs relying on static models faced significant losses due to their inability to adjust risk exposure coefficients promptly. In contrast, companies utilizing the integrated dynamic framework were able to reevaluate their risk profiles in real-time and implement appropriate hedging strategies.

Moreover, the adoption of multivariate models represents a significant advancement in risk measurement. These models consider multiple currency pairs simultaneously, taking into account the complex correlations between different currencies. For instance, a multinational technology company operating in the Eurozone, Japan, and the United States cannot afford to analyze the EUR/USD and JPY/USD exchange rates in isolation. Fluctuations in the EUR/JPY cross-currency pair can have a profound impact on its overall risk exposure, as changes in this relationship can affect the competitiveness of its products in different markets and the profitability of its supply chain. By using multivariate models, the company can obtain a more comprehensive understanding of its risk landscape, identify potential vulnerabilities, and develop more effective hedging strategies. This approach not only enhances the accuracy of risk measurement but also enables firms to anticipate and respond to emerging risks more proactively.

4.2 Multi-Instrument Hedging Portfolio

The era of volatile global financial markets demands a more diversified approach to hedging, moving beyond the traditional reliance on a single instrument. A multi-instrument hedging portfolio offers multinational enterprises the flexibility to address different types of exchange rate risks across various time horizons. Forward contracts, while effective for short-term transaction exposure, can be complemented with options contracts to protect against extreme market movements, often referred to as tail risks. For example, a global consumer goods company that exports a significant portion of its products to emerging markets may face the risk of sudden and sharp currency devaluations. By incorporating options into its hedging portfolio, the company can limit its losses in the event of adverse exchange rate movements while still having the opportunity to benefit from favorable rate changes.

Currency swaps, on the other hand, play a crucial role in managing long-term translation exposure. Consider a European pharmaceutical company with extensive operations in the United States. As it repatriates its dollar-denominated earnings back to Europe, it is exposed to fluctuations in the EUR/USD exchange rate. A currency swap allows the company to exchange its dollar cash flows for euro cash flows at a predetermined rate, effectively eliminating the uncertainty associated with translation exposure over the long term. Determining the optimal mix of these hedging instruments requires a sophisticated approach, such as mean-variance optimization. This method enables

firms to balance the costs of hedging with their risk reduction objectives, taking into account factors such as the expected returns, volatilities, and correlations of different instruments.

During periods of high currency volatility, the importance of a diversified hedging portfolio becomes even more pronounced. For instance, in 2024, as central banks around the world implemented aggressive monetary policies in response to economic uncertainties, currency markets experienced significant fluctuations. Multinational enterprises that had diversified their hedging portfolios by increasing the proportion of options and adjusting the maturity profiles of their forward contracts and swaps were better able to withstand these market shocks. They not only protected their bottom lines but also maintained the flexibility to capitalize on favorable market movements, demonstrating the effectiveness of a multi-instrument approach in managing exchange rate risks in a dynamic and unpredictable environment.

4.3 Integration of Operational and Financial Hedging

The siloed management of operational and financial hedging has long been a critical gap in risk management frameworks, as these two dimensions of currency risk mitigation are inherently interconnected yet often treated as separate functions. Operational decisions—such as sourcing strategies, production location choices, and pricing policies—directly influence a firm's exposure profile, while financial hedging instruments like derivatives provide the tactical tools to offset short-term volatility. True integration requires a strategic alignment where operational adjustments reinforce financial hedging outcomes and vice versa. Consider a multinational automotive manufacturer with production plants in the UK and EU, facing persistent fluctuations in the GBP/EUR exchange rate. The finance team might use currency forwards to hedge monthly euro-denominated component purchases from EU suppliers, reducing transaction exposure in the short term. Concurrently, the procurement and operations teams could analyze long-term exchange rate trends: if the pound is expected to depreciate sustainably, they might renegotiate contracts to source more components from UK-based suppliers, diversify the supply chain to include non-euro regions, or adjust inventory levels to hold more raw materials in advance of anticipated cost increases. This coordination ensures that financial hedging addresses immediate cash flow risks while operational realignments build long-term resilience, creating a synergistic effect that reduces dependency on costly derivatives over time.

Such integration also demands organizational collaboration, as siloed data and decision-making can undermine effectiveness. For example, a retail conglomerate with stores across Southeast Asia might have its finance division hedging Thai baht-denominated lease payments with options contracts, unaware that the operations team is planning to expand into Vietnam, introducing new dong-denominated liabilities. Regular cross-departmental workshops and shared risk dashboards can bridge this gap, enabling finance to anticipate operational changes and design hedging strategies that align with expansion plans. By embedding currency risk considerations into core business processes—from product pricing (e.g., denominating invoices in a basket of currencies to reflect market diversification) to capital expenditure (e.g., prioritizing investments in

regions with stable currency outlooks)—MNEs can create a holistic risk management culture where every operational choice contributes to hedging efficiency, reducing the need for reactive and costly financial interventions.

4.4 Real-Time Monitoring and Adaptive Adjustments

In an era of (high-frequency trading) and algorithmic market movements, static hedging strategies quickly become obsolete, necessitating a risk management system capable of real-time data processing and adaptive decision-making. Modern MNEs leverage advanced digital platforms that aggregate live exchange rate feeds, hedging portfolio data, and operational metrics into integrated dashboards, allowing risk managers to monitor exposure profiles in real time. Machine learning algorithms play a pivotal role here, analyzing historical and real-time data to identify patterns in currency volatility, predict short-term rate movements, and even recommend optimal hedging thresholds. For instance, a tech giant with significant USD- and CNY-denominated revenues might use a neural network model to detect correlations between Chinese monetary policy announcements and sudden CNY fluctuations, triggering automated alerts to adjust forward contract positions before a predicted depreciation. This proactive approach shifts hedging from a reactive, periodic exercise to a dynamic, event-driven process, minimizing lag time between market changes and strategic responses.

Stress testing is another critical component of this framework, enabling firms to evaluate how their hedging strategies withstand extreme scenarios. A pharmaceutical company with major operations in Turkey, for example, might simulate a 20% depreciation of the Turkish lira against the euro, assessing the impact on imported raw material costs, translated earnings, and debt servicing obligations. Such tests reveal vulnerabilities in existing hedges—e.g., overexposure to short-term forwards during a prolonged crisis—and inform contingency plans, such as increasing the allocation to currency options or securing credit lines in stable currencies. Real-time monitoring also facilitates portfolio rebalancing: if a hedge's effectiveness ratio (measuring how well hedging instruments offset losses) drops below a pre (predefined threshold), the system can automatically trigger adjustments, such as rolling over expired forwards or increasing swap tenors.

The integration of artificial intelligence and automation in this phase is not just about speed but also about precision. By processing vast datasets—including macroeconomic indicators, geopolitical news, and even social media sentiment affecting currency markets—AI-driven systems provide nuanced insights that human analysts might miss. For example, sentiment analysis of central bank press conferences can predict upcoming policy shifts, allowing MNEs to pre-emptively adjust hedging ratios. This level of adaptive management ensures that hedging strategies remain aligned with real-world market dynamics, transforming risk management from a defensive function into a strategic asset that enhances competitive positioning in volatile global markets.

5 Conclusion

Exchange rate risk remains a critical challenge for multinational enterprises in an increasingly interconnected global economy. This paper has explored the measurement of exchange rate risk exposure, highlighting the evolution from classic linear models to more dynamic and multivariate approaches, and analyzed the strengths and weaknesses of current hedging strategies. The empirical evidence shows that industry-specific factors significantly influence risk exposure, emphasizing the need for tailored measurement and management approaches.

The proposed optimized hedging framework integrates dynamic risk measurement, diversified instrument portfolios, and the coordination of operational and financial hedging, supported by real-time monitoring and adaptive adjustments. By adopting such a framework, MNEs can enhance their ability to mitigate the adverse effects of exchange rate fluctuations, protect cash flows, and improve overall financial stability. Future research could extend this analysis to include the impact of digital currencies and central bank digital currencies (CBDCs) on exchange rate risk management, as these new forms of money are likely to reshape foreign exchange markets in the coming years.

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