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MANAGING FOREIGN EXCHANGE RISK OF A SMALL BRAZILIAN IMPORTER

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Thesis presented to Escola de Administração de Empresas de São Paulo of Fundação Getulio Vargas, as a requirement to obtain the title of Master in International Management (MPGI).

Knowledge Field: International Economics and Finance

Adviser: Prof. Dr. Rafael F. Schiozer

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ABSTRACT

Currency risk is a recurring theme in companies today. Even for those who do not trade foreign currencies directly, there is still a conversion exposure that cannot be ignored in risk management. The present study proposes to develop an exchange rate management policy for a small Brazilian importer.

A case study of the company PPbr (pseudonym) was elaborated, who supplied data from recent years to build a FX risk management policy. To do so, I proposed a hedging strategy using NDF with maturation in 30, 60 and 90 days; based on two types of analysis: two-way sensitivity analysis and Monte Carlo simulation, obtaining the optimal hedge range for the company.

To verify the solution's efficiency, I prepared a back test, using data from 2021 and compared the results using two methodologies: (1) a t-test for the liabilities quoted in USD; and (2) a Sharpe ratio comparison between the unhedged solution and the proposed solution. The comparison demonstrates no predilection between the solutions. The Sharpe ratio of the unhedged strategy is extremely close to the hedged one, showing that the risk - return of the hedged strategy may not compensate to adopt hedged position; whereas the return of the t-test demonstrates there is no statistical significance difference between the strategies.

Keywords: FX hedge strategy, small Brazilian importer, foreign exchange risk management policy.

RESUMO

O risco cambial é um tema recorrente nas empresas de hoje. Mesmo aqueles que não negociam diretamente com moedas estrangeiras, ainda há uma exposição de conversão que não pode ser ignorada na gestão de risco. O presente estudo se propõe a desenvolver uma política de gestão da taxa de câmbio para um pequeno importador brasileiro.

Para tanto, foi elaborado um estudo de casa da empresa PPbr (pseudônimo), que forneceu dados dos últimos anos para a elaboração de uma política de gestão de risco cambial. Para tanto, eu propus uma estratégia de hedge com o uso de NDF com vencimentos em 30, 60 e 90 dias, embasada por duas análises: análise de sensibilidade bidirecional e simulação de Monte Carlo; obtendo um intervalo ótimo para a empresa realizar o hedge cambial.

Para averiguar a eficiência da solução, eu elaborei um backtest, com os dados de 2021 e comparei os resultados utilizando duas metodologias: (1) t-test referente às obrigações da empresa, cotadas em moeda estrangeira; e (2) comparação do índice Sharpe entre a solução de sem hedge e a minha solução proposta, com proteção. O índice de Sharpe da estratégia sem hedge cambial é extremamente próximo àquela com hedge, mostrando que o retorno do risco da estratégia com hedge pode não compensar. O resultado do t-test demonstra que não há diferença com significância estatística para confirmar se a estratégia com hedge cambial traz um retorno maior que a estratégia sem hedge cambial.

Palavras-chaves: Estratégia de hedge cambial, pequeno importador brasileiro, política de gestão de risco cambial.

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1 INTRODUCTION

The literature that studies the use of derivatives by non-financial firms is mostly limited to large corporations (e.g., Bodnar et al., 1995, 1996, 1998; Froot et al., 1993; Graham & Rogers, 2002) and commodity firms in developed markets (Crocini et al., 2017; Haushalter, 2000; among others). While there is an increase literature focused on the usage of derivatives in Latin America (e.g., Lopes et al., 2013; Saito & Schiozer, 2007), very few of these studies address the financial risk management of small and medium enterprises (hereafter, SMEs). Indeed, few of these companies implement a foreign exchange (hereafter, FX) risk management strategy regardless of the executives' claims of their knowledge about the hedging instruments available (Espanhol, 2020).

In this context, I seek to analyze a Brazilian importer of auto parts (“the firm”). Like most Brazilian SMEs, they are susceptible to FX rate variations and lacks an FX risk management policy. The choice to present this research as a teaching case study (that can be applied in courses like *International Finance*, *Risk Management* and other related topics) is justified by the lack of hands-on case studies focusing on FX risk management in SMEs located in emerging markets.

The purpose of the present case is to answer the following questions: (i) Should the firm introduce an FX risk management policy using derivatives? (ii) If so, what is the optimal hedging ratio? (iii) What derivatives should the company employ?

To answer these three main questions, the remainder of this thesis is organized as follows: Section 2 describes the company and its operations- the relevant automotive market and the current FX exposure of the company. Section 3 analyses the motivations for the firm to enter into hedge contracts, and structure an FX risk management process. Section 4 presents the relevant data and information to answer the three proposed questions. Section 5 puts into context the determining factors that the manager should weight and reflect upon to build the FX risk management assessment. Section 6 proposes a solution to the case and concludes.

2 COMPANY BACKGROUND AND COMPETITIVE FRAMEWORK

PPbr (pseudonym) is a second-generation private family business in Brazil – currently specialized in importing Chinese auto parts for distribution in the Brazilian market. The company started its operation as an import arm of Élice, the largest electric pump manufacturer for windshield wipers in Brazil.

Both companies held the monopoly as sole suppliers of electric pumps to both the Brazilian automakers and the aftermarket. While Élice manufactured the products locally, PPbr outsourced the pumps from Chinese companies. The way the companies were structured allowed them to have independent management, and due to Élice's mismanagement, PPbr outgrew Élice.

In 2010, as a consequence of the Global Financial Crisis of 2008/2009, Élice's situation reached its bottleneck and the companies were disintegrated through a spinoff, before Élice declaring bankruptcy. At the time, PPbr was still profitable, but due to the contagion from Élice's bankruptcy, PPbr's financial situation was problematic. To solve some of the financial problems, PPbr was sold to the current management.

The firm underwent a strong restructuring, shifting its scope from electric pumps to suspension and steering auto parts. Currently the firm works in a lean way, importing suspension and steering auto parts from China for resale in the Brazilian aftermarket.

Since the separation of PPbr and Élice, the macroeconomic situation in Brazil has been complex, with several crises that impacted the Brazilian exchange rate. The main crises, originating from both domestic and international causes, are shown in Table 1 and the repercussions were prejudicial to the Brazilian economy and financial health of the Brazilian companies. The impact these events caused to the FX rate were meaningful, Exhibit 3 links these crises to the FX rate disturbances.

Table 1 - Most important Brazilian economic events from 2008 until present

The table provides an overview of the major economic events since 2008. The column Year defines the approximate period that the crisis began as well as its approximate duration. The column Event states the name which said event is publicly known or called. The column Comments provides a short description of the crisis.

Year (Duration)	Event	Comment
Dec-2007 (2 years)	The Great Recession (Global scale crisis)	The collapse of the US housing market, fueled by easy credit, insufficient regulation, low interest rate and toxic subprime mortgages.
Apr- 2016 (5 months)	Impeachment of President Dilma Roussef (Domestic crisis)	Brazilian former President Dilma Roussef was formally impeached on April 17, 2016. On August 31, 2016 the Senate voted to remove her from office for breaking Brazil's budget law.
May-2017 (-)	Joesley day (Domestic Crisis)	On May 17, 2017 an audio recording was made public. In the recording, Joesley Batista, CEO of JBS (the largest meat processing company worldwide), and Michel Temer, Brazilian President during the time, were arranging the payout of a corrupt deputy, to guarantee his silence.
May- 2018 (11 days)	Truckers' strikes (Domestic crisis)	Truck drivers were unsatisfied with the increase of the fuel price and other fees. For 11 days, they suspended all activities causing interruptions in several supply chains.
Jan- 2020 (ongoing)	World pandemic Covid -19 (Global scale crisis)	In December 2019, a cluster of lung disease of unknown etiology was reported in Wuhan, China. In January 2020, Covid-19 was identified. A global health and economic crisis followed.

Source: Elaborated by the author

Despite these crises, the firm was able to keep a steady growth during the entire period (see Exhibit 4). However, starting in 2020, the volatility of the BRL against USD and the pandemic situation placed the firm in a delicate situation where a currency hedging strategy was necessary, not only to maximize the company's profit, but mainly to avoid financial distress by protecting it from possible depreciations of the Brazilian Real.

Exchange rate fluctuations cannot be fully passed on to the customer, and it takes time to adjust the price of the products according to the exchange rate. In this way, the firm currently works with an exchange rate equal to BRL/USD 5.2900 (last adjustment was in October 2020). Hence, in case the USD remains the on a steady level, the firm is able to maintain a positive profit margin. Otherwise, the firm risks operating at a loss.

It is noteworthy that the products are quoted in Chinese Yuan (RMB) and converted at spot to US dollars, when they are paid. An FX risk management assessment would be based on an imperfect hedge strategy; because of the lack of hedging instruments to mitigate the risks stemming from the BRL/RMB exchange rate; consequently, the firm would not be able to hedge the risks derived from the fluctuations of the RMB in relation to the USD. Regardless, the fluctuations of the RMB against the USD are not so volatile as the fluctuations of the BRL against the USD; hence, the current need to focus only on the BRL/USD hedge strategies.

2.1 Automotive culture

The Brazilian automotive industry reflects the economic heterogeneity of Brazilian society. The range of cars varies from imported luxury vehicles to more popular and affordable ones. Thus, there are suppliers that cater to those who are looking for more affordable products and to those looking for high-end products. The quality of each product is translated into its price.

Several factors affect and transform the current Brazilian automotive market. On one hand a new generation of consumers are increasing their awareness of the environmental problems caused by internal combustion engines. On the other hand, new forms of transport and mobility are disrupting a traditional industry. Additionally, mindful of several financial crises, the younger generation values experience and pleasure over the ownership of things, such as cars or houses (Sassano, 2019) due to the loss of purchasing power. Despite the changes in the foreseeable future, the maintenance of the existing vehicles and demands for auto parts will

likely remain stable; and this change of consumer behavior does not present a threat for the firm yet.

2.2 Aftermarket structure

Customers can purchase their products through several sources. The so-called "originals" are manufactured by the automakers or approved by them, and can be sold directly to the final consumer. There are also manufacturers or importers which, through various layers and intermediaries, reach the final consumer.

To prevent low-quality products, government agencies have regulated a series of minimum requirements that automotive manufacturers or importers must comply with to ensure the suitability and safety of the products. Regulatory measures are important to ensure the well-being and safety of drivers and passengers, but this also creates obstacles for manufacturers and importers, which in turn increase operating costs and limit the entry of new competitors.¹

Nevertheless, consumers look for reliable suppliers, with whom they have had a good experience or word-of-mouth reviews. This makes the industry more conventional and not so dynamic; intermediaries and final consumers will not risk changing their suppliers unless much better conditions are presented.

2.2.1 The players

Due to the characteristics in which the aftermarket operates, two different types of suppliers have consolidated: domestic manufacturers and importers.

Domestic manufacturers:

Few companies opted to manufacture domestically, since the costs associated with a domestic production, generally referred to as "Custo Brasil" (Brazil's cost), are high. These include a complex tax system, an intricate labor legislation that increases labor costs, a lack of good transportation infrastructure and low investor protection that increases the cost of capital.

¹ Since 2015, some suspension auto parts must be certified to be manufactured, imported or consumed in Brazil.

Besides the intrinsic risk as a Brazilian manufacturer, these domestic producers are also affected by the changes of the FX rate. For instance, the raw material for the production of the suspension parts, the iron ore, is quoted in USD affecting both domestic manufacturers and importers. Nevertheless, in general, domestic manufacturers are benefited by a weaker Brazilian Real, they are able to either gain profit margin or gain competitive advantage against importers.

Moreover, domestic manufacturers are able to stabilize their prices during turbulent times, when the BRL/USD volatility increases. Since 2016, the Brazilian Real has suffered a strong depreciation against the US Dollar, from 3,2041 BRL/USD on October 1, 2016 to 5,3079 BRL/USD on September 20, 2021². During a period of crisis, this scenario can be advantageous for the domestic manufacturers as they do not have transaction exposure.

For PPbr, maintaining prices is important, as it retains customers who are looking for quality products at competitive prices. Thus, to compete with domestic manufacturers, a hedging strategy is interesting as it allows the firm to offer the price stability that customers desire.

Importers:

Several Brazilian companies opt to import products from countries with high productivity and cheap labor costs to avoid the “Brazil’s cost”. Despite some positive aspects of this model, an importer is exposed to both USD and the producing country currency variations (in the case of PPbr, the RMB). And the high volatility of a currency, like the Brazilian Real, may undermine any company’s cash flow.

2.3 Pandemic situation

In January 2020, the world watched the onset of the Covid-19 pandemic unravel. In the first months of 2020, the Wuhan territory of China was the virus’ starting point, and was placed in a severe lockdown to stop the disease from spreading to other regions and countries.

The restrictive measures were not enough to contain the disease and on February 26, 2020 the first case of Covid-19 in Brazil was confirmed in São Paulo, where the firm is located. After one month the situation deteriorated, as the number of cases confirmed increased and the

² Source: Yahoo Finance. (September 21, 2021)

hospitals were overcrowded. The state government declared a lockdown on March 24, 2020, where only essential services were allowed.

These restrictions strongly affected the firm which, at first, was prevented from making any sales. Logistics and supply chain were also impacted, as freight- both maritime (between countries) and terrestrial (within Brazil) were intermittent. The most restrictive lockdown lasted three months and the FX rate presented a high volatility during this period. Between July 2020 and July 2021, sporadic restrictions were introduced according to the hospital's situation and increase/ decrease of Covid-19 infections.

In March 2020, as the Covid-19 became more severe, affecting several countries, it also affected overall economies as well as exchange rates. As the global demand for commodities reduced, major commodities exporting countries like Mexico and Brazil were more severely affected. Unlike Brazil, that has floating exchange rate, China has a fixed exchange rate pegged to US Dollar, which may explain why China's exchange rate remained constant during the pandemic period (*Coronavirus Effects on Exchange Rates / FRED Blog*, n.d.).

The period between January 2020 and August 2021 was characterized by a strong depreciation of the Brazilian Real against other currencies. Additional to the health scenario, Brazilian political problems and flight-to-safety (including the search for strong currencies, such as the USD) contributed to the drop of more than 20% of the Brazilian Real against the US Dollar during this period, making the BRL one of the currencies that depreciated the most worldwide (see Exhibit 2).

The company imports directly and exclusively from China; as this was the epicenter of Covid-19's dissemination, the supply chain and logistics were severely affected. The first outbreak on Chinese territory (January 2020) coincided with the Chinese New Year. Thus, the first impact was cushioned by an event that had already been planned and did not affect the company's inventories or logistics. However, from 2020 to 2021, one-off outbreak cases in Chinese ports or cities interrupted the supply of products as ports or cities were closed (e.g., Ningbo in August 2021).

2.4 Current hedging practice

To date, the firm has opted not to put an FX risk management policy in place, because according to the manager, it did not add value to the firm. However, the duration and intensity of the latest crisis, triggered by the Covid-19 pandemic, added more risk to the financial health of the firm. The lack of an FX risk management policy exposed the firm's cash flow to the variations of both USD and RMB, causing PPbr to consider implementing a risk management strategy. The current situation presents an opportunity for the firm to improve its risk management process.

3 MOTIVATIONS FOR FOREIGN EXCHANGE RISK MANAGEMENT

Recent studies discuss broadly the reasoning behind the use of derivatives in corporate risk management (Géczy et al., 1997; Graham & Rogers, 2002; Mian, 1996; among others). From a financial flexibility point of view, hedging combines a firm's internal supply and demand of funds for investment opportunities and reduces cash flow sensitivity (Froot et al., 1993).

That said, an optimal hedging strategy does not translate into total insulation of firm value from marketable sources of risk, and a hedging strategy may reduce the costs whilst protecting part of the cash flow (Géczy et al., 1997; Mian, 1996; Nance et al., 1993; Saito & Schiozer, 2007). Given the negative expected return of a hedge strategy, firms will want to hedge less the more closely correlated are their cash flow with future investment opportunities (Froot et al., 1993). Particularly, in an emerging market such as Brazil, currency fluctuations are an important risk for many firms in such markets, as shocks affect the exchange rate in emerging markets quickly and strongly (Bhattarai et al., 2020; Maćkowiak, 2007). Importers in these countries are hardly hit by sudden large depreciations of the local currencies. In addition, the cost of hedging for importers and firms holding foreign-denominated debt is high in emerging markets because assets denominated in a strong currency work as an insurance for emerging market investors. As a result, importers bear the cost of the currency premium upon hedging, meaning that their hedging contracts have negative expected returns ex-ante because of the currency premium (Burnside et al., 2011; Domowitz et al., 1998; Menkhoff et al., 2012). According to Tufano (1998), cash-flow hedging strategies allow firms to avoid the deadweight costs of external financing by setting their internal cash flows equal to their investment needs. In the presence of agency conflicts between managers and shareholders, these hedging strategies can be used to reduce shareholder wealth, insofar as they remove the valuable discipline that obtaining new external financing imposes on managers.

All in all, *“finance theory indicates that hedging increases firm value by reducing expected taxes, expected costs of financial distress, or other agency costs”* (Nance et al., 1993), adding firm value to the company.

An FX risk management policy allows the firm to increase the certainty of operating margins. This means a hedge strategy may allow the company to minimize the impacts of FX rate fluctuations on cash flow and reported earnings. This analysis is consistent with the goals of

the firm. A hedge strategy would allow the firm to work with more certainty and better explore its profit margin.

4 CONTEXTS

4.1 Company's finances

The firm was able to maintain a stable growth between 2015 and 2020, despite the economic crises that it had to overcome (see Exhibit 4– retail growth per year). In case the price and quality of the products remain the same, the demand for them is predictable, facilitating the forecast of the cash flow for the following months. Hence, minimizing the fluctuations in the price of the products as much as possible is important to maintain demand and cash flow predictability, and guaranteeing cash flow stability for the 3-month-ahead period when a hedge strategy would be applicable.

The firm's last price adjustment took place in October, 2020, when it calculated the markup of the products considering a BRL/USD 5.2900 exchange rate. The forecast for the following three months cash flow (from October 2021 until January 2022) was calculated based on this value (see Exhibit 7 for a simplified cash flow). The firm also built a more succinct table, listing payments due in USD per week, with a history since 2020 and a projection for the coming 3 months (October, November and December of 2021), according to purchases and departure of new shipments (see Exhibit 6).

It is important to highlight that the Chinese currency (de)appreciation affects the firm's cash flow as the products are quoted in RMB. Invoices are automatically converted from RMB to USD and paid in USD. Thus, in general terms, the more devalued the Chinese currency, the more advantageous it is for the company.

Also, after some years, the company's manager realized that it is possible to predict the cash flow's necessity according to the projected inflows in BRL: the projected cash flow for the period should be the projected inflow of the respective month multiplied by a factor. For the following month, this factor is equal to 1; whereas for the following two months, the factor is equal to 0,88. For more than three months the uncertainty caused by sales and currency variations makes a more accurate forecast very challenging, and does not reflect reality.

4.2 Global Financial Market

Economists believe a trend worldwide will take place, where the governments will deescalate their pandemic-era stimulus program, the FED leading this movement by raising the US interest

rate in 2022, to combat higher inflation. It is expected a more aggressive approach to tightening monetary policy and the FED will raise by at least a quarter of percentage point within the first half of 2022 (Smith & Zhang, 2021).

Despite this, the global scenario still brings a lot of uncertainty as new Covid-19 variants are discovered and the lack of raw material and products are causing a general increase of prices.

4.2.2 Central Bank of Brazil and the Brazilian Real

The Brazilian scenario remains uncertain. The institutional crisis brought about by the dispute between the executive, legislative and judicial powers put pressure on the fiscal balance, in an above-normal macroeconomic context: so far, 2021 was the worst year of rain in the historical series; several frosts damaged crops around the country and supply chains worldwide were disrupted (Verde Asset Management, 2021), causing further pressure on the BRL/USD exchange rate.

Another factor that adds uncertainty is the 2022's presidential elections. Generally, presidential election years are more tumultuous from an economic point of view, which affects the Brazilian currency (see Exhibit 8). The political polarity of the upcoming elections demonstrates that a greater degree of uncertainty can lead to something of a roller-coaster ride, regardless of the political outcome.

The weaker and more volatile currency appears to be perpetuated during the last quarter of 2021 and early 2022. According to Reuters (2021), *“the Brazilian currency lost around 10% in the first three months of the year, briefly revisiting its record closing low of 5.88 per U.S. dollar set last year. That mark could be easily breached soon (...). The real is seen at 5.31 per U.S. dollar in 12 months, according to 27 analysts polled March 26-30”*³

The Focus survey edition of September 22, 2021, estimates the GDP growth in 2021 and 2022, respectively, 5,04% and 1,57%. The projections for the inflation index (IPCA) suggest it will reach 8,45% and 4,12% in 2021 and 2022, respectively. And the exchange rate is expected to reach BRL/USD 5,20 at the end of 2021 and maintain this value until the end of 2022. The Brazilian interest rate was increased at the Copom (Monetary's Policy Committee) meeting of

³ Reuters, available at: < <https://www.reuters.com/article/us-forex-poll-latam-idUSKBN2BO6FO>>

September 23, 2021 to 6.25%. Experts project the rate will increase to 8.50% by the end of 2022. (Focus survey, September 22, 2021 edition).

4.3 Hedging products in Brazil

There are four main types of currency derivatives available in Brazil: forwards, futures, options, and swaps. An FX risk management policy involves using one or more of these four products, according to the complexity of the firm's exposure, the availability of these products to the firm (for example, small firms may not have access to the full range of OTC derivatives offered by banks) and the costs of hedging. And new strategies are constantly being developed to meet the demands of the market.

In Brazil, due to a more scrutinized control from the Government, the *non-deliverable forwards* (NDF) contracts are a good tool as a FX rate hedge strategy. A NDF is similar to a regular forward FX contract, i.e., it is an obligation to purchase or sell a specific currency on the settlement date, for a fixed price set at the contracting date. The main differential of a NDF consists of not requiring the physical delivery of currencies (i.e., it is settled by the difference between the spot price at maturity and the previously agreed forward price).

4.4 Hedging Strategy

Despite the variety of contracts available to build a more complex FX risk management policy, the firm decided to examine only the NDF and the results derived from that strategy. The reasoning behind this choice is based on the ease and cost of this alternative. As a company newly introducing an FX risk management policy, it would be unwise to select more complex tools at this stage. Also, the costs involved with more complex contracts could affect the firm's cash flow, and as an SME, this could jeopardize the financial health of the firm.

The firm decided that the hedging should consider the cash hedging and contacted its bank, looking for the alternatives available. The bank offered three alternatives of NDF with different settling dates, 30, 60 and 90 days and strike prices (see Exhibit 5 with the bank's proposal). The firm should adopt a strategy where it prioritizes the balance between decreasing risk and not harming expected return.

5 THE DECISION

It is the end of September/2021 and after almost two years of high FX rate exchange volatility, the depreciation of the BRL started to hurt PPbr's bottom line. The exchange rate used as PPbr's budget for 2021 was 5,2900 BRL/USD; and if the BRL/USD was to continue at an above budget 5,2900 level, the firm would need to engage into a new negotiation of a new wholesale price or risk squeezing its margins and losing profitability. However, a new negotiation could jeopardize the relationship with the clients, who may seek out other suppliers to provide products for more affordable prices.

And while the current strategy had served the company for the previous years, how would the company be affected in case the Brazilian Real depreciates even more? Or if the volatile scenario remains for the following months? Or what if PPbr hedges and the Brazilian Real appreciates? That would make the company lose its margins and restrain the ability to outprice competitors.

According to the company's estimation, the incoming revenues (ranging from BRL 650.000,00 to BRL 750.000,00) will be enough to cover the company's fixed costs and the USD debt, not jeopardizing the company's cash flow. That said, the projections place the BRL/USD to a high of 5,5500 at the end of October, and a great volatility is expected until the end of 2022. Hence, to guarantee a competitive advantage or even maximize the profitable margins, it would be in the company's interest to engage into a FX hedge strategy.

Considering the global and domestic scenarios, the firm's management should make a decision to protect the firm for the following months. Should they leave the company exposed, given the improvement of the world economy? Should they hedge a part or the entire currency exposure using the NDF, and if so, what is the best mix to optimize the result? Should they wait until the Brazilian Real rebounded higher and negotiate better prices with the bank, risking that the opposite may happen?

The currency screen was showing the BRL/USD ticking at 5,4611, as the firm's manager reviewed the bank's proposal, reflecting what would be the best path for the company.

6 THE PROPOSED SOLUTION

The main goal of the firm is to reduce the transaction risk by reducing its exposure. To do so, they have the option to engage into a hedging strategy, using derivatives to mitigate the impacts of the FX rate variation and guarantee the margins of the firm. This not only reduces the transaction risk, but also allows the company a more predictable cash flow. The determination of the fraction of the hedged exposure is the main question of the problem since the products available are only limited to NDFs. To assess this, it is necessary to accurately project the BRL/USD for the following period. As stated before, a hedging strategy considered refers to a cash hedging.

It is also important to note that the development of an FX rate management policy will not be for a specific period, for the next 3 months. Considering the company's area of operation, it is important to maintain a healthy cash flow that the company routinely uses this strategy.

Thus, the hedging strategy needs to be something practicable on a daily basis and, by acquiring more market experience, the company's management will be able to update the available products and refine its strategy.

Despite the impacts of taxes on the company's cash flow, for this hedge strategy I did not consider since it is not the focus nor scope of the present work.

6.1 Hedge strategy

Since it is not possible to insulate 100% of the company from the exogenous impacts, the main goal of the firm is to reach the optimum ratio between protection and expected return. The products available allow protection for the following 30, 60 and 90 days.

As mentioned before, the correct calculation of the BRL/USD will be the pillar to build the base-case scenario, from which the estimations and projections will be assembled. Thus, two solutions were developed; a simplified one and a more complex one. For the first case, I used a two-way sensitivity analysis, observing how the variations of the FX rate will affect the company's cash flow and selecting a critical value to decide the exposure the company is willing to take to guarantee the maximum return. The second model used a Monte Carlo simulation, to ensure that this base-case scenario reflected reality as much as possible. Since the BRL/USD rate has a tendency of increasing according to the interest rate differential (interest rate parity),

I used a model of random walk with trend. Similarly, to the previous model, I obtained the cash net generation for each model in order to decide a critical value and ensure the best hedge strategy for the company, that guarantees less exposure and maximum return.

In order to do so, I used data provided in Exhibit 7, using the projected inflows and outflows for the said month, and converting the USD values using the FX rate calculated for each methodology. In the end, the values of the cash net generation will be used to define the best hedge strategy.

6.1.1 Two-way Sensitivity Analysis

The two-way sensitivity analysis was selected to evaluate the hedging strategy since it is possible to estimate the robustness of the overall result when simultaneously varying the FX rate and the hedging ratio. The possible FX rates were input in the rows whereas the hedging ratios were inserted in the columns (see Table 2). The result of each cell is the expected cash flow according to the FX rate and hedging ratio, considering the expected sales value and fixed costs of the company.

It is interesting to notice that the expected negative return of the fully hedged position does not hold. Since I assume an equal probability of all the FX rate, which does not reflect the reality, this result was expected. To overcome this, I did a new simulation considering the chances of each scenario occurring. For that, I simulated the FX rate according to a Gaussian distribution, being more likely an FX rate value of 5,500 and highly unlikely an FX rate of 4,7500 or 6.2500. The result of this new interaction is shown in Table 3. Despite this new assumption, it is possible to observe that for the 30- and 60- days analysis, the fully hedged position still has a positive return. The 90- days analysis reports a negative return, as expected. This result may be associated with the price of the NDF.

In order to define a critical value, I considered the FX rate uncertainty, and the risk/ return the company is willing to undergo to maximize their profits. Due to the “Brazil cost”, it is important that a company maintain a high financial reserve; in case of eventualities, the financial reserve can be used to cover such unforeseen events, such as labor lawsuits, equipment breakdown among others.

As the firm has a reasonably large savings account (given by initial balance), I assumed that the cash flow must be at least 5% higher of the inflows, so that the company can maintain a healthy financial reserve. As the months of November and December are two months apart, I applied a penalty for those months, multiplying by a factor of 0,88, as empirically obtained by the company's manager and explained throughout the first part of the case. This value will provide me the minimum cash threshold in order to define the best hedging ratio.

The critical values have been rounded to the nearest values; therefore, for October, November and December the critical cash flow values were, respectively, R\$793.000; R\$905.000 and R\$544.000. Any scenario that provides a cash flow below this amount has been rejected.

As I assumed a normal FX rate distribution, there is an equal probability on both sides of the curve, so considering that the company manager accepts an average level of risk in order to maximize profit, it makes sense that for the 30-day NDF, the manager performs a hedge of at least 90% to 100% of his liability. Considering the probability of the FX rate and the returns, a hedge of at least 90% guarantees a return with low risk for the company.

For November, the 60-day NDF, the hedge should be from 40% to 80%. In this case, considering the defined critical value, it is not profitable for the company to enter a position above 80%, since up to such value the return is within the predetermined. Given the probability, the company should hedge at least 40%, to protect its cash flow if the Brazilian Real has a depreciation.

For the 90-day NDF, maturing in December, the company should hedge between 10% and 60%. Similarly, in this range, the company manages to protect itself in all possible scenarios, reaching the critical value and maintaining a reasonable return.

Table 2 - Two - way Sensitivity Analysis Matrix (October/2021, November/ 2021 and December/ 2021)

This table presents the cash flow varying the hedging ratio (established in the first row) versus the FX rate (first column), there is an equal chance that all the FX rate will happen. Panel A summarizes the data for October 2021. Similarly, Panel B provides the same information but using the data for November/2021 and Panel C provides the data for December/2021.

Panela A: October/2021											
% Hedge	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
4,7500	808.340,77	806.983,82	805.626,87	804.269,93	802.912,98	801.556,03	800.199,08	798.842,14	797.485,19	796.128,24	794.771,29
4,8500	806.247,04	805.099,46	803.951,89	802.804,31	801.656,74	800.509,17	799.361,59	798.214,02	797.066,44	795.918,87	794.771,29
4,9500	804.153,31	803.215,10	802.276,90	801.338,70	800.400,50	799.462,30	798.524,10	797.585,90	796.647,70	795.709,49	794.771,29
5,0500	802.059,57	801.330,75	800.601,92	799.873,09	799.144,26	798.415,43	797.686,61	796.957,78	796.228,95	795.500,12	794.771,29
5,1500	799.965,84	799.446,39	798.926,93	798.407,48	797.888,02	797.368,57	796.849,11	796.329,66	795.810,20	795.290,75	794.771,29
5,2500	797.872,11	797.562,03	797.251,95	796.941,86	796.631,78	796.321,70	796.011,62	795.701,54	795.391,46	795.081,37	794.771,29
5,3500	795.778,38	795.677,67	795.576,96	795.476,25	795.375,54	795.274,84	795.174,13	795.073,42	794.972,71	794.872,00	794.771,29
5,4500	793.684,65	793.793,31	793.901,98	794.010,64	794.119,30	794.227,97	794.336,63	794.445,30	794.553,96	794.662,63	794.771,29
5,5500	791.590,91	791.908,95	792.226,99	792.545,03	792.863,07	793.181,10	793.499,14	793.817,18	794.135,22	794.453,26	794.771,29
5,6500	789.497,18	790.024,59	790.552,00	791.079,42	791.606,83	792.134,24	792.661,65	793.189,06	793.716,47	794.243,88	794.771,29
5,7500	787.403,45	788.140,23	788.877,02	789.613,80	790.350,59	791.087,37	791.824,16	792.560,94	793.297,72	794.034,51	794.771,29
5,8500	785.309,72	786.255,88	787.202,03	788.148,19	789.094,35	790.040,51	790.986,66	791.932,82	792.878,98	793.825,14	794.771,29
5,9500	783.215,99	784.371,52	785.527,05	786.682,58	787.838,11	788.993,64	790.149,17	791.304,70	792.460,23	793.615,76	794.771,29
6,0500	781.122,25	782.487,16	783.852,06	785.216,97	786.581,87	787.946,77	789.311,68	790.676,58	792.041,49	793.406,39	794.771,29
6,1500	779.028,52	780.602,80	782.177,08	783.751,35	785.325,63	786.899,91	788.474,18	790.048,46	791.622,74	793.197,02	794.771,29
6,2500	776.934,79	778.718,44	780.502,09	782.285,74	784.069,39	785.853,04	787.636,69	789.420,34	791.203,99	792.987,64	794.771,29
Mean	792.637,78	792.851,13	793.064,48	793.277,83	793.491,19	793.704,54	793.917,89	794.131,24	794.344,59	794.557,94	794.771,29
SD	9.651,63	8.686,46	7.721,30	6.756,14	5.790,98	4.825,81	3.860,65	2.895,49	1.930,33	965,16	0,00
Min	776.934,79	778.718,44	780.502,09	782.285,74	784.069,39	785.853,04	787.636,69	789.420,34	791.203,99	792.987,64	794.771,29
Max	808.340,77	806.983,82	805.626,87	804.269,93	802.912,98	801.556,03	800.199,08	798.842,14	797.485,19	796.128,24	794.771,29

Panel B: November/2021											
% Hedge	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
4,7500	927.491,04	925.627,04	923.763,03	921.899,03	920.035,02	918.171,02	916.307,01	914.443,01	912.579,00	910.715,00	908.851,00
4,8500	924.747,84	923.158,16	921.568,47	919.978,79	918.389,10	916.799,42	915.209,73	913.620,05	912.030,36	910.440,68	908.851,00
4,9500	922.004,64	920.689,28	919.373,91	918.058,55	916.743,18	915.427,82	914.112,45	912.797,09	911.481,72	910.166,36	908.851,00
5,0500	919.261,44	918.220,40	917.179,35	916.138,31	915.097,26	914.056,22	913.015,17	911.974,13	910.933,08	909.892,04	908.851,00
5,1500	916.518,24	915.751,52	914.984,79	914.218,07	913.451,34	912.684,62	911.917,89	911.151,17	910.384,44	909.617,72	908.851,00
5,2500	913.775,04	913.282,64	912.790,23	912.297,83	911.805,42	911.313,02	910.820,61	910.328,21	909.835,80	909.343,40	908.851,00
5,3500	911.031,84	910.813,76	910.595,67	910.377,59	910.159,50	909.941,42	909.723,33	909.505,25	909.287,16	909.069,08	908.851,00
5,4500	908.288,64	908.344,88	908.401,11	908.457,35	908.513,58	908.569,82	908.626,05	908.682,29	908.738,52	908.794,76	908.851,00
5,5500	905.545,44	905.876,00	906.206,55	906.537,11	906.867,66	907.198,22	907.528,77	907.859,33	908.189,88	908.520,44	908.851,00
5,6500	902.802,24	903.407,12	904.011,99	904.616,87	905.221,74	905.826,62	906.431,49	907.036,37	907.641,24	908.246,12	908.851,00
5,7500	900.059,04	900.938,24	901.817,43	902.696,63	903.575,82	904.455,02	905.334,21	906.213,41	907.092,60	907.971,80	908.851,00
5,8500	897.315,84	898.469,36	899.622,87	900.776,39	901.929,90	903.083,42	904.236,93	905.390,45	906.543,96	907.697,48	908.851,00
5,9500	894.572,64	896.000,48	897.428,31	898.856,15	900.283,98	901.711,82	903.139,65	904.567,49	905.995,32	907.423,16	908.851,00
6,0500	891.829,44	893.531,60	895.233,75	896.935,91	898.638,06	900.340,22	902.042,37	903.744,53	905.446,68	907.148,84	908.851,00
6,1500	889.086,24	891.062,72	893.039,19	895.015,67	896.992,14	898.968,62	900.945,09	902.921,57	904.898,04	906.874,52	908.851,00
6,2500	886.343,04	888.593,84	890.844,63	893.095,43	895.346,22	897.597,02	899.847,81	902.098,61	904.349,40	906.600,20	908.851,00
Mean	906.917,04	907.110,44	907.303,83	907.497,23	907.690,62	907.884,02	908.077,41	908.270,81	908.464,20	908.657,60	908.851,00
SD	12.645,53	11.380,97	10.116,42	8.851,87	7.587,32	6.322,76	5.058,21	3.793,66	2.529,11	1.264,55	0,00
Min	886.343,04	888.593,84	890.844,63	893.095,43	895.346,22	897.597,02	899.847,81	902.098,61	904.349,40	906.600,20	908.851,00
Max	927.491,04	925.627,04	923.763,03	921.899,03	920.035,02	918.171,02	916.307,01	914.443,01	912.579,00	910.715,00	908.851,00

Panel C: December/2021											
% Hedge	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
4,7500	815.139,78	809.875,21	804.610,64	799.346,08	794.081,51	788.816,94	783.552,37	778.287,80	773.023,23	767.758,67	762.494,10
4,8500	807.820,76	803.288,10	798.755,43	794.222,76	789.690,10	785.157,43	780.624,76	776.092,10	771.559,43	767.026,76	762.494,10
4,9500	800.501,75	796.700,98	792.900,22	789.099,45	785.298,69	781.497,92	777.697,16	773.896,39	770.095,63	766.294,86	762.494,10
5,0500	793.182,73	790.113,87	787.045,01	783.976,14	780.907,28	777.838,41	774.769,55	771.700,69	768.631,82	765.562,96	762.494,10
5,1500	785.863,72	783.526,75	781.189,79	778.852,83	776.515,87	774.178,91	771.841,95	769.504,98	767.168,02	764.831,06	762.494,10
5,2500	778.544,70	776.939,64	775.334,58	773.729,52	772.124,46	770.519,40	768.914,34	767.309,28	765.704,22	764.099,16	762.494,10
5,3500	771.225,68	770.352,53	769.479,37	768.606,21	767.733,05	766.859,89	765.986,73	765.113,57	764.240,42	763.367,26	762.494,10
5,4500	763.906,67	763.765,41	763.624,15	763.482,90	763.341,64	763.200,38	763.059,13	762.917,87	762.776,61	762.635,35	762.494,10
5,5500	756.587,65	757.178,30	757.768,94	758.359,59	758.950,23	759.540,87	760.131,52	760.722,16	761.312,81	761.903,45	762.494,10
5,6500	749.268,64	750.591,18	751.913,73	753.236,27	754.558,82	755.881,37	757.203,91	758.526,46	759.849,01	761.171,55	762.494,10
5,7500	741.949,62	744.004,07	746.058,52	748.112,96	750.167,41	752.221,86	754.276,31	756.330,75	758.385,20	760.439,65	762.494,10
5,8500	734.630,60	737.416,95	740.203,30	742.989,65	745.776,00	748.562,35	751.348,70	754.135,05	756.921,40	759.707,75	762.494,10
5,9500	727.311,59	730.829,84	734.348,09	737.866,34	741.384,59	744.902,84	748.421,09	751.939,34	755.457,60	758.975,85	762.494,10
6,0500	719.992,57	724.242,72	728.492,88	732.743,03	736.993,18	741.243,33	745.493,49	749.743,64	753.993,79	758.243,95	762.494,10
6,1500	712.673,56	717.655,61	722.637,66	727.619,72	732.601,77	737.583,83	742.565,88	747.547,94	752.529,99	757.512,04	762.494,10
6,2500	705.354,54	711.068,50	716.782,45	722.496,41	728.210,36	733.924,32	739.638,27	745.352,23	751.066,19	756.780,14	762.494,10
Mean	760.247,16	760.471,85	760.696,55	760.921,24	761.145,94	761.370,63	761.595,32	761.820,02	762.044,71	762.269,40	762.494,10
SD	33.739,00	30.365,10	26.991,20	23.617,30	20.243,40	16.869,50	13.495,60	10.121,70	6.747,80	3.373,90	0,00
Min	705.354,54	711.068,50	716.782,45	722.496,41	728.210,36	733.924,32	739.638,27	745.352,23	751.066,19	756.780,14	762.494,10
Max	815.139,78	809.875,21	804.610,64	799.346,08	794.081,51	788.816,94	783.552,37	778.287,80	773.023,23	767.758,67	762.494,10

Table 3 - Two - way Sensitivity Analysis Matrix (October/2021, November/ 2021 and December/ 2021) applying a Gaussian Distribution

This table presents the cash net generation varying the hedging ratio (established in the first row) versus the FX rate (first column), using a Gaussian Distribution for each FX rate to happen, the average equals 5,5500. Panel A, Panel B and Panel C show the data for, respectively, October/2021, November/2021 and December/2021. The highlighted part in greyscale are the values of the cash net generation that do not reach the minimum cash threshold.

Panela A: October/ 2021											
% Hedge	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
4,7500	808.340,77	806.983,82	805.626,87	804.269,93	802.912,98	801.556,03	800.199,08	798.842,14	797.485,19	796.128,24	794.771,29
4,8500	806.247,04	805.099,46	803.951,89	802.804,31	801.656,74	800.509,17	799.361,59	798.214,02	797.066,44	795.918,87	794.771,29
4,9500	804.153,31	803.215,10	802.276,90	801.338,70	800.400,50	799.462,30	798.524,10	797.585,90	796.647,70	795.709,49	794.771,29
5,0500	802.059,57	801.330,75	800.601,92	799.873,09	799.144,26	798.415,43	797.686,61	796.957,78	796.228,95	795.500,12	794.771,29
5,1500	799.965,84	799.446,39	798.926,93	798.407,48	797.888,02	797.368,57	796.849,11	796.329,66	795.810,20	795.290,75	794.771,29
5,2500	797.872,11	797.562,03	797.251,95	796.941,86	796.631,78	796.321,70	796.011,62	795.701,54	795.391,46	795.081,37	794.771,29
5,3500	795.778,38	795.677,67	795.576,96	795.476,25	795.375,54	795.274,84	795.174,13	795.073,42	794.972,71	794.872,00	794.771,29
5,4500	793.684,65	793.793,31	793.901,98	794.010,64	794.119,30	794.227,97	794.336,63	794.445,30	794.553,96	794.662,63	794.771,29
5,5500	791.590,91	791.908,95	792.226,99	792.545,03	792.863,07	793.181,10	793.499,14	793.817,18	794.135,22	794.453,26	794.771,29
5,6500	789.497,18	790.024,59	790.552,00	791.079,42	791.606,83	792.134,24	792.661,65	793.189,06	793.716,47	794.243,88	794.771,29
5,7500	787.403,45	788.140,23	788.877,02	789.613,80	790.350,59	791.087,37	791.824,16	792.560,94	793.297,72	794.034,51	794.771,29
5,8500	785.309,72	786.255,88	787.202,03	788.148,19	789.094,35	790.040,51	790.986,66	791.932,82	792.878,98	793.825,14	794.771,29
5,9500	783.215,99	784.371,52	785.527,05	786.682,58	787.838,11	788.993,64	790.149,17	791.304,70	792.460,23	793.615,76	794.771,29
6,0500	781.122,25	782.487,16	783.852,06	785.216,97	786.581,87	787.946,77	789.311,68	790.676,58	792.041,49	793.406,39	794.771,29
6,1500	779.028,52	780.602,80	782.177,08	783.751,35	785.325,63	786.899,91	788.474,18	790.048,46	791.622,74	793.197,02	794.771,29
6,2500	776.934,79	778.718,44	780.502,09	782.285,74	784.069,39	785.853,04	787.636,69	789.420,34	791.203,99	792.987,64	794.771,29
Mean	793.615,27	793.736,20	793.857,12	793.978,05	794.098,98	794.219,91	794.340,83	794.461,76	794.582,69	794.703,62	794.824,54
SD	9.651,63	8.686,46	7.721,30	6.756,14	5.790,98	4.825,81	3.860,65	2.895,49	1.930,33	965,16	0,00
Min	776.934,79	778.718,44	780.502,09	782.285,74	784.069,39	785.853,04	787.636,69	789.420,34	791.203,99	792.987,64	794.771,29
Max	808.340,77	806.983,82	805.626,87	804.269,93	802.912,98	801.556,03	800.199,08	798.842,14	797.485,19	796.128,24	794.771,29

Panel B: November/2021											
% Hedge	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
4,7500	927.491,04	925.627,04	923.763,03	921.899,03	920.035,02	918.171,02	916.307,01	914.443,01	912.579,00	910.715,00	908.851,00
4,8500	924.747,84	923.158,16	921.568,47	919.978,79	918.389,10	916.799,42	915.209,73	913.620,05	912.030,36	910.440,68	908.851,00
4,9500	922.004,64	920.689,28	919.373,91	918.058,55	916.743,18	915.427,82	914.112,45	912.797,09	911.481,72	910.166,36	908.851,00
5,0500	919.261,44	918.220,40	917.179,35	916.138,31	915.097,26	914.056,22	913.015,17	911.974,13	910.933,08	909.892,04	908.851,00
5,1500	916.518,24	915.751,52	914.984,79	914.218,07	913.451,34	912.684,62	911.917,89	911.151,17	910.384,44	909.617,72	908.851,00
5,2500	913.775,04	913.282,64	912.790,23	912.297,83	911.805,42	911.313,02	910.820,61	910.328,21	909.835,80	909.343,40	908.851,00
5,3500	911.031,84	910.813,76	910.595,67	910.377,59	910.159,50	909.941,42	909.723,33	909.505,25	909.287,16	909.069,08	908.851,00
5,4500	908.288,64	908.344,88	908.401,11	908.457,35	908.513,58	908.569,82	908.626,05	908.682,29	908.738,52	908.794,76	908.851,00
5,5500	905.545,44	905.876,00	906.206,55	906.537,11	906.867,66	907.198,22	907.528,77	907.859,33	908.189,88	908.520,44	908.851,00
5,6500	902.802,24	903.407,12	904.011,99	904.616,87	905.221,74	905.826,62	906.431,49	907.036,37	907.641,24	908.246,12	908.851,00
5,7500	900.059,04	900.938,24	901.817,43	902.696,63	903.575,82	904.455,02	905.334,21	906.213,41	907.092,60	907.971,80	908.851,00
5,8500	897.315,84	898.469,36	899.622,87	900.776,39	901.929,90	903.083,42	904.236,93	905.390,45	906.543,96	907.697,48	908.851,00
5,9500	894.572,64	896.000,48	897.428,31	898.856,15	900.283,98	901.711,82	903.139,65	904.567,49	905.995,32	907.423,16	908.851,00
6,0500	891.829,44	893.531,60	895.233,75	896.935,91	898.638,06	900.340,22	902.042,37	903.744,53	905.446,68	907.148,84	908.851,00
6,1500	889.086,24	891.062,72	893.039,19	895.015,67	896.992,14	898.968,62	900.945,09	902.921,57	904.898,04	906.874,52	908.851,00
6,2500	886.343,04	888.593,84	890.844,63	893.095,43	895.346,22	897.597,02	899.847,81	902.098,61	904.349,40	906.600,20	908.851,00
Mean	908.188,93	908.261,22	908.333,52	908.405,82	908.478,11	908.550,41	908.622,70	908.695,00	908.767,30	908.839,59	908.911,89
SD	12.645,53	11.380,97	10.116,42	8.851,87	7.587,32	6.322,76	5.058,21	3.793,66	2.529,11	1.264,55	0,00
Min	886.343,04	888.593,84	890.844,63	893.095,43	895.346,22	897.597,02	899.847,81	902.098,61	904.349,40	906.600,20	908.851,00
Max	927.491,04	925.627,04	923.763,03	921.899,03	920.035,02	918.171,02	916.307,01	914.443,01	912.579,00	910.715,00	908.851,00

Panel C: December/2021											
% Hedge	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
4,7500	615.139,78	609.875,21	604.610,64	599.346,08	594.081,51	588.816,94	583.552,37	578.287,80	573.023,23	567.758,67	562.494,10
4,8500	607.820,76	603.288,10	598.755,43	594.222,76	589.690,10	585.157,43	580.624,76	576.092,10	571.559,43	567.026,76	562.494,10
4,9500	600.501,75	596.700,98	592.900,22	589.099,45	585.298,69	581.497,92	577.697,16	573.896,39	570.095,63	566.294,86	562.494,10
5,0500	593.182,73	590.113,87	587.045,01	583.976,14	580.907,28	577.838,41	574.769,55	571.700,69	568.631,82	565.562,96	562.494,10
5,1500	585.863,72	583.526,75	581.189,79	578.852,83	576.515,87	574.178,91	571.841,95	569.504,98	567.168,02	564.831,06	562.494,10
5,2500	578.544,70	576.939,64	575.334,58	573.729,52	572.124,46	570.519,40	568.914,34	567.309,28	565.704,22	564.099,16	562.494,10
5,3500	571.225,68	570.352,53	569.479,37	568.606,21	567.733,05	566.859,89	565.986,73	565.113,57	564.240,42	563.367,26	562.494,10
5,4500	563.906,67	563.765,41	563.624,15	563.482,90	563.341,64	563.200,38	563.059,13	562.917,87	562.776,61	562.635,35	562.494,10
5,5500	556.587,65	557.178,30	557.768,94	558.359,59	558.950,23	559.540,87	560.131,52	560.722,16	561.312,81	561.903,45	562.494,10
5,6500	549.268,64	550.591,18	551.913,73	553.236,27	554.558,82	555.881,37	557.203,91	558.526,46	559.849,01	561.171,55	562.494,10
5,7500	541.949,62	544.004,07	546.058,52	548.112,96	550.167,41	552.221,86	554.276,31	556.330,75	558.385,20	560.439,65	562.494,10
5,8500	534.630,60	537.416,95	540.203,30	542.989,65	545.776,00	548.562,35	551.348,70	554.135,05	556.921,40	559.707,75	562.494,10
5,9500	527.311,59	530.829,84	534.348,09	537.866,34	541.384,59	544.902,84	548.421,09	551.939,34	555.457,60	558.975,85	562.494,10
6,0500	519.992,57	524.242,72	528.492,88	532.743,03	536.993,18	541.243,33	545.493,49	549.743,64	553.993,79	558.243,95	562.494,10
6,1500	512.673,56	517.655,61	522.637,66	527.619,72	532.601,77	537.583,83	542.565,88	547.547,94	552.529,99	557.512,04	562.494,10
6,2500	505.354,54	511.068,50	516.782,45	522.496,41	528.210,36	533.924,32	539.638,27	545.352,23	551.066,19	556.780,14	562.494,10
Mean	563.516,04	563.417,62	563.319,19	563.220,76	563.122,34	563.023,91	562.925,49	562.827,06	562.728,64	562.630,21	562.531,79
SD	33.739,00	30.365,10	26.991,20	23.617,30	20.243,40	16.869,50	13.495,60	10.121,70	6.747,80	3.373,90	0,00
Min	505.354,54	511.068,50	516.782,45	522.496,41	528.210,36	533.924,32	539.638,27	545.352,23	551.066,19	556.780,14	562.494,10
Max	615.139,78	609.875,21	604.610,64	599.346,08	594.081,51	588.816,94	583.552,37	578.287,80	573.023,23	567.758,67	562.494,10

6.1.2 Monte Carlo – random walk with a trend

To build a Monte Carlo Simulation, I assumed the FX rate would have a behavior of random walk with a trend. To do so, I calculated the daily volatility of the FX rate based on the historical series from 2011 to October 2021, which was equal to 2,19%. The expected variation was assumed to be equal to the interest rate differential, at 0,0166% per day.⁴ Using the expected return and volatility, I assumed a normal distribution for the variation of the exchange rate.⁵ In summa, the interest rate is responsible for the trend whereas the standard deviation will carry the randomness of the model.

To compute the exchange rate that reliably reflects reality was a key point for the construction of the base-case scenario. Since the exchange rate is the variable with the most uncertainty, the focus was on simulating scenarios for this incognito in order to provide figures that best reflect the future projections.

Given the stochastic aspect of currency fluctuations, I chose to design a Monte Carlo simulation, where random variations could be present and reflect possible scenarios. Furthermore, as there is a trend for this currency, caused by the interest rate differential between Brazil and the United States, I added the expected variation caused by the interest rate.

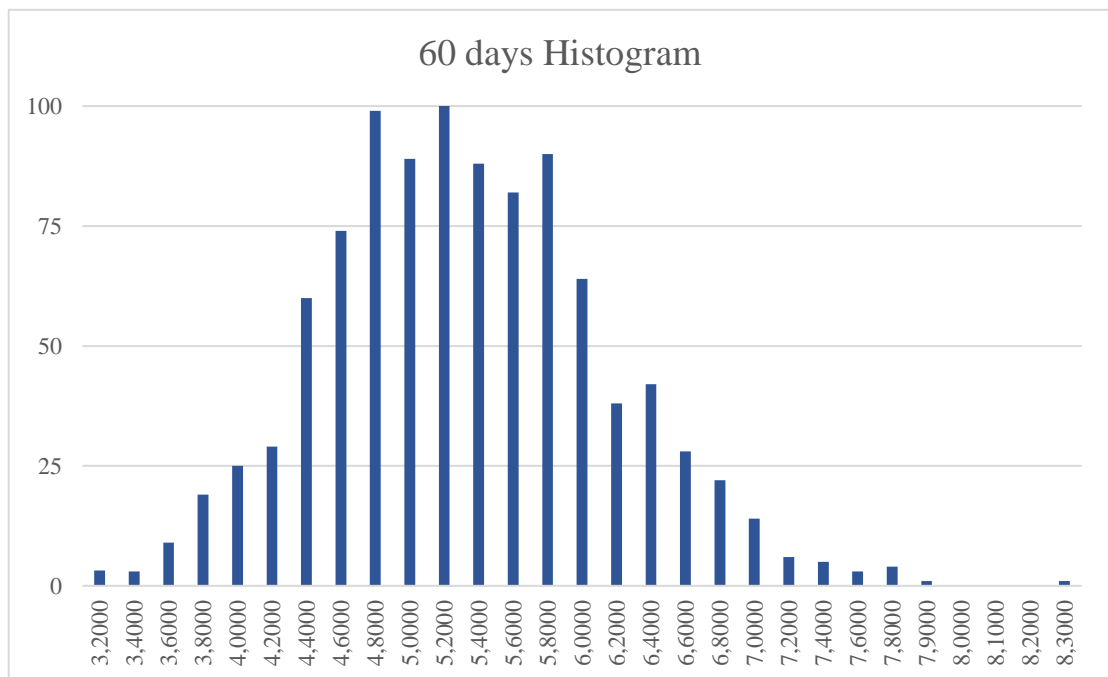
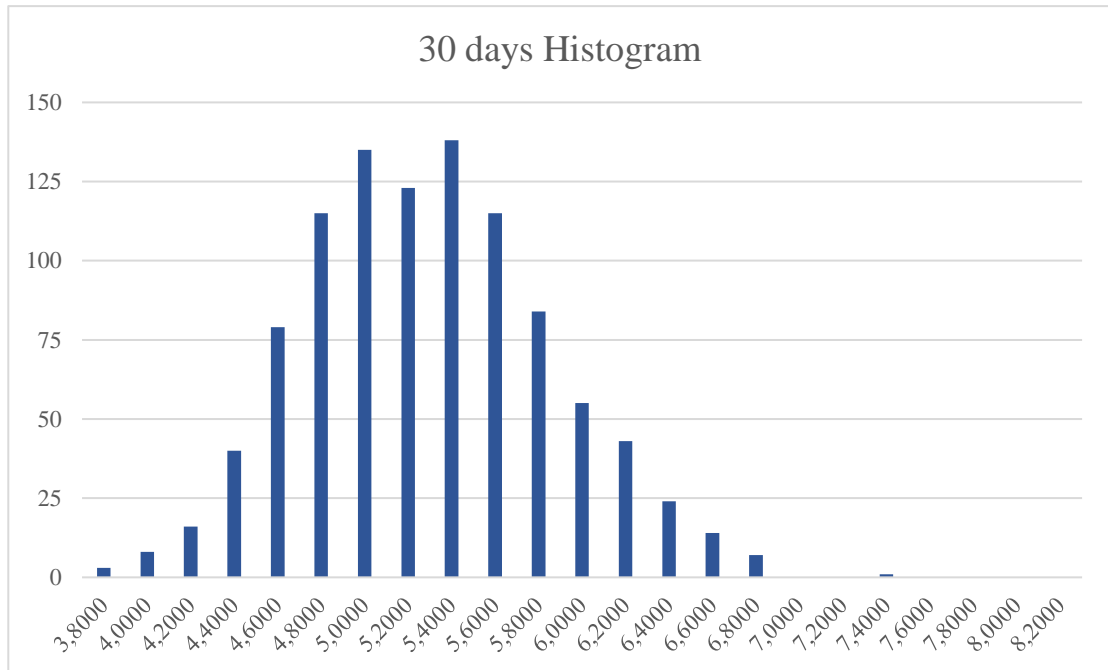
For that, a computer simulation was used with 1,000 random steps for each expiration date, 30 days, 60 days and 90 days. The result obtained are exhibited in the histograms shown in Exhibit 1. As expected, they have a normal distribution around the current FX rate plus the expected variation by the interest differential. In addition, it is noteworthy that the result for 30 days presents an accurate normal distribution. As I increased the maturation date for 60 and 90 days, the distribution presents some peaks and it is more spread (as expected), since the uncertainty from the future increases.

⁴ This procedure ignores the currency risk premium, but provides a good enough approximation for our purposes.

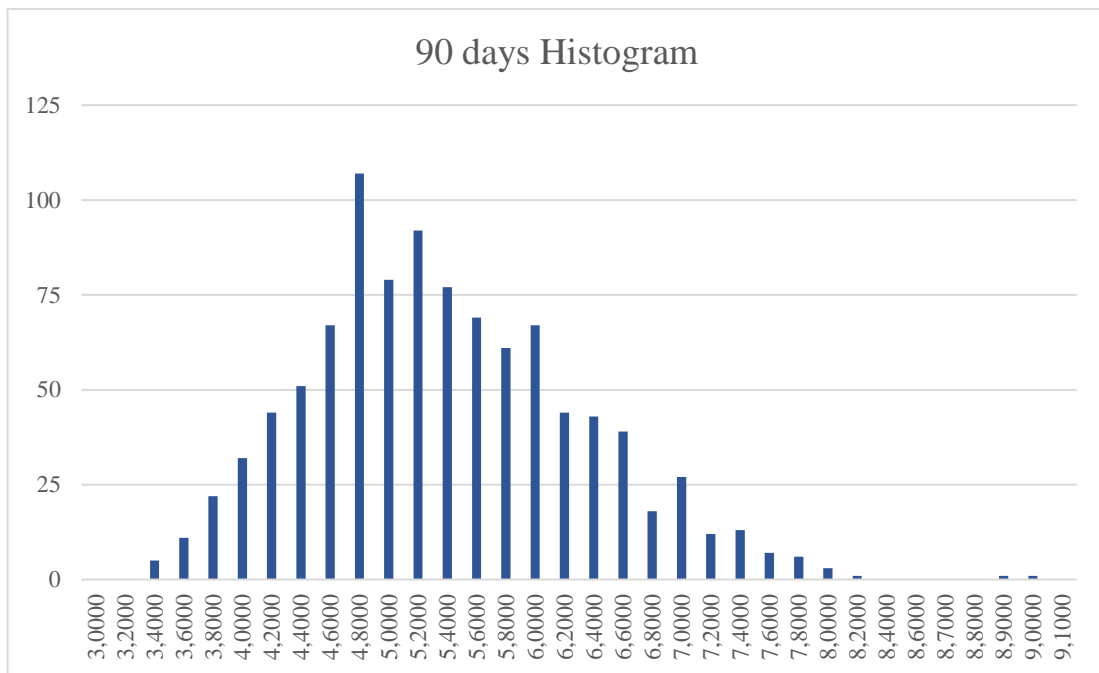
⁵ Research has found the exchange rate variation to be asymmetrical. However, a more complex modelling of the distribution properties would involve the estimation of parameters like the kurtosis and asymmetry of the distribution, which would go beyond the purpose of this application.

Exhibit 1 - Histograms of Monte Carlo simulation for the possible FX rate

These graphs show the frequency of a FX rate bin for the 30-,60- and 90-days horizon (respectively, 30 Days Histogram, 60 Days Histogram and 90 Days Histogram). The daily volatility of 2,19% was calculated for the last 10 years, from September/2011 to September/2021. Whereas the daily trend of 0,0166% is computed using the Brazil's and US's interest rates differential.



(Continued)



Elaborated by the author

In order to obtain a more complete scenario, I considered three possible projections: normal scenario, where the current projection will be maintained for the future and, for that, the volatility value calculated previously was used. An optimistic projection where I considered the scenario was less volatile and used half the volatility value calculated. And a pessimistic projection where I doubled the volatility value calculate, to reflect a more volatile state. For all cases, I assumed the trend would be given by the same value of the variation expected by the interest differential.

Uncertainty increases as the time passes; hence it is more complex to enter into a larger hedge position. This is shown in Table 4, where the statistical values for each scenario and maturation are given according after the simulations.

Table 4 - Statistic of the FX Rate for 30-, 60- and 90-days maturation

I computed the values of the FX rate for 30-, 60-, and 90- days from 1.000 simulations, providing me with the statistical values of a probable normal, more volatile scenario (pessimist one) and less volatile scenario (more optimist)- hence, the more volatile scenario was calculated using the double of the volatility, i.e., 5,8%, whereas the less volatile scenario was calculated using half of the volatility, i.e., 1,45%. As I assumed a normal distribution, the percentiles provide the values of FX rate at 5%, 25%, 75% and 95%.

	Normal scenario			More volatile scenario			Less volatile scenario		
	30 days	60 days	90 days	30 days	60 days	90 days	30 days	60 days	90 days
Mean	5,4923	5,5591	5,5053	5,3778	5,5221	5,5324	5,4623	5,5008	5,5104
Median	5,4453	5,5256	5,4032	5,2617	5,1834	5,1729	5,4619	5,4888	5,4857
Standard	0,6101	0,8456	0,9706	1,2409	1,8749	2,0944	0,3092	0,4376	0,4844
Percentiles									
5%	4,5786	4,3272	4,1138	3,5378	3,1420	2,9049	4,9733	4,7982	4,7389
95%	6,5971	7,0040	7,3100	7,5471	9,1013	9,3034	5,9634	6,2427	6,3370
25%	5,0543	4,9573	4,8380	4,4907	4,2345	4,0615	5,2467	5,1990	5,1775
75%	5,9030	6,0728	6,0458	6,1153	6,3646	6,591	5,6607	5,7886	5,8405

Considering the FX rate obtained, the cash net generation for each scenario was simulated to determine the range of the optimal hedge percentage that the company should enter. Thus, Table 5 provides the general scenario of the possible outcomes for the company, in order to determine the best percentage of hedging.

As expected, by increasing the hedged position, the cash flow return will decrease, the trade-off between risk and return. Assuming the same critical values for October/2021, November/2021 and December/2021, we have, respectively, R\$ 793,000; R\$ 905,000 and R\$ 544,000. Using Monte Carlo simulation, to select the hedge criterion, I used the critical values together with the percentiles for each scenario.

For the 30-day, as the firm wants to protect itself from the uncertainty scenario, I analyzed the 25%-percentile of the three scenarios, normal, pessimistic and optimistic. In an optimistic scenario, the values of no hedging and hedging completely are very close (difference of approximately 0,025%). While in a pessimistic scenario, at 25%-percentile, the company reaches the critical value when it performs at least 90% hedge.

Similarly, for the 60-day maturity, analyzing the 25%-percentile in the three scenarios built; in the normal scenario, the company should hedge at least 60% to guarantee the critical value. Under the optimistic scenario, the company would not need to hedge; and in the pessimistic scenario, the company should hedge at least 80%. Combining the three scenarios and remembering that the focus is on optimizing risk reduction, the ideal would be to hedge between 60% and 80%. At these proportions, the expected return will be approximately equal across all scenarios.

Finally, for the 90-day maturity, in the normal scenario, by hedging at least 40%, the company guarantees the cash flow above the critical value. In the optimistic scenario, at 25%-percentile,

the company would not need to enter into any hedging contracts to guarantee the critical value. And in the pessimistic scenario, the company would need to hedge at least 70% to guarantee the critical value. Combining the three scenarios, for the NDF maturing in 90 days, it is ideal for the firm to hedge between 40% and 70% of its liability.

Table 5 - Expected Cash Flow, according to the scenarios and percentage of hedging

This table reports summary statistics for the different hedge ratio and scenarios; since I assumed a random walk with trend, the values will have a normal distribution appearance. I used the cash flow provided by Exhibit 7 to calculate the projected final balance for each case. Panel A presents the summary statistics for the 30 days NDF. Panel B reports the same data for the 60 days period. Panel C reports a summary for the 90 days period.

Panel A – 30 Days											
Normal Scenario											
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Mean	798.909	798.495	798.081	797.668	797.254	796.840	796.426	796.013	795.599	795.185	794.771
Median	800.000	799.477	798.955	798.432	797.909	797.386	796.863	796.340	795.817	795.294	794.771
SD	12.286	11.057	9.829	8.600	7.372	6.143	4.914	3.686	2.457	1.229	0
Percentiles											
5%	777.920	779.605	781.290	782.975	784.661	786.346	788.031	789.716	791.401	793.086	794.771
95%	817.700	815.407	813.114	810.821	808.529	806.236	803.943	801.650	799.357	797.064	794.771
25%	791.194	791.552	791.909	792.267	792.625	792.983	793.340	793.698	794.056	794.414	794.771
75%	807.276	806.025	804.775	803.525	802.274	801.024	799.773	798.523	797.272	796.022	794.771
Optimistic Scenario											
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Mean	799.034	798.608	798.182	797.755	797.329	796.903	796.476	796.050	795.624	795.198	794.771
Median	799.464	798.994	798.525	798.056	797.587	797.117	796.648	796.179	795.710	795.241	794.771
SD	6.148	5.533	4.918	4.304	3.689	3.074	2.459	1.844	1.230	615	0
Percentiles											
5%	788.065	788.736	789.406	790.077	790.748	791.418	792.089	792.759	793.430	794.101	794.771
95%	808.294	806.942	805.590	804.237	802.885	801.533	800.181	798.828	797.476	796.124	794.771
25%	794.980	794.960	794.939	794.918	794.897	794.876	794.855	794.834	794.813	794.792	794.771

75%	803.468	802.599	801.729	800.859	799.990	799.120	798.250	797.380	796.511	795.641	794.771
Pessimistic Scenario											
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Mean	797.142	796.905	796.668	796.431	796.194	795.957	795.719	795.482	795.245	795.008	794.771
Median	800.941	800.324	799.707	799.090	798.473	797.856	797.239	796.622	796.005	795.388	794.771
SD	25.979	23.381	20.783	18.185	15.587	12.990	10.392	7.794	5.196	2.598	0
Percentiles											
5%	749.443	753.976	758.509	763.042	767.574	772.107	776.640	781.173	785.706	790.238	794.771
95%	834.838	830.831	826.825	822.818	818.811	814.805	810.798	806.791	802.785	798.778	794.771
25%	782.040	783.313	784.586	785.860	787.133	788.406	789.679	790.952	792.225	793.498	794.771
75%	814.742	812.745	810.748	808.751	806.754	804.757	802.760	800.763	798.765	796.768	794.771
Panel B – 60 Days											
Normal Scenario											
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Mean	914.195	913.661	913.126	912.592	912.057	911.523	910.989	910.454	909.920	909.385	908.851
Median	915.403	914.747	914.092	913.437	912.782	912.127	911.472	910.816	910.161	909.506	908.851
SD	23.054	20.749	18.444	16.138	13.833	11.527	9.222	6.916	4.611	2.305	0
Percentiles											
5%	872.747	876.358	879.968	883.578	887.189	890.799	894.409	898.020	901.630	905.241	908.851
95%	949.085	945.061	941.038	937.015	932.991	928.968	924.944	920.921	916.898	912.874	908.851
25%	900.626	901.449	902.271	903.094	903.916	904.739	905.561	906.384	907.206	908.029	908.851
75%	930.350	928.200	926.050	923.900	921.750	919.601	917.451	915.301	913.151	911.001	908.851
Optimistic Scenario											
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Mean	914.772	914.180	913.588	912.996	912.404	911.812	911.220	910.627	910.035	909.443	908.851

Median	915.215	914.579	913.942	913.306	912.669	912.033	911.397	910.760	910.124	909.487	908.851
SD	11.243	10.119	8.994	7.870	6.746	5.621	4.497	3.373	2.249	1.124	0
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Percentiles											
5%	895.300	896.655	898.011	899.366	900.721	902.076	903.431	904.786	906.141	907.496	908.851
95%	932.209	929.873	927.537	925.202	922.866	920.530	918.194	915.858	913.523	911.187	908.851
25%	907.365	907.513	907.662	907.810	907.959	908.108	908.256	908.405	908.554	908.702	908.851
75%	922.840	921.441	920.042	918.643	917.244	915.845	914.446	913.048	911.649	910.250	908.851
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Pessimistic Scenario											
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Mean	914.069	913.547	913.025	912.504	911.982	911.460	910.938	910.416	909.895	909.373	908.851
Median	922.205	920.869	919.534	918.199	916.863	915.528	914.193	912.857	911.522	910.186	908.851
SD	45.414	40.873	36.331	31.790	27.249	22.707	18.166	13.624	9.083	4.541	0
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Percentiles											
5%	828.414	836.458	844.502	852.545	860.589	868.633	876.676	884.720	892.764	900.807	908.851
95%	974.896	968.292	961.687	955.083	948.478	941.874	935.269	928.665	922.060	915.456	908.851
25%	889.165	891.133	893.102	895.071	897.039	899.008	900.976	902.945	904.914	906.882	908.851
75%	946.155	942.424	938.694	934.964	931.233	927.503	923.773	920.042	916.312	912.581	908.851
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Panel C – 90 Days											
Normal Scenario											
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Mean	579.481	577.782	576.083	574.385	572.686	570.987	569.289	567.590	565.891	564.193	562.494
Median	586.822	584.389	581.956	579.524	577.091	574.658	572.225	569.792	567.360	564.927	562.494
SD	68.315	61.483	54.652	47.820	40.989	34.157	27.326	20.494	13.663	6.831	0
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Percentiles											
5%	458.297	468.717	479.137	489.556	499.976	510.396	520.815	531.235	541.655	552.074	562.494

95%	677.490	665.991	654.491	642.991	631.492	619.992	608.493	596.993	585.493	573.994	562.494
25%	535.867	538.530	541.192	543.855	546.518	549.181	551.843	554.506	557.169	559.831	562.494
75%	629.000	622.349	615.699	609.048	602.397	595.747	589.096	582.446	575.795	569.145	562.494

Optimistic Scenario

	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Mean	579.722	577.999	576.276	574.553	572.831	571.108	569.385	567.662	565.940	564.217	562.494
Median	581.351	579.466	577.580	575.694	573.808	571.923	570.037	568.151	566.266	564.380	562.494
SD	33.397	30.057	26.717	23.378	20.038	16.698	13.359	10.019	6.679	3.340	0
Percentiles											
5%	522.103	526.142	530.181	534.220	538.259	542.298	546.338	550.377	554.416	558.455	562.494
95%	632.506	625.505	618.504	611.503	604.501	597.500	590.499	583.498	576.497	569.495	562.494
25%	557.455	557.959	558.463	558.966	559.470	559.974	560.478	560.982	561.486	561.990	562.494
75%	602.871	598.834	594.796	590.758	586.720	582.683	578.645	574.607	570.570	566.532	562.494

Pessimistic Scenario

	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Mean	576.050	574.694	573.339	571.983	570.627	569.272	567.916	566.561	565.205	563.850	562.494
Median	598.686	595.067	591.448	587.829	584.209	580.590	576.971	573.352	569.733	566.113	562.494
SD	143.076	128.769	114.461	100.153	85.846	71.538	57.230	42.923	28.615	14.308	0
Percentiles											
5%	323.372	347.284	371.197	395.109	419.021	442.933	466.845	490.758	514.670	538.582	562.494
95%	766.983	746.534	726.085	705.637	685.188	664.739	644.290	623.841	603.392	582.943	562.494
25%	503.877	509.739	515.600	521.462	527.324	533.186	539.047	544.909	550.771	556.632	562.494
75%	672.439	661.444	650.450	639.455	628.461	617.466	606.472	595.478	584.483	573.489	562.494

6.1.3 Back Testing

Both strategies, Two-way sensitivity analysis and the Monte Carlo Simulation, provided a similar range of hedging for each maturation, as summarized in Table 6.

Table 6 - Summary of the Hedging Strategy per Analysis

I computed the values provided from each simulation of hedging strategies (Two-Way Sensitivity Analysis and Monte Carlo Simulation) and maturity date. The last column is the result of the combination of both simulations.

	Two-way Sensitivity Analysis		Monte Carlo Simulation		Intersection Strategy	
	Min	Max	Min	Max	Min	Max
30- days NDF	90%	100%	90%	100%	90%	100%
60-days NDF	40%	80%	60%	80%	60%	80%
90-days NDF	10%	60%	40%	70%	40%	60%

To guarantee the robustness of this strategy, a back testing could be implemented to analyze if this strategy is efficient under other scenarios. This is important because of the recurrence with which containers are imported. This allows the decision-making process more dynamic, allowing the firm to use this strategy constantly.

In order to build the back testing, a simulation from January/2020 to September/2021 was implemented. Each month, I evaluated if the company should enter into a hedge contract for the following 30, 60 and 90 days; according to the hedging ratios developed for the FX risk management policy.

To define the prices of the NDF for the 30-, 60- and 90-days maturation date, I assume the covered interest parity holds, and that the NDF's prices are strongly linked to it. To do so, the interests' rates in force during the time (see Table 7) were used. Then, I assumed that at the end of each month, the firm's manager would have the option to enter into a 30-, 60-, or 90- days NDF.

Table 7 - Historical Brazilian and US interest rates (December 2019 - September/2021)

The table provides the Brazilian and American interest rates for the period. For Brazil, I opted to use the Selic, since it is the standard interest rate for this analysis. For the American rates, I selected the upper limit of FOMC's target federal funds rate for the given period.

Brazil			US		
Initial Date	Final Date	Annual goal	Initial Date	Final Date	Annual goal
12/12/2019	05/02/2020	4,50%	31/10/2019	02/03/2020	1,75%
06/02/2020	18/03/2020	4,25%	03/03/2020	15/03/2020	1,25%
19/03/2020	06/05/2020	3,75%	16/03/2020	30/11/2021	0,25%
07/05/2020	17/06/2020	3,00 %			
18/06/2020	05/08/2020	2,25%			
06/08/2020	17/03/2021	2,00%			
18/03/2021	05/05/2021	2,75%			
06/05/2021	16/06/2021	3,50%			
17/06/2021	04/08/2021	4,25%			
05/08/2021	22/09/2021	5,25%			
23/09/2021	27/10/2021	6,25%			

Source: BACEN, available at: < <https://www.bcb.gov.br/controleinflacao/historicotaxasjuros>>

FED, available at: < <https://www.federalreserve.gov/monetarypolicy/openmarket.htm>>

Using the Monte Carlo simulation and inputting the initial value of the simulation as the last day of the month, I calculated the forecasted FX rate, ignoring the real FX rate or the one assuming CIP. Finally, according to the range of hedging calculated previously, I decided the final value of the hedge I should enter.

To establish the exact value the company should hedge, using the previous algorithm which calculates the FX rate forecasts, I also calculate for the NDF maturation, to compare the values. The cases where the NDF price was equal to the prediction, or had either slight improvement or worsening (less than 5% of difference), I assume the hedge would be the minimum range, 10%, 40% and 80%, respectively for the 30-, 60-, 90- days NDF. When the value of the NDF

presented a great advantage for the company, at least 25% greater than the value of the NDF, the company would enter into a larger hedging position, 50%, 60% and 100%, respectively for the 30-, 60-, 90- days NDF. The other cases, I selected a value between the range or when the price of the NDF seemingly was not profitable, the company could opt out.

The results of the hedged position were compared to no hedging, in order to assess the efficiency of this strategy (see Table 8). It is interesting to notice that despite several having a positive return, most months had an almost zero return or even negative. Due to the high volatility of the Brazilian Real, it is more difficult to predict an outcome and to expect a positive return.

Table 8 - Comparison between the proposed solution (hedged position) and no hedging (Values in Brazilian Real)

I computed the values of paying the monthly liability at the end of the month, using the BRL/USD of the last week of the month, and the price of the NDF was calculated assuming the covered interest parity holds. The no hedge values were determined using the historical value of the PTAX of the last week of the month.

	Hedged Solution	No Hedge
April/2020	159.795	206.462
May/2020	169.721	199.894
June/2020	94.196	99.963
August/2020	133.158	131.537
September/2020	328.088	328.617
October/2020	250.280	258.224
December/2020	261.224	237.934
January/2021	202.225	190.987
February/2021	99.849	95.863
March/2021	176.195	181.132
April/2021	102.001	101.211
May/2021	104.396	100.668
June/2021	108.728	99.938
July/2021	101.597	93.104
September/2021	108.919	111.454

To assess if the proposed solution presents an advantage comparing to leave the company exposed and settle at the spot, I ran a t-test to evaluate the existence of statistical relevance. The null hypothesis (H_0) is that no statistical difference exists between the strategy returns and the alternative hypothesis (H_1) is that there exists a statistical difference between the returns of the strategies. They can be defined as

$$H_0: SR_1 - SR_2 = 0$$

$$H_1: SR_1 - SR_2 \neq 0$$

The results are shown in Table 9. The p-value of this case is 0,4636 meaning that, from the standpoint exclusively of expected return, the proposed solution is not statistically better than not hedging. Despite the test rejecting my null hypothesis, it is important to highlight that the goal of this strategy is not only maximize the return, but also minimize the risk.

Table 9 - t-test of the proposed solution and no hedge

p-value	0,4636
T-test	0,7430

To overcome this obstacle, I computed and compared the Sharpe ratios of portfolio hedged, analyzing the risk and return of each portfolio. To do so, I calculate the average return of my strategy versus the non-hedged strategy; the return was calculated comparing the critical values pre-established. The values were computed and stated in Table 10.

Table 10 - Average statistics for No Hedge and Hedging Strategy

	No Hedge	Hedging Strategy
Returns	59,71 %	59,64 %
Standard Deviation	62,85 %	62,45 %
Sharpe Ratio	0,9500	0,9549

7 CONCLUSION

In this dissertation I studied a real-life case study to build a hands-on strategy for a Brazilian importer. The data provided allowed me to develop a base-case scenario to estimate the projections and try to develop a FX risk management policy. This case study shows the need for a company to develop a FX risk management policy, since the high volatility of the Brazilian economy leaves an importer exposed to the FX rate highs and lows, jeopardizing the company's cash flow.

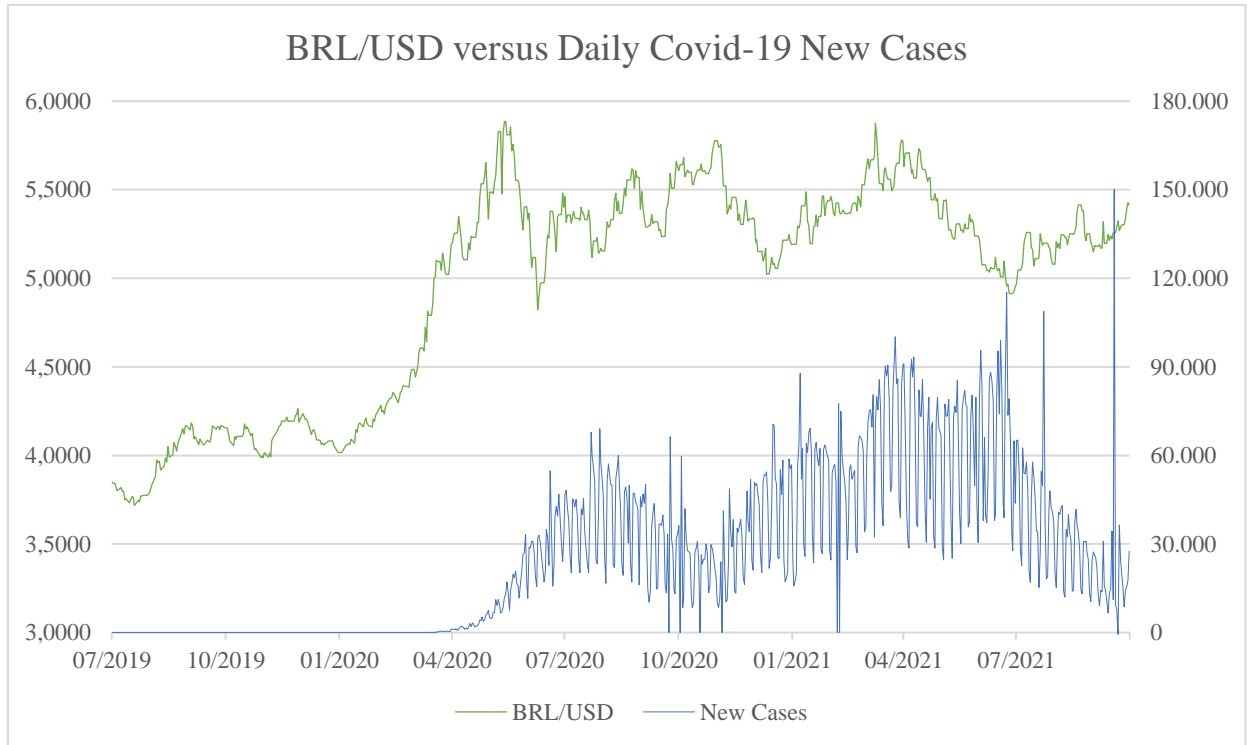
The back test shows that there does not exist a statistical significance between the proposed strategy and leaving the company exposed to pay the liabilities on the spot. That said, the risk-return of the hedged strategy is similar to the no hedge strategy, according to the Sharpe index. Hence, at first, the company could adopt a hedging strategy, using the hedging ranges defined during the present analysis. This could guarantee the company more stability, without prejudicing the company's finances, since they would not engage into a riskier investment nor decrease their return.

As a first FX risk management strategy, this solution still has some room to development and the possibility to increase the levels of complexity. For a more exhaustive solution, the company could overcome some of the assumptions I adopted, in order to better reflect the reality. Firstly, I assume the Covered Interest Parity holds. Thus, the FX rate has only a positive trend; which the historical data proves is not true. A more realistic strategy could adopt a negative, positive or even neutral trend to provide an adaptive strategy, tightly following the currency trend. Several factors may also contribute to the (de)increase of a currency. Using a more realistic tendency, which is not only supported by the interest rates differential could provide a more accurate scenario for the company.

Finally, I assumed a NDF would be contracted for a payment for the following month; e.g., the company should contract a NDF to expire at the end of April to pay the debts of May. A more accurate strategy could narrow down the week of the payment and the company could hedge for that date. NDF are flexible contracts that can be personalized according to the needs of the client.

APPENDIX

Exhibit 2 - Comparison between new covid-19 infections and BRL/USD variation

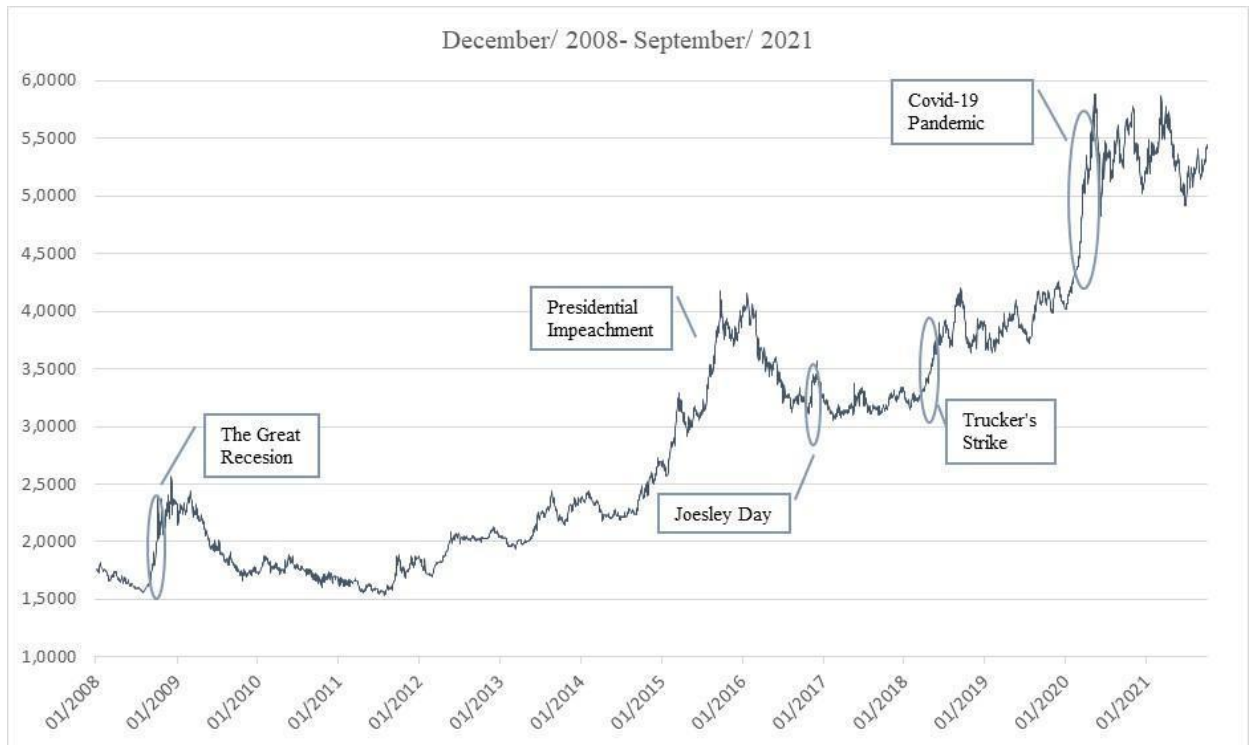


Source: Daily new infections of covid-19 cases from January 1st 2020 to September 30th 2021 data available at: <https://ourworldindata.org/>.

BRL/USD from January 1st 2020 to September, data available at: Yahoo Finance <https://finance.yahoo.com/>

Exhibit 3 - BRL/USD exchange rate (January/2008 – January/2021)

The graph provides the BRL/USD exchange rate variations combine with the major economic events which had a meaningful impact in Brazil



Source: Yahoo Finance. Available at: <https://finance.yahoo.com/>

Exhibit 4 - Company's growth per year

Year	Company's revenue (R\$)
2010	6.080.160,32
2011	4.026.861,23
2012	2.823.909,60
2013	5.122.581,91
2014	7.698.355,82
2015	11.522.599,04
2016	13.473.313,79
2017	16.422.322,54
2018	13.933.822,80
2019	15.547.849,19
2020	14.259.431,01

Source: Company documents

Exhibit 5 - The bank e-mail proposal

October 1st 2021

Dears, good morning.

As requested, I am forwarding this email with the products for currency protection available at the bank. All prices are indicative and based on spot BRL/USD 5,3600.

According to the characteristics of the company, size and frequency of imports and the information given to me, I suggest the NDF product. We work with three expiration dates, 31, 60 and 90 days from this date.

The following is a summary and the main characteristics of the NDF, as well as the exchange values for the aforementioned dates.

NDF:

Hedging instrument in which a currency is reserved for settlement at a future date (at a predetermined rate) and, at maturity, if the foreign currency quotation (Ptax) is greater than the Forward Rate, the bank will make a positive adjustment to the company's account.

Likewise, if the Ptax is lower than the Forward Rate, the bank will make a negative adjustment to the company's account.

- › The positive adjustment is subject to Income Tax (only on the adjustment amount).
- › The company can recover the income tax withheld at source, if it has tax profit and is included in the Taxable Income.
- › Quotation and contracting through our exchange desk.

Due Date	FX rate [BRL/USD]
31 days (November 1 st)	5,3981
60 days (December 1 st)	5,4295
90 days (January 1 st)	5,4693

Source: Company documents

Exhibit 6 - USD liabilities converted to BRL debt per week

The USD liabilities of the companies were calculated for each week and then converted at spot according to the PTAX rate of the date. Not necessarily the PTAX of the date matches the FX rate the company paid.

	PTAX Rate	Focus prediction ⁶	CIP prediction ⁷	Week	USD Debt	BRL Debt [converted @spot]
	4,0604			07/01/2020	17.674,62	71.766,03
	4,1458			14/01/2020	40.162,80	166.506,94
	4,1885			21/01/2020	-	
	4,2061			28/01/2020	-	
	4,2468			04/02/2020	-	
	4,3210			11/02/2020	-	
	4,3265			18/02/2020	-	
	4,3866			25/02/2020	-	
	4,4724			03/03/2020	-	
	4,7229			10/03/2020	-	
	4,9990			17/03/2020	-	
	5,1417			24/03/2020	-	
	5,1927			31/03/2020	-	
	5,2853			07/04/2020	-	
	5,1985			14/04/2020	19.019,40	98.872,35
	5,3154			21/04/2020	-	
	5,6526			28/04/2020	19.033,74	107.590,12
	5,5406			05/05/2020	-	
	5,8171			12/05/2020	-	
Real	5,7190			19/05/2020	-	
	5,4434			26/05/2020	36.722,33	199.894,33
	5,3665			02/06/2020	-	
	4,8216			09/06/2020	-	
	5,1532			16/06/2020	-	
	5,2519			23/06/2020	19.033,77	99.963,46
	5,4021			30/06/2020	-	
	5,3543			07/07/2020	-	
	5,4015			14/07/2020	-	
	5,3277			21/07/2020	-	
	5,1414			28/07/2020	-	
	5,3187			04/08/2020	-	
	5,4805			11/08/2020	-	
	5,5083			18/08/2020	23.879,70	131.536,56
	5,6106			25/08/2020	-	
	5,4909			01/09/2020	22.698,33	124.634,27
	5,2983			08/09/2020	-	
	5,2683			15/09/2020	-	
	5,4126			22/09/2020	22.897,48	123.934,91

⁶ This prediction was made using the Focus estimates at the end of each month. Some values were computed using interpolation

⁷ This prediction was made using the Covered Interest Parity theory. Applying the Brazilian and American interests' rates of, respectively, 6,25% and 0,25%.

5,6602		29/09/2020	14.142,17	80.047,51
5,5734		06/10/2020	22.095,08	123.144,69
5,5297		13/10/2020	-	
5,6056		20/10/2020	-	
5,6227		27/10/2020	24.023,92	135.079,28
5,7411		03/11/2020	-	
5,3847		10/11/2020	-	
5,4149		17/11/2020	-	
5,4406		24/11/2020	-	
5,3311		01/12/2020	24.083,47	128.391,38
5,0983		08/12/2020	-	
5,1177		15/12/2020	21.404,72	109.542,94
5,1189		22/12/2020	-	
5,2459		29/12/2020	-	
5,2953		05/01/2021	17.864,94	94.600,22
5,4877		12/01/2021	-	
5,2948		19/01/2021	-	
5,4655		26/01/2021	17.635,42	96.386,39
5,4305		02/02/2021	-	
5,3643		09/02/2021	17.870,69	95.863,74
5,3680		16/02/2021	-	
5,4634		23/02/2021	-	
5,6407		02/03/2021	32.111,69	181.132,41
5,8746		09/03/2021	-	
5,6145		16/03/2021	-	
5,5055		23/03/2021	-	
5,7808		30/03/2021	-	
5,6627		06/04/2021	-	
5,7322		13/04/2021	-	
5,5453		20/04/2021	-	
5,4353		27/04/2021	18.620,96	101.210,50
5,4381		04/05/2021	18.511,67	100.668,31
5,2222		11/05/2021	-	
5,2715		18/05/2021	-	
5,3185		25/05/2021	-	
5,2166		01/06/2021	19.157,65	99.937,80
5,0452		08/06/2021	-	
5,0586		15/06/2021	-	
5,0131		22/06/2021	-	
4,9248		29/06/2021	-	
5,0885		06/07/2021	-	
5,1727		13/07/2021	17.999,16	93.104,25
5,2509		20/07/2021	-	
5,1754		27/07/2021	-	
5,1746		03/08/2021	-	
5,2318		10/08/2021	-	
5,2597		17/08/2021	-	
5,3799		24/08/2021	-	
5,2028		31/08/2021	-	
5,1898		07/09/2021	-	
5,2470		14/09/2021	-	
5,2897		21/09/2021	20.937,32	110.752,14
5,3370	5,2500	28/09/2021	-	

Prediction	N/A	5,3177	5,3439	05/10/2021	-	
	N/A	5,3855	5,3509	12/10/2021	-	
	N/A	5,4532	5,3578	19/10/2021	27.432,00	N/A
	N/A	5,5210	5,3647	26/10/2021	-	
		5,5500	5,3677	29/10/2021 ⁸	-	
	N/A	5,5463	5,3717	02/11/2021	-	
	N/A	5,5397	5,3786	09/11/2021	39.657,61	N/A
	N/A	5,5331	5,3855	16/11/2021	-	
	N/A	5,5266	5,3924	23/11/2021	-	
	N/A	5,5200	5,3994	30/11/2021	33.532,55	N/A
	N/A	5,5150	5,4063	07/12/2021	-	
	N/A	5,5100	5,4132	14/12/2021	-	
	N/A	5,5050	5,4201	21/12/2021	-	
	N/A	5,5000	5,4271	28/12/2021	37.983,99	N/A
	N/A	5,4950	5,4340	04/01/2022	-	

⁸ The date was entered as it is the last business day of October

Exhibit 7 - Assets and liabilities month track – simplified cash flow of the firm (January/2020 – January/2022)

This Table presents a simplified financial overview of the company from January/2020 to January/2022. The values from October, November and December of 2021 and January of 2022 are estimations. Panel A presents the values of Ptax, obtained at the last business day of each month. Panel B reports the company's simplified cash flow, the Initial Balance from January/2020 was provided by the company and it was the value in their saving accounts on January 31st, 2020. The Inflows were all the receivables the company had during the monthly period; whereas Outflows present all the payables of the company, including the ones in other currencies (i.e., Products Payments). The Cash Net Generation is the summation of the Initial Balance plus Inflows less Outflows, and the final value will be the Initial Balance for the next month. It is important to highlight that Panel A and Panel C are quoted in USD; whereas the values from Panel B are in BRL.

Panel A – Ptax/month												
	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20
USD Rate	Ptax	Ptax	Ptax	Ptax	Ptax	Ptax	Ptax	Ptax	Ptax	Ptax	Ptax	Ptax
Ptax @the last business day of the month	4,242	4,4848	5,1927	5,3348	5,4036	5,4021	5,1539	5,3900	5,6305	5,7778	5,3425	5,1908

(Continued)

Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22
Ptax	Ptax	Ptax	Ptax	Ptax	Ptax	Ptax	Ptax	Ptax	Initial Forecast	Forecast 1	Forecast 2	Forecast 3
5,438	5,528	5,7716	5,3364	5,238	4,9551	5,0804	5,2516	5,4276	N/A	N/A	N/A	N/A

Panel B – Cash Flow [BRL]											
	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20
	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual
Initial Balance	1.819.362,85	2.118.690,96	2.464.908,44	2.765.018,94	2.503.945,23	2.950.145,35	3.649.082,18	3.864.778,17	2.810.743,35	3.519.357,10	2.127.234,46
Inflows	1.227.915,83	825.799,81	1.301.579,71	0,00	670.456,48	831.867,04	1.438.974,83	1.244.929,22	1.423.340,75	1.147.801,56	791.163,62
Outflows	928.587,72	479.582,33	1.001.469,21	261.073,71	224.256,36	132.930,21	1.223.278,84	2.298.964,04	714.727,00	2.539.924,20	1.527.711,31
Products Payments [BRL] [converted @spot]	1.819.362,85	2.118.690,96	2.464.908,44	2.765.018,94	2.503.945,23	2.950.145,35	3.649.082,18	3.864.778,17	2.810.743,35	3.519.357,10	2.127.234,46
Cash Net Generation	238.272,96	0,00	0,00	206.462,47	199.894,33	99.963,46	0,00	131.536,56	328.616,69	258.223,98	0,00
	2.118.690,96	2.464.908,44	2.765.018,94	2.503.945,23	2.950.145,35	3.649.082,18	3.864.778,17	2.810.743,35	3.519.357,10	2.127.234,46	1.390.686,77

(Continued)

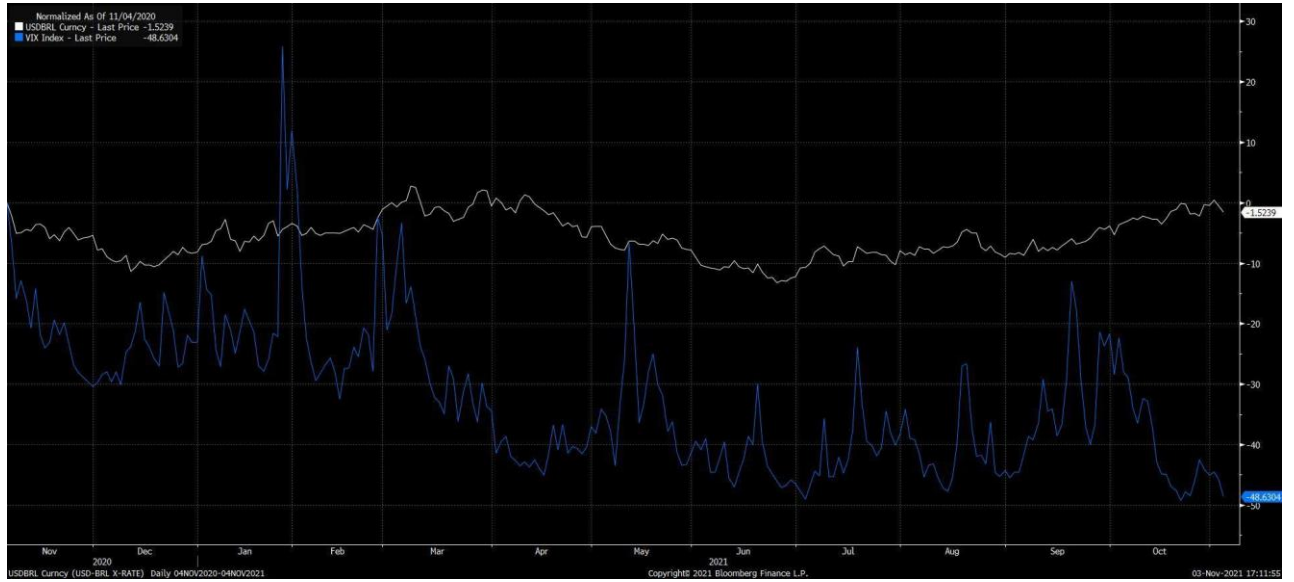
Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22
Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Initial Forecast	Forecast 1	Forecast 2	Forecast 3
1.390.686,77	1.144.865,34	1.323.269,75	1.374.740,71	831.669,20	1.169.840,33	721.338,22	734.132,50	660.513,12	1.129.321,30	907.793,04	907.793,04	1.057.793,04	962.793,04
525.088,53	828.184,54	854.815,28	321.597,22	743.381,06	501.433,13	547.128,06	578.487,19	704.717,45	426.199,88	750.000,00	800.000,00	675.000,00	850.000,00
770.909,96	649.780,13	803.344,32	864.668,73	405.209,93	949.935,24	534.333,78	652.106,57	235.909,27	647.728,14	750.000,00	650.000,00	770.000,00	650.000,00
237.934,32	190.986,60	95.863,74	181.132,41	101.210,50	100.668,31	99.937,80	93.104,25	111.453,54	0,00	N/A	N/A	N/A	N/A
1.144.865,34	1.323.269,75	1.374.740,71	831.669,20	1.169.840,33	721.338,22	734.132,50	660.513,12	1.129.321,30	907.793,04	907.793,04	1.057.793,04	962.793,04	1.162.793,04

Panel C – USD Liabilities											
	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20
Initial Balance	-	57.837,42	0,00	0,00	38.053,14	36.722,33	19.033,77	0,00	23.879,70	59.737,98	46.118,99
Purchase [USD]	57.837,42	0,00	0,00	38.053,14	36.722,33	19.033,77	0,00	23.879,70	59.737,98	46.118,99	0,00
Payments [USD]	-	57.837,42	0,00	0,00	38.053,14	36.722,33	19.033,77	0,00	23.879,70	59.737,98	46.118,99
Final balance	57.837,42	0,00	0,00	38.053,14	36.722,33	19.033,77	0,00	23.879,70	59.737,98	46.118,99	0,00
Net Exposure	57.837,42	0,00	0,00	38.053,14	36.722,33	19.033,77	0,00	23.879,70	59.737,98	46.118,99	0,00

(Continued)

Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22
0,00	45.488,19	0,00	0,00	32.111,69	18.620,96	18.511,67	19.157,65	17.999,16	0,00	20.937,32	27.432,00	73.190,16	37.983,99
45.488,19	0,00	0,00	32.111,69	18.620,96	18.511,67	19.157,65	17.999,16	0,00	20.937,32	27.432,00	73.190,16	37.983,99	N/A
0,00	45.488,19	0,00	0,00	32.111,69	18.620,96	18.511,67	19.157,65	17.999,16	0,00	20.937,32	27.432,00	73.190,16	37.983,99
45.488,19	0,00	0,00	32.111,69	18.620,96	18.511,67	19.157,65	17.999,16	0,00	20.937,32	27.432,00	73.190,16	37.983,99	-
45.488,19	0,00	0,00	32.111,69	18.620,96	18.511,67	19.157,65	17.999,16	0,00	20.937,32	27.432,00	73.190,16	37.983,99	-

Exhibit 8 - Implied Volatility BRL/USD November, 2020 – October, 2021



Source: Bloomberg (2021)

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