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# Efficiency of Options Market as an Exchange Rate Risk Hedging Instrument

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## Abstract:

Since 1999, Colombia adopted an exchange rate regime in which the United States dollars/Colombian pesos (USD/COP) exchange rate is floating. This means that quoted prices in the market of this currency depend on the existing supply and demand. In some instances, Banco de la República intervenes in the purchase or sale of currencies (dollar) in order to regulate the prices slightly. This paper presents the empirical validation of the options as hedging instruments, some inefficiencies of this financial instrument were found due to their low availability and high transaction costs in the use of this asset as an exchange risk hedging instrument. The goal of this study was validate the USD/COP options assets as hedging instruments of exchange risk, that has not yet studied on Colombian companies, who carry out foreign currency transactions; The present study argues the importance for the companies to use a hedging strategy to diversify the exchange rate risk; consequently, companies who perform currency operations (with dollars in this case) must include operations to manage financial risks in the USD/COP exchange rate through financial instruments, such as the exchange rate options contracts, to reduce transaction costs. For this, the spot prices and USD/COP options between 2011 and 2018, found in the Colombian stock exchange, were analyzed by valuing its risk through the VaR (value at risk), evaluating its impacts as a risk-hedging instrument in the exchange rate, and comparing hedging effects through a Sharpe ratio model (Alaganar & Bhar, 2007; de Bruin & Walter, 2017; Jorion, 2007).

**Keywords:** International Trade; Financial Risk; *Options*; Exchange Rate Risk; Exchange Risk.

## 1. Introduction

Since 1999, Colombia adopted an exchange rate regime in which the USD/COP exchange rate is floating. This means that quoted prices in the market of this currency depend on the existing supply and demand. In some instances, Banco de la República

intervenes in the purchase or sale of currencies (dollar) in order to regulate the prices slightly.

These fluctuations in the exchange rate affect the assets and liabilities of companies who go through any internationalization process because of the constant exposure to investing (portfolio) or financing (providers) processes. In agreement with Kozikowski (Broll et al., 1999; Kozikowski, 2013; Mouradian, 2017), exchange risk refers to the uncertainty that is caused by the future market price of a currency. This could affect the prices in the assets and liabilities in foreign currency at the time of applying them to the local one. In the same line, Jacque (2014) defines the concept of exchange rate exposure as the foreign currency amount of a company who is constantly involved in import/export processes. This is due to the fluctuation of currency prices in which negotiations take place. Finally, Grath (2016) describes exchange risk as to the impact in local currency prices because of the exchange rate applied in purchase and sales operations in foreign currency.

This article presents an analysis of the *options* derivative for the USD/COP exchange rate to use it as a hedging instrument and balance exchange risk. Furthermore, when companies perform foreign trade operations, they have a high degree of vulnerability when facing the international market. That is why they are considered the object of study so that they contribute to their permanence in time.

For the analysis, the closing prices of the USD/COP *spot* and *options contracts* market were collected with the available information available in the Colombian Stock Market's platform for the years 2011 to 2018 by using the *value at risk* (VaR) model, proposed by Jorion (Balbás & Charron, 2019; P. Jorion, 2007; Philippe Jorion, 2011; Ye & Peng, 2008), and the variance/covariance measures. The behavior of both assets was verified in the time series 0 to 1 month and 1 to 3 months.

Among the main research findings of this study, the increase of exposure to risk in the exchange rate concerning time is identified. That is, the longer time exists between the contract date and the currency payment date, the higher the risk exposure caused by variations in the exchange rate. In addition to this, the low availability of the *options* asset in the Colombian Stock Market modifies its use as a hedging instrument.

Finally, the behavior of the *spot* value of the USD/COP currency is different from the behavior of the *options* contracts that are derived from the USD/COP exchange rate. This generates an increase in cost transactions in operations of imports/exports performed in dollars.

## 2. Exchange rate

Grounded on Krugman, Obstfeld (2012), and Kozikowski (2013), the exchange rate is defined by the price of a currency in contrast to another one. For this study, it could be defined as the amount of Colombian pesos (COP) that have to be paid for every American dollar (USD). Since the exchange rate has a variation according to the supply and demand of the foreign currency (Banco de la República, 2013), it also conditions

the prices of financial assets and plays an important role in international trade, allowing the comparison of products and services that are produced in different countries.

Based on Krugman (2012), the variations of the exchange rate are also defined as appreciations or depreciations. Depreciation of Colombian pesos against the American dollars happens when more pesos must be paid for a dollar. On the contrary, when less Colombian pesos must be paid for each American dollar, we have an appreciation of the peso against the dollar.

The purchase and sale of currencies is the functionality that international finances generate so that, through the exchange rate, currencies can be bought and sold in any part of the world. The price is determined by the currency market, that is to say, this market conditions the other financial international markets inasmuch as it assigns the exchange prices of the currencies.

In Colombia, the National Directorate of Taxes and Customs (DIAN, 2019), mentions the currency market constituted by the Colombian Stock Exchange, the Exchange market brokers, as well as by the people and companies that need to transfer purchasing power of a currency to the Colombian peso through the exchange rate.

Besides having the feature of any market in which buyers and sellers constantly exist, the purchase and sale of currencies represent 75% of the international interbank operations, and the 89% of the transactions are performed in dollars (Garcia & Diez, 2014).

The currency market conditions the prices of currency exchange rates on the grounds that it compares the proposals between buyers and sellers that offer their currency and buy another one (Dhanani, 2003; Kozikowski, 2013; Lam & Lai, 2015; Ngo, 2017; Xiong & Zhang, 2010).

### 2.1. Finance and exchange risk

We can define-finance risk as to the changes in the interest rate or the capital costs in local currency. This type of risk exposes a company to may end up in default. This is because of the given probability that a business does not generate needed surpluses, or that the financial results are not initially planned (Grath, 2016; Mu et al., 2012; Wu et al., 2015; Ye & Peng, 2008).

Every company is exposed to risks, even more so when they are developing processes of internationalization. Its risk profile can vary due to the increase in the development of domestic or international markets. This is the main reason why companies ought to identify their risks, such as the exchange rate in order to handle processes for reducing the impact on company finances.

One of the risks to which companies are more exposed, specifically those that develop internationalization processes, is the risk in the exchange rate that is caused by a risk of positive or negative changes in the future economic value of the company. This is determined by a variation in the exchange rate of the local currency with respect to a foreign one that has investments or financing. In Addition, describes it as the decrease of the sales revenue from the exporter or the increase of costs from the importer that is

caused by a variation in the exchange rate between the transaction (purchase or sale) and the payment days. Finally, in addition the exposition of risk in the exchange rate as the value of the transaction amount in terms of foreign currency; this conditions the size risk to which the company is exposed (Font & Grau, 2012; Grath, 2016; Zhou et al., 2013).

Based on the aforementioned, we can conclude that financial risks are related to the probability and the impact that unexpected variations in macroeconomic variables have on company cash flow, and thus, in the value of this one.

## 3. Methodology

Data collection was carried out through the *Set fx* platform, which is in charge of registering all the operations of the currency market in Colombia. Quotation *spot* prices from the USD/COP closing exchange rate in 2011 and 2018 were obtained. Likewise, data from closing quotations of the derived *options* of USD/COP exchange rate were taken from 0 to 1 month; from 1 to 3 months for the same period.

In total, 5.474 observations were conducted in which closing prices of the different options contracts (Hedged portfolio) were compared to the closing prices of the spot value (unhedged portfolio) of USD/COP exchange rate. This allowed us to assess its efficiency as a hedging instrument through the probabilistic models of VaR (Value at Risk), Sharpe's ratios model in order to make a comparison of an investment portfolio in dollars without the hedging use and others with the hedging use in USD/COP options contracts.

The VaR model is used to measure the potential loss of an investment portfolio with a determined level of uncertainty, which had 5% in this study as suggested by Jorion (Philippe Jorion, 1991, 2011; Li & Gu, 2018; Pan & Yan, 2010), that is, calculated data with daily prices of this research. Once every 20 days, the prices will be below the calculated value, thereby facilitating risk management in the exchange rate.

Analytically, the VaR defines the upper limit of the integral in relation to the expected paybacks, which they can be described in the following formula:

$$VaR = \propto * \sqrt{\delta^2 * \Delta t} \qquad (1)$$

In equation (1), $\propto$ determines the possible area of risk exposure, $\delta^2$ is the variance of asset prices, and $\Delta t$ refers to the times of risk exposure. From here, the upper limit of risk exposure to the exchange rate is obtained as presented by Jorion (2011).

The Sharpe ratios measurement model (de Bruin & Walter, 2017; Du et al., 2018; Sharpe, 1964) is widely used for risk measurement in investment portfolios. In this study, it was used to measure the efficiency in the use of options contracts in the exchange rate as a tool for hedging in USD/COP currencies.

$$Sr = \frac{\hat{\mu}_k}{\hat{\delta}_k} \qquad \text{k = Portafolio} \qquad (2)$$

In equation (2), $\widehat{\mu_k}$ represents payback mean of the prices, and $\delta_k$ represents its standard deviation.

The study consisted of an empirical validation to characterize the reality of the companies exposed to currency operations where hypothetical series of peso/dollar exchange rate were analyzed in order to perform calculations and analysis of the impact in foreign trade operations.

### 3.1. Hypothesis

For the study, the following hypotheses were formulated.

$$H_0 = SR_H - SR_U = 0$$

$$H_1 = SR_H - SR_U \neq 0$$

Where $SR_H$ corresponds to Sharpe risk calculations of the portfolio with the use of USD/COP options contracts, and $SR_U$ corresponds to the unhedged portfolio results.

### 3.2. Data collection

Once the information of *spot* prices and *options* of USD/COP exchange rate was obtained, asset measures from 0 to 1 month and 1 to 3 months were carried out with the contained information in the *SetFx* tool of the Colombian Stock Exchange. Numbers for the years 2011 to 2018 were taken, and different indicators that measure risk exposure were calculated. Likewise, indexed texts and books were taken into account so as to develop theoretical bases in research and the above mentioned platforms.

This study was divided into the following phases; i) information preparation, whose objective was to explore and revise the international, national and local background, as well as theoretical references that allowed to develop the bases for a problem statement and to begin developing the research study. ii) Instruments were elaborated and applied to systematize security behavior of USD/COP *spot* and *options* during 2011-2017. iii) Lastly, obtained information was analyzed to determine the efficiency of financial *options* instruments in USD/COP as a hedging instrument in relation to the exchange rate risk.

## 4. Findings

Below, we present the behavior of closing price *spot* from USD/COP and the quoted prices of USD/COP *options* at 30 and 90 days based on the data reported through the *SetFx* platform of the Colombian Stock Exchange.

### 4.1. Analysis of USD/COP Spot (unhedged portfolio) value between 2011 and 2018

The analysis, through the variance model (VaR), evidenced the behavior by taking the closing *spot* prices reported through *Set Fx* platform with a total of 1.808 days. They were observed with the use of USD/COP exchange rate operations from 2011 to 2017.

In table 1, we describe the risk exposure that companies had in terms of daily, monthly, quarterly and six-monthly expiration in order to compare them with hedging *options* instruments that are available in the Colombian Stock Exchange.

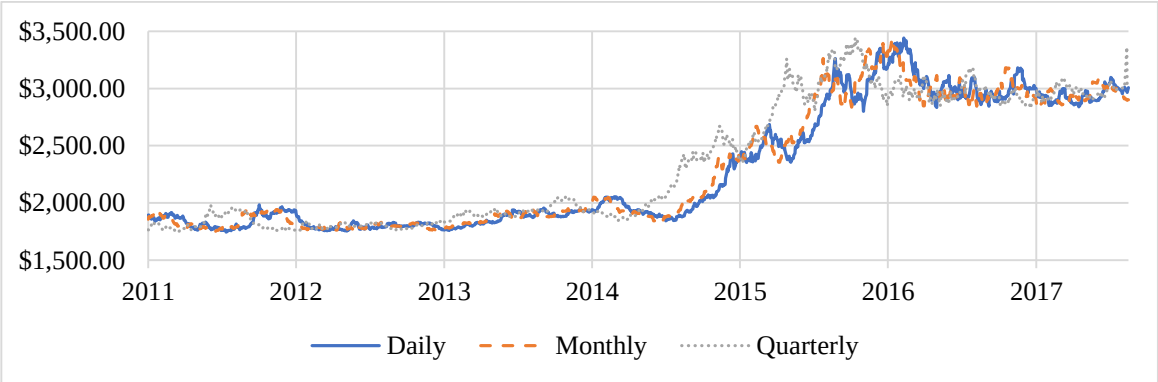
*Table 1. Summary of risk exposure in the exchange rate*

| Expiration | Risk exposure |
|---|---|
| Daily | 1,93 % ± |
| Monthly | 8,94 % ± |
| Quarterly | 13,31 % ± |

*Source: Data obtained from Set Fx.*

According to the summary exposed in table 1, as expiration is extended, risk exposure is higher. When a company had a one day expiration contract, it faced either an increase or decrease of 1,93% in the exchange rate price, thereby reaching a higher or lower risk of 17,17% for a six-monthly expiration. This can affect companies' cash flow due to a higher value in the price of their imports or a lower sales income.

*Figure 1. Spot prices for daily, monthly and quarterly closing 2011-2018*




*Source: Data obtained from Set Fx*

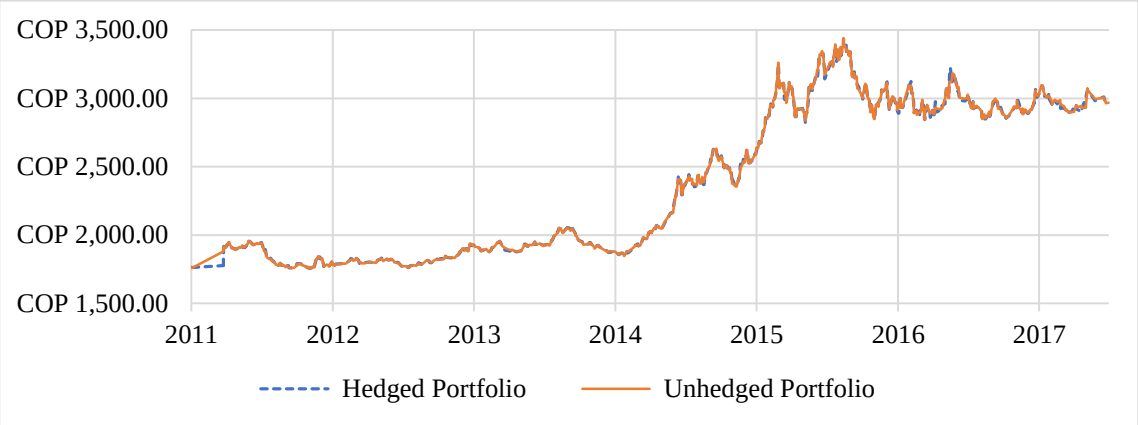
### 4.2. Analysis of USD/COP options (hedged portfolio) price between 2011 and 2018

Finally, we analyze the efficiency of USD/COP *options* assets in one month and one quarter based on the data reported by the *Set Fx* platform of the Colombian Stock Exchange and evaluated through the VaR model.

From 1.808 days in which USD/COP currencies were quoted in the Colombian currency market, the derivative with higher availability was the USD/COP options to 90 days that had a 1.377 days quotation and the options to 30 days quoted 965 days. This demonstrates a low availability as a hedging instrument, thereby conditioning its use as a hedging instrument in exchange rate risk.

### 4.2.1. Analysis of 30 days USD/COP Options

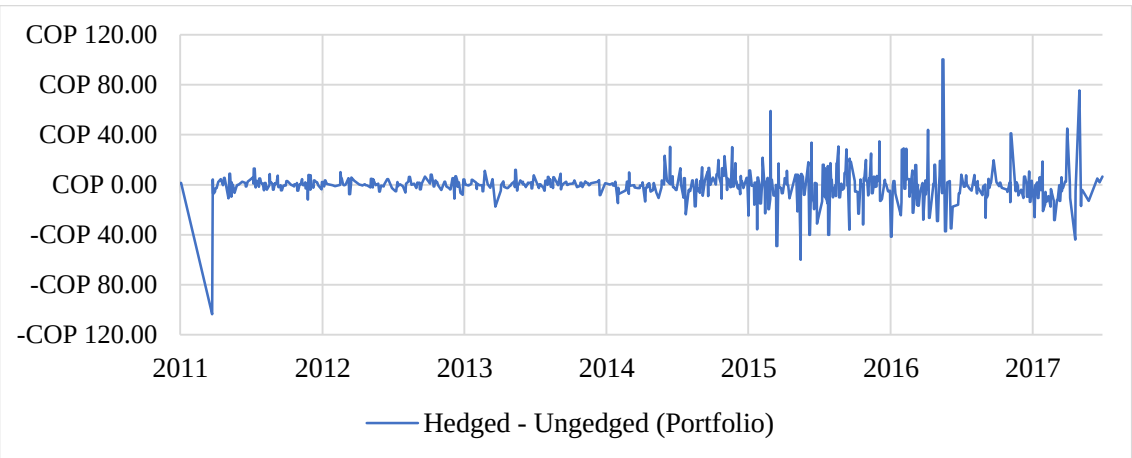
*Figure 2. 30 days Hedged Portfolio Vs 30 days Unhedged Portfolio.*




*Source: Data obtained from Set Fx*

In Figure 2, we can see that price behavior of hedged and the unhedged portfolio with closing date to 30 days are similar. However, when the differences in Figure 4 prices are calculated, we found a different behavior.

*Figure 3. Differences between 30 days hedged portfolio and 30 days unhedged portfolio.*

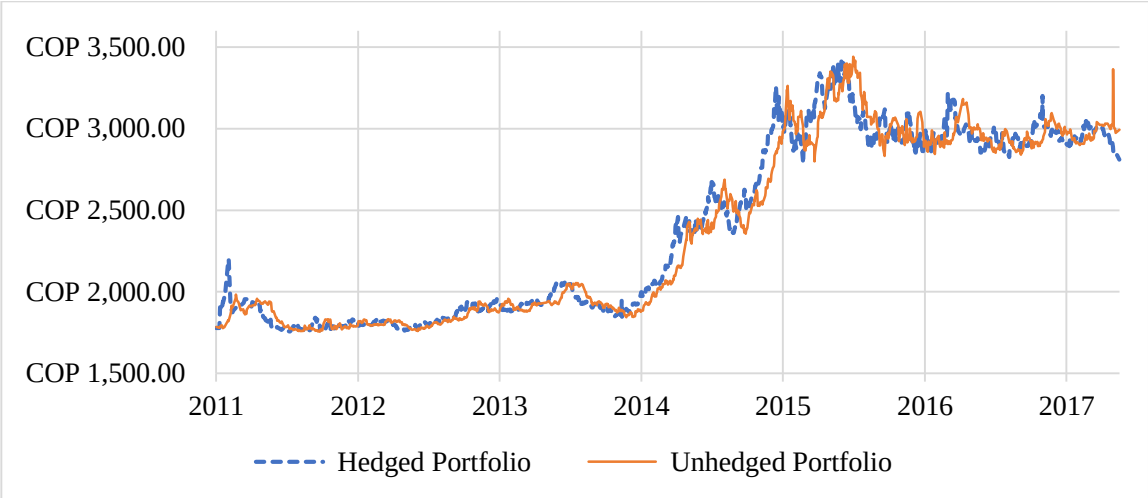



*Source: Data obtained from Set Fx*

The price differences (Hedged Portfolio – Unhedged Portfolio), we found that in 48% of the times, future contracts in options were effective to face a lower price in the USD/COP exchange rate. Likewise, we found minimal differences of -COP 103,65 and a maximum of COP 100,18. Indeed, we could observe that from 2014 on, the volatilities in price differences increased.

### 4.2.2. Analysis of 90 days USD/COP Options

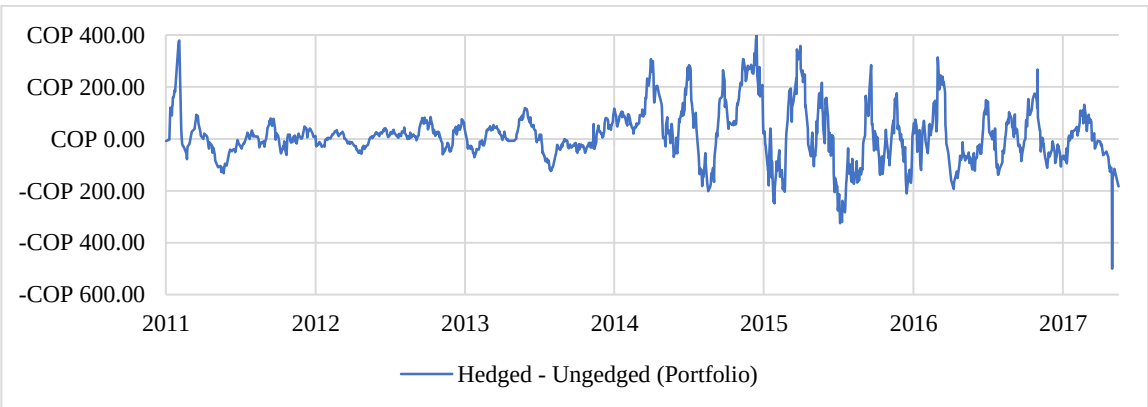
*Figure 4. 90 days Hedged Portfolio Vs 90 days Unhedged Portfolio*




*Source: Data obtained from Set Fx*

In Figure 4, we observe that the behaviors on the prices to 90 days of unhedged and the hedged portfolio using options are clearly different. This shows a higher risk exposure in comparison with the prices to 30 days.

*Figure 5. Differences between 90 days hedged portfolio and 90 days unhedged portfolio.*




*Source: Data obtained from Set Fx*

In Figure 5, we compare the 90 days hedged portfolio and the unhedged portfolio. We found more differences than the prices to 30 days and a minimum difference of -COP 500 as well as a higher maximum of -COP 382,28 showing a higher risk exposure in the exchange rate. Likewise, in 57% of all cases, the hedged portfolio was above the USD/COP closing spot price.

Table 2. Summary of Options prices

| Description | Unhedged Portfolio | Hedged Portfolio Option 30 days | Hedged Portfolio Option 90 days |
|---|---|---|---|
| Maximum | COP 3.441,00 | COP 3.432,00 | COP 3.432,00 |
| Minimal | COP 1.746,00 | COP 1.755,55 | COP 1.756,00 |
| Deviation | COP 533,02 | COP 548,81 | COP 541,90 |

*Source: Data obtained from Set Fx*

In table 3, by summarizing the closing prices of the USD/COP options contracts, we could identify that no similarities exist in any of the assets. This generated highly expensive prices in comparison with the highest closing *unhedged portfolio* price. Hence, it increased the transaction costs in hedging risk operations with this asset.

Lastly, by comparing the closing unhedged portfolio price with the hedged portfolio using options contracts, we found a quite low percentage in which the difference was negative. This indicates that this hedging asset is optimal for purchase (imports) rather than sales (exports) in dollars.

*Table 3. Statistical data Unhedged portfolio and Hedged portfolio*

| Asset | Observations | Mean % | Stdev % | Max % | Min % | Skewness | Kurtosis | Correlation |
|---|---|---|---|---|---|---|---|---|
| Unhedged Portfolio | 1.706 | 0,027 % | 0,736 % | 4,129 % | -3,435 % | 0,034 | 3,626 | |
| **30 Days** | | | | | | | | |
| 30 Days Unhedged Portfolio | 964 | 0,026 % | 0,765 % | 4,832 % | -4,180 % | 0,174 | 8,027 | 0,9997 |
| 30 Days Hedged Portfolio (Options Contracts) | 964 | 0,054 % | 1,097 % | 7,698 % | -4,509 % | 0,650 | 6,543 | |
| **90 Days** | | | | | | | | |
| 90 Days Unhedged Portfolio | 1.376 | 0,031 % | 0,839 % | 10,688 % | -10,953 % | 0,325 | 30,141 | 0,9822 |
| 90 Days Hedged Portfolio (Options Contracts) | 1.376 | 0,034 % | 1,080 % | 11,093 % | -14,450 % | -0,713 | 35,133 | |

Source: Data obtained from Set Fx

In table 3, we compare statistical data of standard deviation percentages (Stdev%), the percentage of maximum variation (Max %), the percentage of minimal variation (Min

%), skewness, kurtosis as well as prices correlation of the hedged portfolio with options contracts and the unhedged portfolio.

From 1.706 observations that were carried out in *unhedged portfolio* prices, we obtained an availability from the *options contracts* to 30 days in 964 occasions, and from the *options contracts* to 90 days in 1.376 events. This demonstrates the low availability of this hedging instrument in the exchange rate.

Likewise, it shows that the longer the exposure to one variation in the exchange rate is, the higher expositions and variations are. This causes that companies, who perform operations in USD/COP, have to conduct hedging operations.

*Table 4. VaR and Sharpe Ratios calculation*

| ASSET | VAR | SHARPE RATIOS | $SR_H - SR_U$ |
|---|---|---|---|
| Unhedged Portfolio | 1,72% | 3,67% | |
| **30 Days** | | | |
| 30 Days Unhedged Portfolio | 1,78% | 3,41% | 1,54% |
| 30 Days Hedged Portfolio (Options Contracts) | 2,56% | 4,95% | |
| **90 Days** | | | |
| 90 Days Unhedged Portfolio | 2,17% | 4,04% | -0,89% |
| 90 Days Hedged Portfolio (Options Contracts) | 2,52% | 3,15% | |

*Source. Data obtained from Set Fx*

When making the VaR and Sharpe Ratios calculation for *unhedged* USD/COP *portfolio*, showed in table 4, and compared with a hedged portfolio with options contracts, we could appreciate that the hedging instrument to 90 days is more efficient.

Finally, according to the findings, we should choose the alternative Hypothesis $H_1 = SR_H - SR_U$ 0 inasmuch as we have a positive difference when hedging to 30 days, whereas we have a negative difference when hedging to 90 days.

## 5. Conclusions

The companies that perform operations in dollars were exposed to a high risk in the exchange rate from 2011 to 2017. When risk exposition is longer, the difference is higher with a daily, monthly and quarterly exposition of 1.93%, 8,94% and 13,31%, respectively.

This is summarized in a higher or lower cost in imports and a higher or lower income in exports for the companies who carry out dollar operations.

The highest positive exposition was +18,08% in the quarter from November 2, 2015 to February 2, 2017. The highest negative exposure was of -30,80% in the quarter from March 17, 2014 to its closure on September 17, 2017.

After evaluating the behavior of *options* hedging instruments from 2011 to 2017, we could notice that there is low liquidity in these assets. This conditions the availability of hedging instruments for risk management in the USD/COP exchange rate.

The assets with the highest availability were 90 days of *options contracts*. However, this had the lowest correlation to the closing *unhedged portfolio* prices, which showed a different behavior between the prices of this asset and dollars in cash. This asset can be more efficient for hedging in export processes due to the fact that, at least in 56,94% of the reviewed events, closing *options* prices were higher than the closing *unhedged portfolio* price at the contract's expiration.

There is a lower risk exposure in the use of options to 90 days than in the use of options to 30 days due to a negative difference in Sharpe ratios and a lower VaR.

After this, Banco de la República ought to create market generators, similar to the ones that are created for purchase/sell in cash-currencies in order to guarantee higher liquidity in the *options*. Likewise, it should allow that the brokers of the exchange market, such as financial entities or stockbrokers, to facilitate the asset availability with low price without conditioning minimum values of high contracts since the access to the SMEs is restricted.

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