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TRADING & QUANTITATIVE RESEARCH REPORT

FX Optimization

Maximizing Efficiency and Minimizing Costs in Multi-Currency Cash Flow Management

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Introduction & Theory

Introduction

In today's interconnected global economy, businesses operating across multiple countries face the intricate challenge of managing multi-currency cash flows. Maintaining bank accounts in different currencies is essential for handling international transactions and mitigating currency mismatches [12]. However, this approach also exposes companies to foreign exchange (FX) market risks, interest rate fluctuations, and transaction costs [6]. Strategic financial management in such environments is critical, as it can significantly impact a company's profitability and operational efficiency [4].

FX swaps have emerged as an essential financial instrument for companies to optimize their foreign currency management. These swaps allow businesses to balance positive and negative account balances, minimize interest rate costs, and make effective use of available liquidity [1]. The complexity of choosing the optimal trades in the FX market has led to the development of various models that consider factors such as interest rates, bid-ask spreads, and swap prices [7]. Existing methods often rely on static frameworks or focus narrowly on specific currency pairs, limiting their applicability in dynamic multi-currency environments. Unlike these approaches, this paper introduces a dynamic, data-driven optimization model designed to holistically manage multi-currency cash flows while accounting for both market volatility and operational constraints. By addressing the limitations of existing methods, this study aims to provide a more robust and practical solution for companies navigating the complexities of FX markets.

Background

Foreign exchange management is a fundamental aspect of international business operations. Companies with global footprints often hold accounts in multiple currencies to facilitate transactions in local markets. This practice, while operationally beneficial, creates exposure to interest rate expenses on negative balances and missed opportunities for earnings on positive balances. The inherent risk associated with currency volatility further complicates the management of multi-currency accounts, necessitating sophisticated strategies to optimize financial outcomes [11, 6].

A common scenario for such companies involves a combination of positive and negative account balances across currencies. Negative balances, especially in currencies with high interest rates, incur significant costs. For instance, holding a negative NOK balance when interest rates are elevated leads to high borrowing costs [9]. Similarly, maintaining unused positive balances in currencies with low interest rates may result in an inefficient allocation of resources. To address these challenges, companies often rely on FX swaps as a means of reducing financial inefficiencies [3, 8].

An FX swap is a contractual agreement involving two simultaneous transactions: a spot exchange and a forward exchange. For example, a company with a negative NOK balance and a positive USD balance might initiate a swap to eliminate the NOK liability. NOK is exchanged for USD in the spot market, and the reverse transaction is executed on the forward date [1]. The pricing of these swaps depends on the spot rate and swap points, which reflect interest rate differentials between the two currencies. Swap points are calculated using the formula:

$$\text{Forward Price} = \text{Spot Price} + \left(\frac{\text{Swap Points}}{10,000}\right)$$

The decision-making process for FX swaps involves prioritizing which currency balances to address first. Currencies with high interest rates typically take precedence, as the costs of maintaining negative balances are greater. In contrast, positive balances in currencies with lower interest rates can be strategically used to offset liabilities. The bid and ask prices of currency pairs influence the cost-effectiveness of such trades. The bid price represents the maximum amount a buyer is willing to pay for a currency, while the ask price indicates the minimum amount a seller is willing to accept. The spread between these prices reflects transaction costs, which must be carefully accounted for when planning FX swaps [10, 2].

Given the complexities of managing multi-currency accounts, companies require structured models to optimize their transactions. By incorporating variables such as interest rates, swap points, and bid-ask spreads, these models provide a strategic roadmap for minimizing costs and maximizing financial efficiency [5]. This project aims to develop an optimization model that identifies the most advantageous FX transactions by analyzing daily data on exchange rates, swap points, and interest rates. The model will enable companies to rank and select transactions based on criteria such as minimized costs or maximized gains, thereby supporting data-driven decision-making in the FX market and improving overall financial performance.

Theory
A foreign exchange swap is a contractual agreement to exchange and re-exchange a currency pair at two different value dates - the near and far leg - at a set rate. Unlike traditional FX transactions which trade fixed amounts of the base currency, swaps can trade a fixed amount of either the base or the term currency. These are the only two types of swaps: (1) buy/sell swap (2) sell/buy swap.

1. Understanding Bid, Ask, and Spread
In foreign exchange trading, two rates are always quoted for currency pairs: the *Bid Rate*, which is the price at which a trader can sell the base currency, and the *Ask Rate*, which is the price at which a trader can buy the base currency. Bid Rate: If you buy and sell a currency in the swap – you are trading the swap at the bid swap points. Ask Rate: If you sell and buy a currency in the swap – you are trading the swap at the ask swap points. Whether you pay or receive the swap points depends on their sign. The spread, defined as

$$\text{Spread} = \text{Ask Rate} - \text{Bid Rate}$$

reflects market maker profits and liquidity. A tighter spread often indicates higher market liquidity [2]. To further understand the implications of bid and ask rates, note that for the *Bid Rate*, a positive point is that one may sell at higher prices in the future, while a negative point is the risk of selling at lower prices. Similarly, for the *Ask Rate*, the positive aspect is buying at higher prices later, whereas the negative aspect is buying at lower prices.

2. Base Currency vs. Terms Currency
There are two different styles for displaying currency: American Terms and European Terms. These styles refer to how the exchange rate between two currencies is quoted [6, 11]. In American Terms, the rate shows how many USD are required to purchase one unit of another currency. For example, EUR/USD = 1.10 means that 1 EUR costs 1.10 USD, with USD as the terms currency and EUR as the base currency. In European Terms, the rate shows how much of the foreign currency is required to purchase 1 USD; for instance, USD/SEK = 10.50 means that 1 USD costs 10.50 SEK, making USD the base currency and SEK the terms currency. To convert between these formats, the relationship is used.

$$\text{USD/SEK} = \frac{1}{\text{SEK/USD}}$$

3. Today's Exchange Rate, Spot, and Interest Rates
Foreign exchange transactions are classified based on settlement periods. Cash transactions (T+0) settle on the same business day, Tomorrow Next (T/N, T+1) settle on the next business day, Spot transactions (T+2) follow the standard two-business-day cycle, and Forward Outright transactions (T+3 or longer) settle beyond the spot date and are used for hedging. In addition, overnight swaps allow traders to roll over currency positions without taking on exchange rate risk. Common instruments include Overnight (O/N) swaps, which extend a position by one day; Tomorrow Next (T/N) swaps, which reverse a transaction on the following business day; and Spot Next (S/N) swaps, which start on the spot date and reverse the next day. Interest rate differentials determine whether a currency trades at a forward premium or discount, a forward discount occurs when a currency with a higher interest rate is expected to depreciate relative to the counter currency, while a forward premium occurs when a currency with a lower interest rate is expected to appreciate. These adjustments are embedded in forward contracts to hedge against currency fluctuations, and interest rates play a key role in FX pricing and investor decisions [7].

4. FX Swaps: Near Leg and Far Leg
A foreign exchange swap consists of two simultaneous transactions: the near leg and the far leg. The near leg is the initial exchange of currencies, typically settled at the spot rate, and the far leg is the reversing exchange at a future date, settled at a forward rate that incorporates interest rate differentials. FX swaps are commonly used for liquidity management, hedging, and arbitrage, allowing institutions to adjust their currency exposure without directly assuming market risk. The swap rate applied to the far leg is determined by the interest rate differential between the two currencies; typically, a currency with a higher interest rate trades at a discount, while one with a lower interest rate trades at a premium. This pricing adjustment between the near and far leg is reflected in swap points, which are added or subtracted from the spot rate to determine the forward price [7].

5. Swap Points
Swap points reflect the interest rate differential between two currencies and adjust the forward rate [6, 7]:

$$\text{Forward Rate} = \text{Spot Rate} + \left(\frac{\text{Swap Points}}{10,000}\right)$$

Both bid and ask swap points (SP) are calculated using the formula:

$$\text{SP} = \text{Spot Rate} \cdot (i_{\text{terms}} - i_{\text{base}}) \cdot \frac{T}{360} \cdot 100$$

The variables i_{base} and i_{terms} represent the interest rates for the base and terms currencies in the currency pair. The difference between bid and ask swap points lies in the interest rates applied. When calculating bid swap points, the interest rate for the base currency corresponds to the offered lending rate, while the interest rate for the terms currency is the bid borrowing rate. For ask swap points, the roles are reversed: the base currency uses the bid borrowing rate, and the terms currency uses the offered lending rate.

6. Interest Rate Parity and Forward Pricing
Interest rate parity ensures that forward rates reflect interest rate differentials [9]:

$$\text{Forward Rate} = \text{Spot Rate} \cdot \frac{(1 + i_{\text{terms}} \cdot \frac{T}{360})}{(1 + i_{\text{base}} \cdot \frac{T}{360})}$$

7. Holding Costs: Loan and Deposit Rates
Balances incur costs or generate income, which is calculated by:

$$\text{Cost/Profit} = \text{Balance} \cdot \frac{\text{Interest Rate}}{360}$$

For example, for -1,000,000 EUR at a 2% loan rate [11], the no swap outcome (NSO) for a single account on a given day is:

$$\text{NSO} = -1,000,000 \cdot \frac{0.02}{360} = -55.56 \text{ EUR/day}$$

8. Comparing Strategies: Swaps vs. Holding Costs
By comparing the interest costs of maintaining a negative balance with the gains from executing swaps, one can determine the optimal strategy. For instance, if the swap outcome (SO) is calculated as

$$\text{SO} = -1,000,000 \cdot \frac{-20}{10,000} = +2,000 \text{ EUR}$$

this illustrates how swaps can eliminate holding costs while generating additional gains [2, 7].

9. Definitions
This report analyzes FX swaps in the context of cost minimization rather than profit generation. Therefore, some tailored definitions are used.

To ensure comparability across all currencies and pairs, the home currency ("HC") SEK is used as a benchmarking tool. Loan balances of 1 SEK equivalent in corresponding currency accounts are used to calculate the Swap Advantage per SEK for each swap configuration. This ensures comparable ranking irrespective of account balances.

As there is no buy/sell or sell/buy order for the HC-conversion to determine usage of ask or bid rates and points, the conversion is done using a MID-rate which is the average of the ask and bid.

The calculation of Swap Outcome and No Swap Outcome is deeply dependent on whether the loan currency is the base or term currency in the currency pair. This creates two scenarios for No Swap Outcome and Swap Outcome, which in turn leads to two Swap Advantage calculations.

Loan is base:

$$\text{NSO}_{\text{base}} = \frac{\text{balance}_{\text{depo}} \cdot i_{\text{depo}}}{r_{\text{bidtom}}} + \text{balance}_{\text{loan}} \cdot i_{\text{loan}}$$

$$\text{SO}_{\text{base}} = -\frac{\text{balance}_{\text{loan}} \cdot \left(\frac{r_{\text{bidon}}}{10\,000}\right)}{r_{\text{bidtom}}}$$

Loan is term:

$$\text{NSO}_{\text{term}} = \frac{\text{balance}_{\text{depo}} \cdot i_{\text{depo}}}{r_{\text{asktom}}} + \text{balance}_{\text{loan}} \cdot i_{\text{loan}}$$

$$\text{SO}_{\text{term}} = -\frac{\text{balance}_{\text{depo}} \cdot r_{\text{askon}}}{10\,000}$$

Where i_{loan} and i_{depo} represent the interest rates applied to the negative and positive balances, respectively. The variables r_{bidtom} and r_{asktom} refer to the tomorrow rates and r_{bidon} and r_{askon} are the overnight swap points.

Lastly, the Swap Advantage is calculated:

$$\text{Swap Advantage} = \text{Swap Outcome} - \text{No Swap Outcome}$$

At this stage, the Swap Advantage is still denominated in the loan currency. It is converted to the HC using:

$$\text{Swap Advantage per SEK} = \frac{\text{Swap Advantage}}{r_{\text{midtom}}}$$

This allows the advantage of all swap configurations to be ranked on a consistent scale, regardless of currency notional and account balances.

Note that the r_{midtom} is the average tomorrow rate of the HC and loan currency pair - not the loan and depo pair used in the calculation of SO and NSO. Also note that the formula assumes that the HC is the base currency for the HC loan pair. The inverted tomorrow rate is used when the HC is the terms currency.

Data & Method

Data

The dataset used in this project spans from mid-November 2023 to mid-November 2024, providing key information on currency pairs relevant to the optimization model. It includes data for pairs such as NOKSEK, EURSEK, EURGBP, GBPUSD, EURUSD, USDSEK, GBPSEK, EURNOK, USDNOK, GBPNOK, EURDKK, USDDKK, SEKDKK, NOKDKK, and GBPDKK. These pairs were chosen to cover the most significant currencies involved in the analysis, namely SEK, NOK, EUR, GBP, USD, and DKK.

In this study, we will exclusively use European Terms and not American Terms when quoting exchange rates.

For each currency pair, the dataset contains detailed swap price information, including BID_TOD and ASK_TOD, which represent today's bid and ask rates, and BID_ON and ASK_ON, which provide the swap points for overnight transactions. This data enables the precise calculation of forward rates and the evaluation of swap advantages.

In addition to swap prices, the dataset includes daily interest rates for each currency. These rates are divided into loan rates (labeled as "loan_rate_pct") and deposit rates (labeled as "depo_rate_pct"), which are essential for calculating the costs and benefits of maintaining balances or executing swaps.

We generated synthetic account balances to simulate diverse financial scenarios. The different balances were particularly useful for testing the model's robustness under varying conditions, including extreme negative balances and combinations of positive and negative balances across currencies.

Overall, the dataset's granularity is daily, providing a comprehensive view of currency movements and financial metrics over the analysis period. This detailed and structured data forms the foundation for building and testing the optimization model.

Method

1. Preprocessing

To prepare the data for analysis, swap prices, interest rates, and account balances were first structured into Python dictionaries. The `DATE` column was converted into a standardized datetime format to ensure consistency across datasets. Swap prices and interest rates were aligned by date so that each calculation used the correct daily data, and any missing values were handled using forward-filling or interpolation techniques, resulting in a complete dataset for all currency pairs. Additionally, synthetic account balances were generated to test various market conditions, including extreme negative balances and combinations of positive and negative balances, ensuring robustness in swap evaluation and optimization.

2. Swap Evaluation and Home Currency Normalization

Since swap advantages need to be comparable across different currencies, all calculations were performed in a single home currency (with SEK as the default). For each currency pair, the swap advantage was evaluated by comparing the cost of maintaining a negative balance without a swap (the *No Swap Outcome*) with the benefit of executing a swap (the *Swap Outcome*). These outcomes were calculated based on account balances, applicable interest rates, and swap points, and then expressed in the home currency using the mid-market exchange rate.

To enable direct comparison across different pairs, the results were normalized per home currency unit. This measure, referred to as the *Swap Advantage per Unit (SAU)*, is formally defined in the Definitions section. The SAU was then used to rank all swap opportunities on a unified scale.

3. Optimization with Account Balances

After evaluating the swap advantages, the model incorporated fabricated account balances to determine optimal transaction decisions. The optimization process was carried out in a single step to ensure both efficiency and logical consistency. Initially, all available swaps for a given day were ranked from highest to lowest based on the swap advantage per unit of home currency. The most profitable swap was executed first on the account where it was feasible, and each swap was maximized according to the available balance in the involved accounts. If a swap could be fully executed, it was performed at maximum volume; if limited by the available balance, it was executed partially. Each swap affected the available balances for subsequent swaps, once a currency was fully utilized, it could

no longer be used for additional transactions. The model ensured that no swap was executed beyond the available funds in the respective accounts, and the optimization continued until no further profitable swaps could be made. Final account balances were recorded once all beneficial swaps had been executed at maximum possible volume.

4. Visualization and Output

The final step involved generating output files and visualizations to analyze swap effectiveness. This included creating a table of daily swap recommendations for each currency, as well as producing line and bar charts that illustrated swap advantages over time. Additionally, comparisons were made between the outcomes of executing swaps and maintaining negative balances without swaps. The results were then exported to an Excel file with separate sheets summarizing the optimal swaps for specific dates and currencies, providing actionable insights into whether swaps were beneficial overall and if certain currencies consistently offered better swap opportunities.

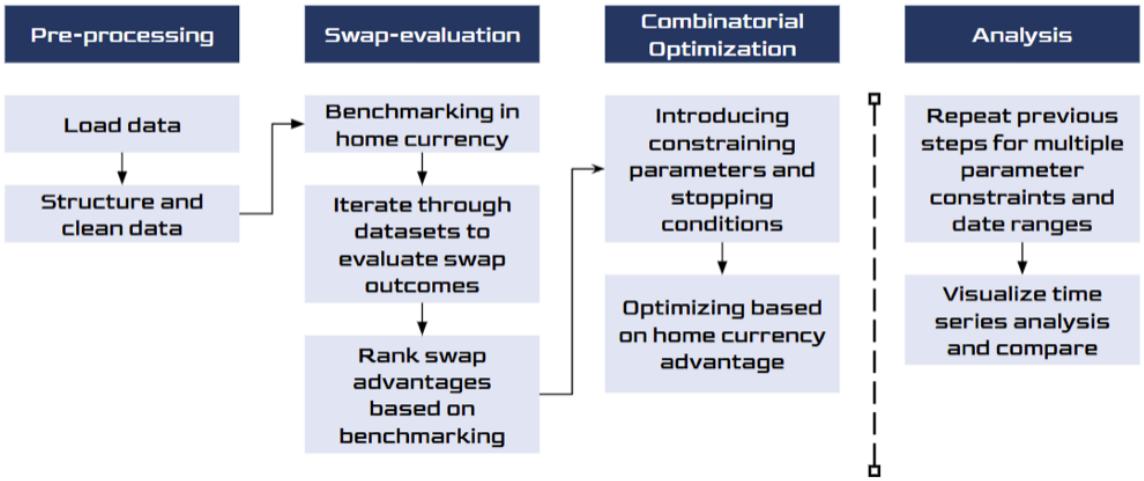

Figure 1: Overview of the FX swap optimization methodology.

Results

To evaluate the effectiveness of FX swap strategies, 20 different scenarios were simulated based on configurations where three out of six currencies consistently held negative balances. All accounts were initialized with balances equivalent to ±1,000,000 SEK in their respective currencies. This setup ensured an even exposure across currencies and enabled a comprehensive exploration of negative balance configurations under realistic market conditions. All financial outcomes were converted into SEK to maintain consistent comparison across scenarios.

The results demonstrate that FX swaps significantly improve financial outcomes. On average, the swap strategy yielded a cost of -12,781.8 SEK compared to -31,625.0 SEK when holding the negative balances without executing swaps. This corresponds to an average saving of 18,843.2 SEK per configuration. Expressed in relative terms, this is equivalent to an average saving of 83.5%. These values are presented in Table 1. The table summarizes the average swap advantage, hold cost, and percentage savings across all 20 scenarios.

Swaps executed on Fridays were generally more favorable. This is because Friday swaps cover a three-day period over the weekend due to non-settlement on Saturdays and Sundays. Although trading activity is paused during weekends, interest accrual continues, which allows interest rate differentials to compound and generate higher swap advantages when timed correctly.

The impact of currency configurations varied considerably. As shown in Table 2, the most favorable configurations included [SEK, EUR, DKK] and [SEK, NOK, DKK], which achieved percentage savings of 409.9% and 140.6% respectively. These configurations refer specifically to the three currencies that held negative balances out of the six evaluated in each simulation scenario. Other top-performing configurations, such as [NOK, EUR, DKK] and [SEK, NOK, EUR], also delivered strong savings of over 100%. These scenarios typically involved high-interest currencies like NOK and DKK being swapped into lower-interest currencies such as EUR or USD, amplifying the gain from the swap.

In contrast, several configurations yielded more modest results. For instance, configurations like [NOK, USD, GBP], [EUR, USD, GBP], and [USD, GBP, DKK] produced the lowest percentage savings, ranging from 30.4% to 43.2%. While still positive, these results indicate less favorable interest rate differentials or less optimal swap directionality. Nevertheless, no scenario resulted in a net loss from using swaps, confirming the consistent benefit of applying the strategy when executed with correct assumptions.

These findings are consistent with the global heatmap shown in Figure 2, which ranks swap combinations by effectiveness across the full simulation period. In this ranking, a lower number corresponds to a more advantageous swap outcome. These are visually represented by darker red shades in the heatmap, while higher numbers indicating less favorable swaps are shown in darker blue. The most advantageous swaps were found in configurations such as EUR/DKK with DKK as the loan currency, EUR/SEK with SEK as the loan currency, and EUR/USD with USD as the loan currency. Other high-ranking combinations included USD/DKK with DKK as the loan currency. At the opposite end of the scale, the weakest swaps included GBP/DKK with GBP as the loan currency, EUR/SEK with EUR as the loan currency, and USD/DKK with USD as the loan currency.

To better understand these patterns, Figures 3 and 4 display interest rate differentials across currencies. The strongest-performing swaps corresponded to the widest gaps, particularly between DKK and USD, EUR and USD, and DKK and GBP. Swaps involving currencies with narrower differentials, such as NOK versus GBP or USD, had more limited room for optimization and often resulted in lower advantages.

Overall, the results confirm that FX swap strategies can substantially reduce the cost of managing negative balances. However, their effectiveness depends heavily on currency selection, timing, and correct use of interest rate directionality. The following section presents the detailed tables and visualizations that support these findings.

Table 1: Average swap outcomes across all 20 scenarios. All values in SEK.

Dataset	Average Swap Outcome	Average Hold	Average Swap Advantage	Average % Savings
All Scenarios	-12781.8	-31625.0	18843.2	83.5%

Table 2: All 20 results sorted by percentage savings. All values in SEK.

Negative Accounts	Total Swap Outcome	Total Hold	Swap Advantage	Percentage Savings
SEK, EUR, DKK	14580.3	-4704.8	19285.1	409.9%
SEK, NOK, DKK	6574.3	-16196.4	22770.7	140.6%
NOK, EUR, DKK	4345.9	-15015.4	19361.3	128.9%
SEK, NOK, EUR	957.4	-17499.8	18457.2	105.5%
SEK, GBP, DKK	-3270.0	-24772.1	21502.1	86.8%
SEK, USD, DKK	-5913.8	-26863.9	20950.1	78.0%
EUR, GBP, DKK	-5229.9	-23591.1	18361.2	77.8%
EUR, USD, DKK	-8180.2	-25682.9	17502.7	68.1%
SEK, EUR, GBP	-8876.5	-26075.4	17198.9	66.0%
NOK, GBP, DKK	-13716.8	-35082.7	21365.9	60.9%
SEK, EUR, USD	-11559.0	-28167.3	16608.3	59.0%
NOK, USD, DKK	-16463.5	-37174.6	20711.1	55.7%
SEK, NOK, GBP	-18082.3	-37567.1	19484.8	51.9%
SEK, NOK, USD	-20551.7	-39658.9	19107.1	48.2%
NOK, EUR, GBP	-19286.6	-36386.1	17099.5	47.0%
USD, GBP, DKK	-25992.9	-45750.2	19757.4	43.2%
NOK, EUR, USD	-22098.7	-38477.9	16379.3	42.6%
SEK, USD, GBP	-30435.5	-48234.6	17799.1	36.9%
EUR, USD, GBP	-31710.4	-47053.6	15343.3	32.6%
NOK, USD, GBP	-40725.8	-58545.2	17819.4	30.4%

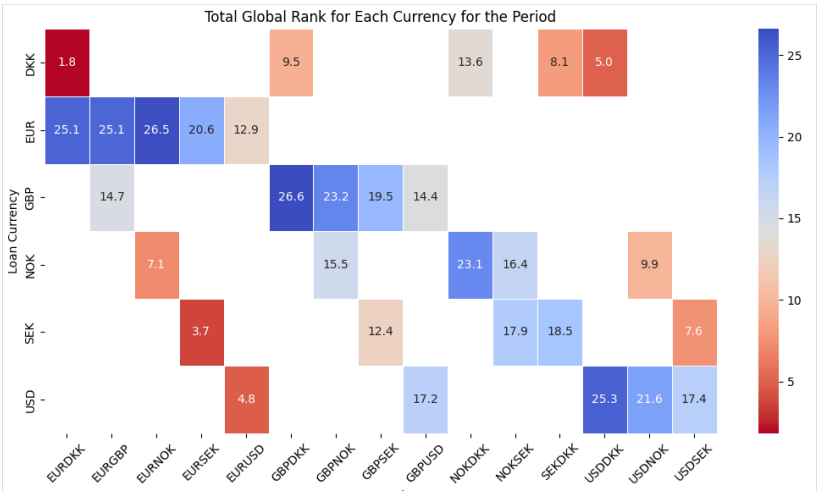

Figure 2: Heatmap displaying the most advantageous FX swaps based on global ranking by loan currency and currency pair.

Figure 3: Heatmap showing loan rate differentials between currencies.

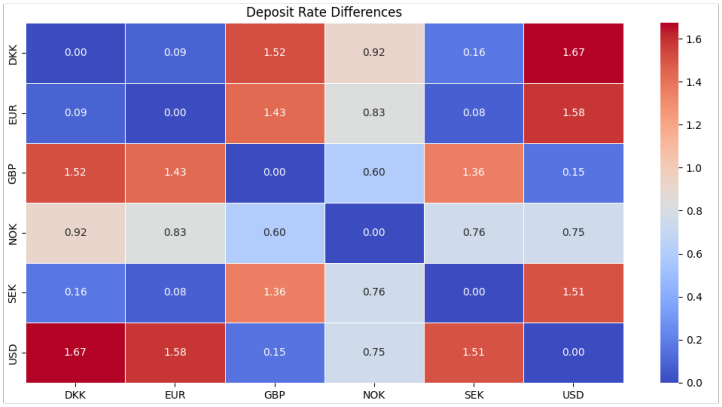

Figure 4: Heatmap showing deposit rate differentials between currencies.

Analysis & Conclusion

Analysis

The results of this study confirm that FX swaps are a highly effective tool for optimizing multi-currency cash management in dynamic and volatile environments. Across 20 simulated scenarios, where various configurations of currencies consistently held negative balances, the execution of swaps led to significant cost reductions. The average saving was 18,843.2 SEK per configuration, corresponding to a relative improvement of 83.5% compared to not using swaps (Table 1). These high savings levels suggest that swap strategies can meaningfully improve treasury performance, even when accounting for diverse market scenarios.

A key insight from the simulations is the critical importance of which currencies hold negative balances. Scenarios where NOK, DKK, or SEK appeared among the negative accounts consistently outperformed others. These currencies, when used as loan currencies in well-aligned swap directions, allowed the model to exploit favorable interest rate differentials. In nearly every top-performing configuration (Table 2), one or more of these currencies played a central role, reinforcing their value in swap optimization.

However, while the majority of configurations showed strong financial advantages from executing swaps, not all scenarios were equally beneficial. Several cases yielded relatively modest improvements. For instance, configurations such as [NOK, USD, GBP] and [EUR, USD, GBP] resulted in percentage savings between 30–40%. This suggests that FX swaps are not universally effective and must be selectively applied based on currency context and rate alignment.

These less favorable outcomes were often associated with configurations where the loan currency was itself a high-interest currency, such as GBP, USD, or EUR, used in directions that failed to capitalize on available interest rate differentials. Additionally, swaps involving multiple high-rate currencies, particularly those not involving SEK or DKK as the loan currency, were generally less advantageous. The presence of such cases underscores the importance of not only identifying strong interest rate gaps but also ensuring the correct directional setup to avoid neutralizing swap potential through misaligned currency roles or overlapping interest environments.

Beyond interest rate gaps, the directionality of the swap, especially the choice of loan currency, was shown to be essential. This is most clearly reflected in the global heatmap ranking (Figure 2), where EUR/DKK with DKK as the loan currency, EUR/SEK with SEK as the loan, and EUR/USD with USD as the loan ranked among the most advantageous configurations. Conversely, configurations such as GBP/DKK with GBP as the loan currency, EUR/SEK with EUR as the loan, and USD/DKK with USD as the loan yielded some of the weakest outcomes. This demonstrates that effective swap strategies are not only about choosing currency pairs with wide rate spreads but also ensuring the correct loan/deposit orientation is used to unlock those benefits.

Figures 3 and 4 provide further evidence of why these patterns emerge. The largest interest rate differentials were observed between DKK and USD, EUR and USD, and DKK and GBP, all of which present opportunities for cost reduction through swaps. In contrast, currency pairs involving NOK, such as NOK/GBP, NOK/USD, or NOK/SEK, show relatively narrow interest rate spreads, which may limit their advantage in certain swap directions despite NOK appearing frequently among top-performing scenarios. This highlights the importance of pairing swap decision-making with real-time rate differentials and correct loan currency orientation. The fact that the heatmaps for both loan and deposit rates display consistent differentials confirms that the structure of the FX market allows for systematic identification of swap potential based on public interest rate data.

Another valuable finding is the impact of temporal execution patterns. Swaps executed on Fridays were particularly effective because they span the weekend and are priced over a three-day period rather than the typical one-day tenor. Although markets are closed during weekends, interest continues to accrue, allowing firms to capitalize on multi-day interest rate differentials through a single transaction. This highlights that timing, often overlooked in theoretical models, can have a material impact on swap efficiency. Firms that align their execution with the FX settlement calendar can extract additional value without adding operational complexity.

Still, the model's assumptions introduce limitations. Real-world FX trading includes bid-ask spreads, transaction fees, execution latency, and slippage, which are not fully captured in the simulation. While balances were converted using mid rates for comparability, swap outcomes were evaluated using bid or ask rates and swap points, depending on direction. As such, the model reflects realistic trading conditions. Therefore, while the results show the potential for high savings, they

should be interpreted with an understanding of the practical risks and barriers to execution.

Strategically, the findings highlight that corporate treasury departments operating across currencies should move away from passive balance maintenance and embrace active swap strategies. Simply holding negative balances results in unnecessary cost. With the right data and tools, treasuries can proactively manage exposures to optimize interest outcomes on a daily basis. The ranking framework used in this study could easily be adapted into a dashboard or automated tool to inform trading decisions based on up-to-date rates and forecasts.

Conclusion

This study demonstrates that FX swap execution is a highly valuable strategy for reducing financial inefficiencies and optimizing liquidity in multi-currency environments. The average savings of 83.5% highlight the significant upside available to firms that actively manage currency exposures rather than relying on static approaches. In scenarios with the right interest rate gaps and swap directions, cost improvements exceeding 400% were achieved.

The most effective swaps occurred when currencies such as DKK, SEK, and NOK were used as loan currencies in well-directed swaps. The global heatmap ranking reinforces that it is not only about choosing "the right currencies" but also about how those currencies are used in the swap direction. Loan currencies like DKK and SEK led to the highest-ranking swaps, whereas using the same currencies in reverse roles or pairing multiple low-interest currencies often led to significantly weaker results.

However, the full analysis also revealed several configurations with more modest swap outcomes. These cases reinforce that FX swaps are not a one-size-fits-all solution and must be tailored to the specific market and interest rate environment. Poor swap direction, narrow interest differentials, and adverse timing can all erode or reverse the intended benefits of a swap. This underlines the need for rigorous evaluation of each swap's viability before execution.

This indicates that firms with FX exposure should not rely on static allocation or intuition when managing balances. Instead, treasury departments should implement dynamic, data-driven strategies that continuously evaluate the most advantageous swap opportunities based on both market data and internal liquidity needs. The timing of swap execution is also crucial, particularly the "Friday effect" where swaps spanning the weekend are priced over three days, enabling firms to optimize interest gains through extended settlement horizons.

Looking forward, FX swap optimization has the potential to become a cornerstone of financial strategy for firms managing global operations. The framework developed in this study offers a scalable foundation that can be further enhanced through integration of real-time FX and rate data, transaction cost estimation, and liquidity constraints. Incorporating predictive analytics and AI-driven optimization, particularly approaches based on time series forecasting and reinforcement learning, could enable automated adaptation to shifting market conditions. Such models may not only improve forecast accuracy, but also detect subtle patterns in volatility, liquidity, and policy shifts that influence swap performance, thereby supporting more agile and effective financial decision-making.

Moreover, future research could expand the scope of analysis by including macroeconomic variables, central bank announcements, or geopolitical factors that affect interest rates and exchange rates. Incorporating these dimensions would allow for even more refined strategies and stress-tested scenarios.

In conclusion, FX swap optimization is not just a financial tactic but a strategic capability. When integrated with data-driven tools, timely execution, and intelligent modeling, it can provide companies with substantial cost advantages, improved cash flow control, and stronger resilience in increasingly uncertain global markets.

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