

MODELING FOREIGN EXCHANGE MANAGEMENT IN A GROUP OF COMPANIES

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Introduction

Foreign exchange management is a critical issue for diversified groups of companies, as daily conversions affect not only accounting results but also operational liquidity, payment discipline, procurement costs, and the quality of internal cash distribution. In groups where various subsidiaries simultaneously buy and sell foreign currency through multiple banks, even small differences in execution rates can accumulate into significant costs. For this reason, studying centralized foreign exchange management is relevant both for financial management and for improving the effectiveness of intragroup coordination. This article is devoted to the development and empirical presentation of an approach to modeling foreign exchange management in a group of companies based on anonymized transaction-level data. The article is structured as follows: a literature review summarizes the main scientific approaches used to formulate the purpose of this study; the research methodology and data used are presented; and the research findings are then presented. The analysis section presents the empirical and model results; the concluding sections discuss practical proposals and conclusions.

Research methodology: Mathematical model formulation

The methodological basis of this study is formed by a multi-level view of the problem of managing foreign exchange operations. Since foreign currency conversions within a group of companies simultaneously have operational, financial, and optimization dimensions, the problem is examined at three successive levels. At the first level, descriptive and comparative analysis of actual transactions is used to identify exchange-rate differences among banks and their effects on execution outcomes. At the second level, the behavioral regularities of individual companies are examined in terms of the direction of FX flows, net positions, and temporal structure. At the third level, the problem is formulated as a group-level optimization task whose objective is to reduce the total cost of foreign exchange conversions through intra-group netting, bank selection, and the consideration of operational constraints. The empirical basis of the study consists of anonymized primary operational records of foreign exchange conversions carried out by 49 companies belonging to one diversified corporate group and executed through several partner banks. The dataset covers

2,100 transactions from 2025 through March 2026 and includes transaction dates, currency directions, executed rates, transaction amounts, and company-level identifiers that were anonymized for confidentiality. Company names and bank names are not disclosed in the article; instead, the analysis focuses on comparable behavior, execution quality, and group-wide coordination effects.

$$Net_{i,t}^{(c)} = In_{i,t}^{(c)} - Out_{i,t}^{(c)} \quad (1)$$

This quantity makes it possible to distinguish between companies that are primarily net buyers of a given currency and those that are net sellers of that currency. Moreover, the time series of net positions make it possible to study recurring patterns of FX behavior by day, month, or other time interval. The objective of this analysis is not only to describe the financial behavior of individual firms, but also to identify the preliminary possibilities for intra-group netting. The third stage of the research constitutes the central methodological core of the study and concerns the modeling of intra-group netting and centralized optimization. If, at a given point in time, some companies have demand for a currency while others have supply of the same currency, then an opportunity for intra-group offsetting or netting arises. If total demand at the group level for a given day is denoted by $D_t^{(c)}$ -, and total supply by $S_t^{(c)}$, then the maximum possible volume of intra-group netting is determined by the following expression:

$$M_t^{(c)} = \min (D_t^{(c)}, S_t^{(c)}) \quad (2)$$

At the final stage of the methodology, the problem is also considered from a scenario-based and stochastic perspective. Since future exchange rates and bank quotations are not known with certainty, it is appropriate to evaluate optimization outcomes not only on the basis of observed data, but also using random or bootstrap scenarios. For this purpose, empirical distributions are formed from historical observations, from which possible future quotes are generated, and for each scenario the external conversion cost is recalculated. The resulting outcomes make it possible to assess not only the average efficiency of optimal allocation, but also its variability, riskiness, and sensitivity to changes in market conditions. Thus, the methodology is complemented by a Monte Carlo type simulation assessment, which makes it possible in the empirical part of the article to compare baseline and centralized management scenarios.

Literature review

The starting point of the literature is the general theory of foreign exchange risk management. Jacques interprets foreign exchange risk as a combination of transaction, translation, and economic impacts and argues that the primary management objective is to reduce the negative impact of exchange rate fluctuations on cash flows and firm value [Jacques, 1981, 81-84]. This line of research considers foreign exchange risk management not only as a

hedging problem but also as a broader issue of organizing financial decision-making within multinational firms.

A second line of research explains why firms choose particular foreign exchange risk management tools. Kim and Sung show that the choice between internal and external methods depends on firm size, operational impact, and the relative cost of implementation; in particular, larger international companies are more likely to use formal risk management mechanisms, while internal methods remain important because they are less expensive to implement [Kim and Sung, 2005, 263-268]. This approach is particularly relevant for groups of companies, where centralized coordination and netting can replace some external hedging operations.

A third line of research focuses on cash flow optimization and payment netting. Shapiro demonstrates that multilateral netting can significantly reduce transfer costs and unnecessary gross payment flows [Shapiro, 1978, 51-58]. Adkins develops a dynamic deterministic model for international cash management and demonstrates that multicurrency payment decisions can be formalized as an optimization problem rather than being resolved solely through decentralized operating procedures [Adkins, 1991, 345-360]. Righetto, Morabito, and Alem extend this logic by showing how optimization techniques can be used to manage uncertain cash flows under cost and liquidity constraints [Righetto et al., 2016, 137-152].

A fourth line of research examines the microstructure of the market in which corporate foreign exchange transactions take place. Shaboud, Rim, and Sushko emphasize the fragmented and multi-platform nature of the modern foreign exchange market [Shaboud et al., 2023, 1-5]. BIS guidance on execution algorithms emphasizes the increasing importance of multi-bank execution quality and order allocation logic [BIS, 2020, 1-6], while BIS supervisory guidance on settlement risk emphasizes that foreign exchange decisions should also take into account counterparty, liquidity, and settlement considerations, rather than focusing solely on the best apparent quote [BIS, 2000, 1-4]. Results of the existing studies show that the problem of foreign exchange risk management within a group of companies lies at the intersection of risk management, internal offsetting, optimization, and transaction execution quality. An analysis of the results of research on foreign exchange transaction management allows us to highlight the importance of this issue for diversified groups of companies and formulate the main objectives of this study as identifying bank-level differences that represent differences in execution results, analyzing the behavioral structure of companies' net foreign exchange positions, assessing the potential for intra-group netting, and discussing the institutional implications of centralized execution.

Scientific novelty

The scientific novelty of the article lies in combining several strands of the literature within one empirical framework. Unlike studies that examine only exposure measurement, only hedging choice, or only theoretical netting models, this paper simultaneously analyzes

transaction-level bank execution, company-level currency behavior, and group-level optimization opportunities. The study therefore links treasury operations with formal modeling and demonstrates how decentralized FX activity can be transformed into a measurable coordination problem.

A second novel element is the use of anonymized daily operational data from one diversified group of companies observed across multiple banks and multiple legal entities. This makes it possible to evaluate not only the theoretical maximum of intra-group netting, but also the practical relevance of execution dispersion, timing concentration, and residual external demand. The resulting framework is especially useful for large diversified groups, including trading, service, and operating subsidiaries that regularly execute FX transactions but do not wish to disclose commercially sensitive identities in academic publication.

The mathematical formulation of the problem is built according to the principle of gradually increasing complexity, starting from the baseline decentralized approach and ending with constrained centralized optimization and stochastic extended models. Consider a group of companies consisting of N companies, B banks, and C currencies. Time is considered in discrete form as $t = 1, 2, \dots, T$ days or other reporting periods. Let us define the following indices and parameters.

- $i \in I = \{1, 2, \dots, N\}$ company index
- $b \in B = \{1, 2, \dots, M\}$ bank index
- $c \in K = \{1, 2, \dots, C\}$ currency index
- $t \in \{1, 2, \dots, T\}$ time index

It follows from formula (1) that if $Net_{i,t}^{(c)} > 0$, then the company has a net inflow or supply in that currency, whereas if $Net_{i,t}^{(c)} < 0$, then it is interpreted as net demand for that currency. Since the external conversion problem is conveniently formulated in the language of demand and supply, let us also define:

$$S_{i,t}^{(c)} = \max \{Net_{i,t}^{(c)}, 0\}, \quad (3)$$

$$D_{i,t}^{(c)} = \max \{-Net_{i,t}^{(c)}, 0\} \quad (4)$$

Thus, $S_{i,t}^{(c)}$ denotes the volume of currency supplied by the company, while $D_{i,t}^{(c)}$ denotes the volume of currency demanded. At the group level, total supply and total demand for a given currency at a given time will be denoted as follows:

$$S_t^{(c)} = \sum_{i=1}^N S_{i,t}^{(c)}, \quad D_t^{(c)} = \sum_{i=1}^N D_{i,t}^{(c)} \quad (5)$$

For bank-provided quotations, let us assume that $r_{b,t}^{(c)}$ describes the unit conversion value applied by bank b at time t for currency c . In the following models, the system of variables depends on the scenario under consideration, but the main decision variables will be represented in the following general way:

- $x_{b,t}^{(c)}$ - the volume of currency c converted through bank b in the external market,
- $y_{ij,t}^{(c)}$ - the volume of currency c offset or transferred within the group from company j to company i .

Intra-group netting model

The simplest approach is that each company acts independently and satisfies its own external FX demand without intra-group netting or centralized bank selection, but from the point of view of group management, the natural next step is to make use of the possibility of intra-group netting. If at the same point in time some companies have supply of a given currency while others have demand for it, then part of these volumes can be offset without carrying out an external market transaction. At the group level, the maximum possible intra-group netting volume for a given currency is defined as the minimum of total supply and total demand:

$$M_t^{(c)} = \min (S_t^{(c)}, D_t^{(c)}) \quad (6)$$

In this case, the residual external demand for conversion will be:

$$R_t^{(c)} = D_t^{(c)} - M_t^{(c)} \quad (7)$$

Analysis

The empirical analysis was carried out on anonymized foreign exchange conversion data for 49 companies belonging to one diversified corporate group. The dataset includes 2,100 transactions executed from 2025 through March 2026 and makes it possible to examine the problem at three mutually connected levels: the level of individual company positions, the level of currency-specific internal matching, and the level of group-wide external execution. Since the names of companies and banks are not disclosed for confidentiality reasons, the analytical emphasis is placed on the structure of flows, the size of offsetting positions, and the managerial implications of the observed transaction pattern.

The first analytical result is that decentralized foreign exchange behavior creates a measurable duplication of external transactions. During the period under study, gross supply amounted to 39.94 billion, while gross demand amounted to 35.76 billion. If the companies are considered separately, each subsidiary tends to solve its own conversion problem through its own bank relationship and at its own execution rate. From the point of view of the group as a whole, however, part of this activity is economically unnecessary, because some companies are sellers of a currency at the same time as other companies are buyers of the same currency. The maximum possible intra-group netting volume was estimated at 4.69 billion, which means that this amount could have been matched internally before approaching external banks.

The importance of this result becomes clearer when it is interpreted through gross external activity rather than only through the netted amount itself. A netting volume of 4.69 billion reduces both sides of the market-facing operation: one company does not need to sell ex-

ternally and another company does not need to buy externally. Therefore, the potential reduction in gross external activity equals 9.38 billion. This is not merely an accounting effect. It represents a practical reduction in bank spreads, operational workload, confirmation procedures, settlement exposures, and liquidity movements between the group and external counterparties. In this sense, the economic meaning of the model is that centralization transforms a set of independent market transactions into an internal allocation problem plus a smaller residual external conversion problem.

Aggregate netting indicators: The main aggregate indicators can be summarized as follows: gross currency supply amounted to 39.94 billion, gross currency demand amounted to 35.76 billion, and maximum intra-group netting amounted to 4.69 billion. This implies a reduction of 9.38 billion in gross external activity, because every internally matched transaction removes both an external purchase and sale from the market-facing process. The gross netting ratio was 12.38%, while 13.11% of gross demand and 11.74% of gross supply could be covered through internal matching. These figures show that the effect is financially material and operationally relevant. The relative indicators confirm that the effect is substantial even when compared with the large total volume of transactions. A gross netting ratio of 12.38% means that almost one-eighth of all gross currency flows could be eliminated from the external market-facing process through coordination alone. Demand coverage of 13.11% shows the extent to which the group can satisfy its own currency needs without external purchases. Supply absorption of 11.74% shows the extent to which internal currency sellers can be matched with internal buyers. These indicators are useful because they move the analysis from the absolute size of the group to the quality of treasury coordination. A group may have large currency turnover, but the managerial question is how much of that turnover is genuinely external and how much is created by fragmented internal organization. The results also show that the benefit of centralization should not be understood as a one-time saving. The same mechanism may operate repeatedly whenever opposite positions arise inside the group. If companies regularly conduct imports, service payments, repayments, revenue conversions, or intra-group settlements in different currencies, the opportunity for matching is reproduced across time. Therefore, even a moderate ratio of internal matching can have a significant cumulative effect over a year. For this reason, the proposed model should be interpreted not only as a calculation of historical savings, but also as a diagnostic tool for identifying whether the treasury system is organized around group-level optimization or around isolated company-level execution.

Currency-level interpretation: At the currency level, AMD generated the strongest absolute result: approximately 4.04 billion of possible intra-group netting, with 22.26% of demand and 10.43% of supply covered internally. RUB had a smaller absolute netting volume, but its supply absorption reached 66.5%, which indicates that targeted internal matching can sharply reduce external sales in this currency. EUR and USD also demonstrate

the practical value of centralization. In EUR, 86.95% of demand could be covered internally, while in USD the corresponding figure was 43.66%. The currency structure of the results is analytically important because the value of a centralized treasury system depends not only on the total volume of flows, but also on the currencies in which opposite positions are concentrated. The strongest absolute netting potential was observed in AMD, where the possible intra-group matching volume amounted to approximately 4.04 billion. In AMD, 22.26% of gross demand and 10.43% of gross supply could have been balanced inside the group. This result suggests that local-currency flows are a central area for operational coordination. It also indicates that even when subsidiaries operate under the same group structure, their cash-flow profiles may differ sufficiently to create internal counter-parties for conversion needs. The AMD result is especially relevant for groups whose subsidiaries have different business models. Some companies may accumulate local-currency liquidity from sales, while others may require local currency for taxes, payroll, local procurement, or settlement of domestic obligations. Without a coordinating center, these companies may simultaneously sell and buy through different banks. With a central treasury or an internal FX company, the same flows can be redirected within the group. The analytical implication is that the highest-value currency for centralization is not always the currency with the highest volatility; it may be the currency with the strongest internal coincidence of supply and demand. The RUB results provide a different but equally useful interpretation. Although the absolute netting volume in RUB was smaller than in AMD, the absorption rate of supply reached 66.5%. This means that a large part of RUB supply generated by some companies could be used by other group companies instead of being sold externally. From a treasury-management perspective, such a result is important because it identifies currencies in which external sales can be reduced sharply even if the total amount is not the largest in the dataset. The indicator is therefore useful for designing currency-specific rules: high-volume currencies may require broad daily netting procedures, while currencies with high absorption ratios may require more targeted matching controls.

Relatively high internal coverage ratios were also obtained for EUR and USD. In the case of EUR, 86.95% of demand could have been covered internally, while the corresponding figure for USD was 43.66%. These values show that the group contains internal liquidity that can partially replace bank purchases in major international currencies. The practical conclusion is that multi-currency management should not be limited to measuring open exposure after transactions have already occurred. It should begin earlier, at the stage of planning and collecting expected demand and supply from subsidiaries. When the central unit receives this information before execution, it can decide which flows should be matched internally and which residual positions should be sent to external banks.

Time profile of netting opportunities: The time profile of netting opportunities is uneven, and this unevenness is one of the most important findings for treasury design. If matching

opportunities were distributed uniformly, a simple monthly consolidation process might be sufficient. The observed pattern, however, shows that high-value matching windows appear in specific days and weeks. The largest absolute potential was recorded in the week of April 14, 2025, when the possible AMD netting volume alone reached approximately 482.0 million. In the weeks of June 2 and June 16, 2025, the gross netting ratio amounted to 91.83% and 83.68%, respectively. These results indicate that timing is not a technical detail; it is a direct source of financial value.

The managerial interpretation is that the frequency of centralization should be adapted to the rhythm of the group's operations. Monthly netting may be administratively simple, but it can miss short-term coincidences of supply and demand. Daily netting may capture more opportunities, but it requires stronger data collection, faster approval procedures, and clearer settlement discipline. Weekly netting may be a practical compromise for many corporate groups. The empirical results therefore support a differentiated approach: currencies and subsidiaries with frequent opposite flows should be included in a higher-frequency netting cycle, while less active currencies can be managed through a lower-frequency procedure. Time concentration also affects liquidity planning. When opposite flows coincide, the group can reduce its need for external liquidity and avoid unnecessary conversion spreads. When they do not coincide, the treasury center must decide whether to execute the residual position immediately, hold a short-term open position within approved limits, or use internal liquidity to bridge the timing difference. This decision cannot be made only by comparing spot rates. It must also consider settlement dates, cash availability, counter-party limits, and the risk that expected internal flows may not materialize. For this reason, the analytical model should be connected with a treasury calendar that records expected payments, receipts, and conversion requests by company and by currency.

Execution dispersion and bank selection: The analysis of internal netting should be combined with the analysis of execution quality across banks. In a decentralized system, subsidiaries may use different banks at different times and may receive different execution rates for similar conversion needs. Even when the spread difference in one transaction appears small, the cumulative effect can be significant because the group executes many transactions across currencies and counterparties. Centralized execution reduces this problem in two ways. First, it decreases the number and volume of external trades by matching internal positions. Second, it allows the residual external position to be placed with banks that offer the best available quotation, liquidity, and settlement conditions. This point is particularly important because bank selection is not only a question of finding the best nominal rate. A large group must also consider execution certainty, settlement risk, operational reliability, documentation standards, and concentration limits. A quote that appears attractive may be less useful if the bank cannot execute the required size, if settlement arrangements are weak, or if the group already has excessive counterparty concentration.

Therefore, the proposed model should be understood as a two-stage decision system. At the first stage, internal netting determines the residual demand or supply by currency and date. At the second stage, the residual position is allocated among external banks according to execution quality and risk constraints. The empirical findings support this institutional logic. Since the group has both meaningful internal matching potential and repeated external execution needs, the creation of a centralized FX coordination unit would not merely formalize existing procedures. It would change the economic content of the process. Subsidiaries would no longer approach banks independently for every conversion. Instead, they would submit requests to the central unit, which would aggregate positions, identify internal matches, calculate residual exposures, compare bank quotations, and execute only the remaining external volume. This creates a clearer audit trail and gives management a better basis for evaluating whether the group is paying avoidable spread costs.

Risk and control implications: The strengthening of centralization also creates new control requirements. Internal netting reduces external volume, but it does not eliminate foreign exchange risk. If the central unit delays external execution or temporarily holds residual positions, market risk appears at the level of the treasury center. If internal matches are recorded without timely settlement, liquidity risk and internal credit risk may arise between subsidiaries. If bank allocation is based only on rate comparison, counterparty concentration and settlement risk may increase. Therefore, the analytical result should be implemented together with clear limits and procedures. At a minimum, the centralized framework should include daily or weekly reporting of currency demand and supply, rules for the confirmation of internal matches, approved settlement dates, limits for open positions, and a procedure for comparing bank quotations. It should also include a periodic evaluation of realized execution results against available market alternatives. Such a control system would make it possible to distinguish between three sources of performance: savings from internal netting, savings from better bank selection, and risk-adjusted costs caused by timing or liquidity constraints. Without this separation, management may overestimate the effect of one factor and underestimate another. The analysis therefore confirms the main hypothesis of the article: foreign exchange management in a group of companies is not only a hedging problem, but also a coordination and optimization problem. The data show that a significant part of external activity can be reduced through intra-group matching, especially in currencies and weeks where opposite flows coincide. The results also show that the practical value of the model depends on institutional design. The group needs a central unit capable of collecting information from subsidiaries, matching internal positions, executing residual flows through several banks, and controlling the risks created by centralization. In this form, the model provides both an analytical measurement of netting potential and a practical basis for redesigning the treasury process.

Proposal: A practical solution to the problem of managing foreign exchange conversions in a group of companies may be the creation within the group of a specialized foreign exchange intermediary company that would operate in two interconnected directions. The first direction is the concentration and netting of intra-group foreign exchange flows. In this case, the company becomes a centralized unit that collects the currency demand and supply of the subsidiaries, performs their matching, and takes only the net residual position to the external market. In the literature on international cash management, this logic is treated as a classical way of reducing transfer costs, spread costs, and unnecessary gross payment flows [Shapiro, 1978, 51-58; Adkins, 1991, 345-360]. The second direction concerns intermediary or brokerage functions in the external market. The company can simultaneously obtain quotations from several banks or liquidity providers, select the best execution conditions, and split volumes among counterparties. This corresponds to the structure of the modern FX market, in which execution quality, venue fragmentation, and multi-bank access play an increasing role [Chaboud et al., 2023, 1-5; BIS, 2020, 1-6]. The proposed FX company can therefore be characterized as a hybrid structure serving both as an internal transaction hub for the group and as an external execution coordinator. Such an arrangement is particularly useful for diversified corporate groups whose subsidiaries differ by business model but repeatedly generate offsetting currency positions. By entering the market only with residual positions, the group can reduce total spreads, negotiate better terms, and establish unified limits for counterparties, concentrations, confirmations, and settlement controls. In addition to these advantages, the emerging risks must also be assessed. A centralized FX unit would create operational, liquidity, counterparty, and model risk, and if it holds even short-term open positions, market-risk measurement becomes necessary. For this reason, the institutional proposal should be accompanied by a dedicated risk-management framework that includes open-position limits, settlement controls, and periodic Value at Risk measurement.

Conclusion

The study shows that foreign exchange management in a group of companies should be viewed not only as a hedging problem but also as a coordination and optimization problem. Using anonymized operational data on 2,100 transactions from 49 companies during 2025 through March 2026, the article demonstrates that meaningful savings can be achieved through centralized treasury logic. The empirical results indicate a maximum possible intra-group netting volume of 4.69 billion and a potential reduction of 9.38 billion in gross external activity, with especially strong effects in AMD and in weeks where internal supply and demand closely overlap. These findings imply that the greatest practical benefit of the proposed framework is for diversified corporate groups whose subsidiaries execute recurring conversions through several banks and therefore face both spread dispersion and avoidable duplication of market transactions. The article shows how centralized intermediary model improves execution quality, data visibility, and control discipline, provided that it is

supported by counterparty limits, settlement-risk controls, and market-risk measurement. In this sense, the main contribution of the article is to connect the analytical estimation of netting potential with a concrete institutional design for centralized FX management.

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Modeling foreign exchange management in a group of companies

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This article examines the problem of foreign exchange management in a group of companies from the perspective of centralized treasury coordination, intra-group netting, and execution quality. The study is motivated by the fact that diversified corporate groups often conduct foreign exchange conversions through several banks and several subsidiaries at the same time, which creates duplication of external transactions, uneven execution outcomes, and avoidable spread costs. The aim of the article is to develop and empirically illustrate a framework that connects company-level currency behavior, bank-level execution differences, and group-level optimization opportunities. The empirical basis of the research consists of anonymized primary operational data covering 2,100 foreign exchange transactions executed by 49 companies in 2025 through March 2026. Company names and bank names are not disclosed in order to preserve commercial confidentiality. The methodology combines descriptive comparison of bank execution, analysis of company net positions by currency and time, and modeling of intra-group netting under centralized management. The results show that gross supply amounted to 39.94 billion, gross demand to 35.76 billion, and the maximum possible intra-group netting volume to 4.69 billion. This corresponds to a potential reduction of 9.38 billion in gross external activity. The strongest netting potential was observed in AMD, while high internal coverage ratios were also identified for EUR and USD.