EFFICIENCY OF OPTION MARKET AS AN EXCHANGE RATE RISK HEDGING INSTRUMENT: USD – COP CASE.

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ABSTRACT

This article evaluates the efficiency of contract *options*, which are derived from United States dollars/Colombian pesos (USD/COP) exchange rate as hedging instruments of exchange risk to which Colombian companies, who carry out foreign currency transactions, are exposed. For this, the *spot* prices and USD/COP *options* between 2011 and 2017, 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 (1964).

In addition to 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 derivative as a hedging instrument.

KEY WORDS

International trade; financial risk; *options*; exchange rate risk; exchange risk.

JEL CLASSIFICATION
G11, G14, G23, G32.

CONTENT

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INTRODUCTION

Since 1999, Colombia adopted an exchange rate regime in which 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 (2013), 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 the impact in local currency prices because of exchange rate applied in purchase and sales operations in foreign currency.

Therefore, 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 contracts of *options,* to reduce transaction costs. This occurs due to the fact that there are a few companies who acknowledge these tools and do not have a finance department (a priori hypothesis) that implements strategies leading to the mitigation of USD/COP exchange rate.

This article presents an analysis of the *options* derivative for the USD/COP exchange rate in order 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 as 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* market were collected with the available information available in the Colombian Stock Market's platform for the years 2011 to 2017 by using the *value at risk* (VaR) model, proposed by Jorion (2007), and the variance/covariance measures. The behavior of both assets was verified in the time series 0 to 1 month, 1 to 3 months, 3 to 6 months and higher to six months.

Among the main research findings of this study, the increase of exposure to risk in exchange rate in relation to 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 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.

1. 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 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.

In accordance with the above-mentioned, we can deduce that the exchange rates allow to fix international prices of goods and services as well as to compare national prices with the foreign ones.

1.1. Exchange rate and currency market

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 the 75% of the international interbank operations, and the 89% of the transactions are performed in dollars (Garcia & Díez, 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 (Kozikowski, 2013).

2. FINANCE AND EXCHANGE RISK

We can define-finance risk as the changes in interest rate or the capital costs in a 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 as stated by Grath, (2016).

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 impact on company finances.

In agreement with Ye *et al.* (2014), financial risk refers to the uncertainty on the economic value of the company in the future. This value can be affected by changes in interest rates, devaluation processes, inflation rates or because of the variations in the exchange rate of local currencies in comparison with the foreign ones.

One of the risks to which companies are more exposed, specifically those that develop internationalization processes, is the risk in 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. Grath (2016) 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, Grath defines 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.

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.

2.1. Colombian Financial system

In agreement with Uribe (2006), the Colombian financial system is constituted the money market,the currency market, the capital market and among others. The main functions of this market are the finance facilitation of debt issuers at short-term as well as the support to the effective execution of monetary policy and to temporary formation of interest rates.

Currency market, illustrated by Carbaugh (2016), refers to the highest liquidity scenario in the world which involves individuals, companies, governments and banks that buy and sell currencies or any other debt instruments. This market functions in three levels. 1) Transactions between export/import clients, investors or tourists and commercial banks. 2) Currency runners or *brokers* through the national inter-bank market. Finally, 3) the currency exchange between commercial banks and branches or foreign correspondents.
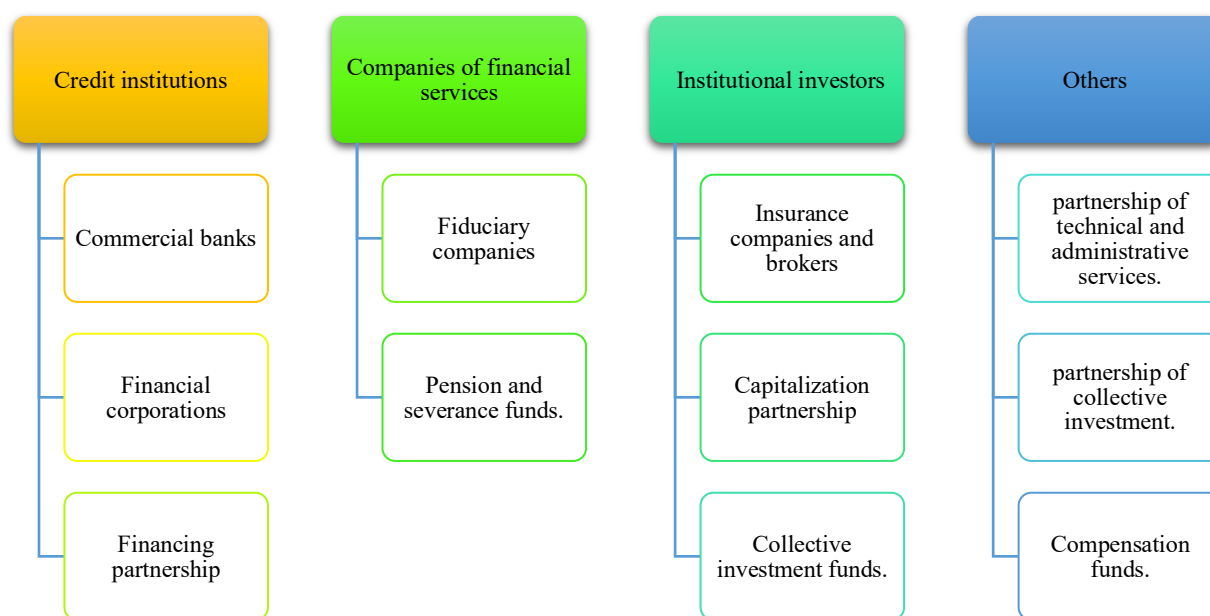
The two main components of capital markets are the bank employee[3] (intermediate) and the value (disintermediate), which are described by the Financial Superintendence of Colombia (2017). The

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[3] Because money is the key element for the operation of the banking financial system, it must be clear that nowadays: "the amount of money that is made in the economy ultimately depends on the monetary policy of the central bank. In ordinary times, this is carried out by fixing interest rates (…) In modern economy, most of the money takes the form of bank deposits (…) The main way to create the deposits is through loans that commercial banks offer. Every

intermediate colombian market is shaped by credit establishments, societies of financial services, institutional investors and other companies that are shown in Graphic 1. The first ones have the main function of channeling and collecting superlative resources from a sector to transfer them to those with deficit through loans, advances or transactions.

Based on this, Uribe (2013) points out that societies of financial services are brokers with public resources. They do not implement the capture through deposits, and the placement is not implemented through credits on the grounds that their main function is to provide financial specialized advice for resource administration. On the other hand, those institutions whose function is to collect available resources from the agents for investing in value stocks are known as institutional investors. Lastly, Fradique-Méndez (2014) mentions those entities that are not included in the previous groups, but provide complementary services and related financial activities. They are classified as other institutions.

Graphic 1. Banking system in Colombia.

Credit institutions	Companies of financial services	Institutional investors	Others
Commercial banks	Fiduciary companies	Insurance companies and brokers	partnership of technical and administrative services.
Financial corporations	Pension and severance funds.	Capitalization partnership	partnership of collective investment.
Financing partnership		Collective investment funds.	Compensation funds.

Source: Banrep (2013).

The Colombian Stock exchange (2008, p.24) defines the stock market as "*the group of agents, institutions, instruments and negotiation forms that interact with each other, facilitating capital transference for investment through the trading of stocks*". It is constituted by issuers of securities, investors, brokers and different infrastructure providers. The market issuers are those entities that move security titles of any field and that are registered in the National Register of Securities and Issuers. On the other hand, the investors are all those natural or legal people that invest their resources in security values. A security broker is the one in charge of the approach between plaintiffs and offerers for security title negotiation. Lastly, infrastructure providers for Colombian

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time a bank makes a loan, it simultaneously deposits money corresponding to the bank account of the borrower, thereby making new money" (McLeavy, Radia & Thomas, 2015, p. 355).

Market are the Centralized Security Deposit, the BVC[4], Risk Assessment Companies and the Stock Market Self-regulator Autorregulador del Mercado de Valores (AMV).

According to Fradique-Méndez (2014), the second classification of the titles deals with how returns are established. These can be determined from negotiation time in fixed income or liquidation time of the future security in variable income. Finally and based on how securities are transferred, these can be nominal—which imply holder's record in the register that the issuer manages at the disposal of the legitimate holder, that is, the person who has received the security and appears as endorsee—, or the securities to the owner, which exclusively require delivery in order to be legitimately transferred to the person that receives it.

The third category Agudelo (2014) belongs to the securities that are generally traded, for instance, participation rights in collective investment funds, deposit certificates of goods, derivative contracts and exchange traded funds (ETF). The latter stand out because of the diversification, reduction in time selection, tracking and balancing of the portfolio inasmuch as they offer collective portfolios with "*fewer administration costs, immediate liquidity and higher transparency in regard to the index, price or reference currency*". The underlying index replica can be either direct or physical,, in other words, the direct or partial purchase of index securities. Also, the use of financial instruments derived indirectly or synthetically as pointed out by the National Commission of Security Market (2015).

Finally, those actions that were not included in capital, monetary or currency market, were classified as other financial markets.

3. METHODOLOGY

Data collection was carried out through the *Set fx* platform, which is in charge of registering all the operations of currency market in Colombia. Quotation *spot* prices from the USD/COP closing exchange rate in 2011 and 2017 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 were compared to the closing prices of the *spot* value of USD/COP exchange rate. This allowed to assess its efficiency as 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.

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[4] On February 15, 2017, the BVC and Deceval signed a memorandum of understanding for a possible cooperative integration. On March 22, 2017, the explanatory guide of the Deceval-BCV corporative integration was issued in order to "generate efficiency in the security chain of capital colombian market to reduce costs and enhance service supply". Finally, on December 15,2017, the BVC and Deceval were announced one single organization after the closing of the transaction and the exchange of shares between both identities. However, on February 28, 2018, there was no manual that changed functions in any of the two entities, thus, they appear in the text separately. (2017, p.3)(BVC b, 2017, p.3).

The VaR model is used to measure potential loss of an investment portfolio with a determined level of uncertainty, which had a 5% in this study as suggested by Jorion (2007), 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:

$$VaR = \propto * \sqrt{\delta^2 * \Delta t} \tag{1}$$

In equation (1), $\propto$ determines the possible area of risk exposure, δ^2 is the variance of asset prices, and Δt refers to the times of risk exposure. From here, the upper limit of risk exposure of the exchange rate is obtained as presented by Jorion (1990).

The Sharpe ratios measurement model (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 exchange rate as a tool for hedging in USD/COP currencies.

$$Sr = \frac{\widehat{\mu_k}}{\widehat{\delta_k}} \qquad k = \text{Portafolio} \tag{2}$$

In equation (2), $\widehat{\mu_k}$ represents payback mean of the prices, and δ_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 analysed in order to perform calculations and analysis of the impact in foreign trade operations.

Among the risks that can condition companies preservation is the business risk, which is affected by decisions made during normal company operations such as the production size, price allocation, distribution channels, among others. Also, the financial risk can be mentioned, which is conditioned by asset prices and the company capacity to cover its costs. For instance, a study carried out by Toro *et al.* (2015) identified that 73,44% of the companies in Medellin showed financial risk in 2013.

The application of the VaR model to estimate the exchange rate risk has been used throughout the years in several research studies worldwide. Wang *et al.* (2010) used the same model to measure the exchange rate risk from Chinese Yuan against the Euro (EUR/CNY) and the Japanese Yen (JPY/CNY). This study showed the exposition to exchange rate risk for a continued appreciation of the Yuan. Zhou Li *et al.* (2013) applied it for valuing the exchange risk of the prices in financial entities' assets in contrast to quoted rates from *renmimbi* (RNB). In their article, they evaluated payment capacity of bank entities in accordance with potential losses because of variations in the exchange rate. Finally, Raul de Jesus *et al.* (2013) used the VaR to measure the risk of potential loss of investments on exchange rate changes from Mexican pesos against the US dollar (USD/MXN).

3.1. Hypothesis

For the study, the following hypotheses were formulated.

$$H_0 = SR_H - SR_U = 0$$
$$H_1 = SR_H - SR_U \; 0$$

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 portfolio results without the use of risk hedges.

3.2. Data collection

Once 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 2017 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 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. RESULTS

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* value between 2011 and 2017

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 in 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.

Graphic 2. Spot prices for daily, monthly and quarterly closing 2011-2017
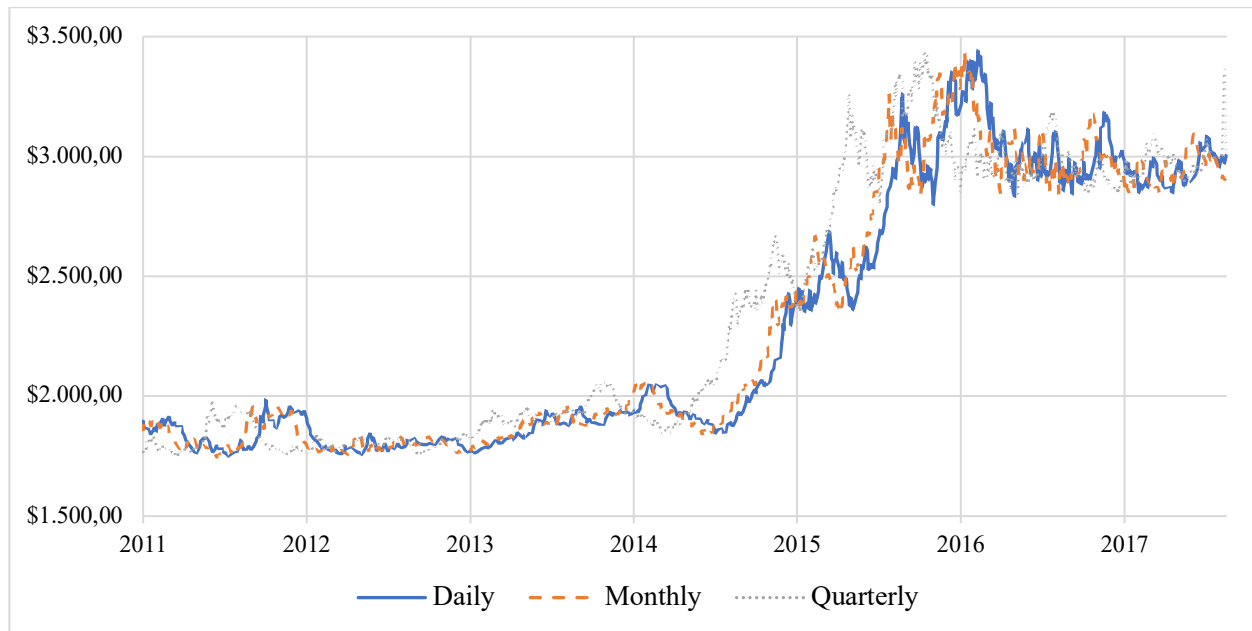
Source: data obtained from *Set Fx*

Graphic 2 contains the closing prices behavior of the USD/COP *spot* market along with its daily, monthly and quarterly expiration. It is clear that the closing price behavior is not constant and has a different variation.

Table 2. Summary of maximum and minimal daily, monthly, quarterly and six-monthly variations 2011-2017.

Expiration	Maximum variation	Minimal variation
Daily	10,45 %	-10,95 %
Monthly	13,14 %	-10,65 %
Quarterly	18,09 %	-25,13 %

Source: data obtained from *Set Fx*

In table 2, we introduce the summary of higher and lower variations in the *spot* prices of daily, monthly, quarterly and six-monthly closing. During 2011 to 2017, the highest variation was 10,45% and the lowest was -10,95% in the closing daily price. The least predictable of this variation was that it occurred in a 3-day period, in which closing dates 11/12/17; 12/12/17 and 13/12/17 reached a closing price of $3.030,00; $3.364,00 and $3.015,00, respectively.

Regarding monthly expiration, a higher variation of 13,14% and a lower variation of -10,65% were identified. Based on quarterly expiration, variations of +18,09 and -25,13% in such period were identified

Finally, we can identify that when companies do not manage these risk exposures, it is quite likely that their cash flow is affected, and hence, liquidity, which jeopardizes company durability.

4.2. Analysis of USD/COP *options* price between 2011 and 2017

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 hedging instrument, thereby conditioning its use as a hedging instrument in exchange rate risk.

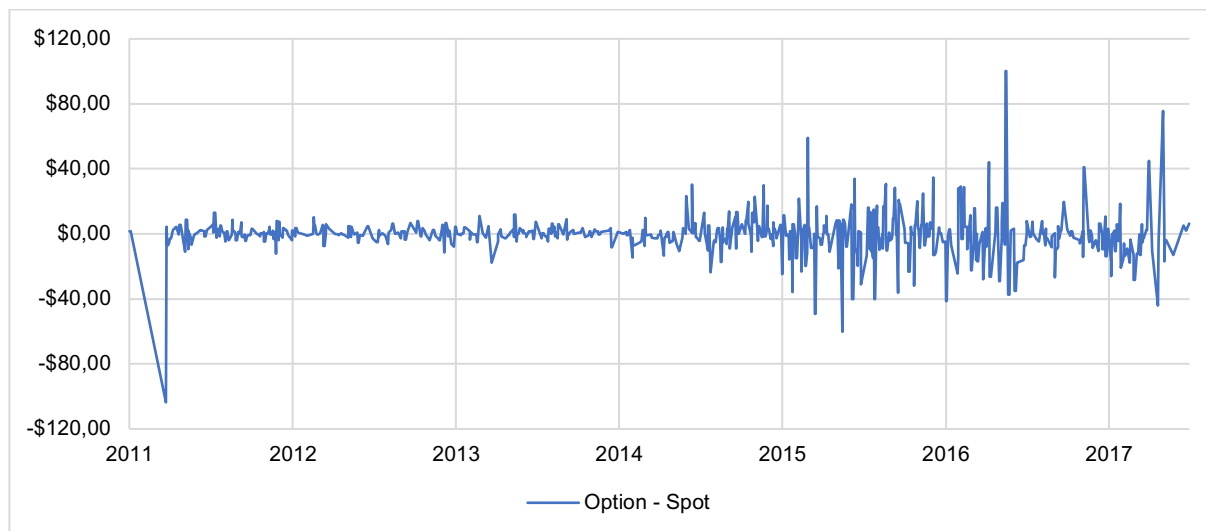### 4.2.1. Analysis of USD/COP Options to 30 days

Graphic 3. Options Prices to 30 days and Spot Prices to 30 days.
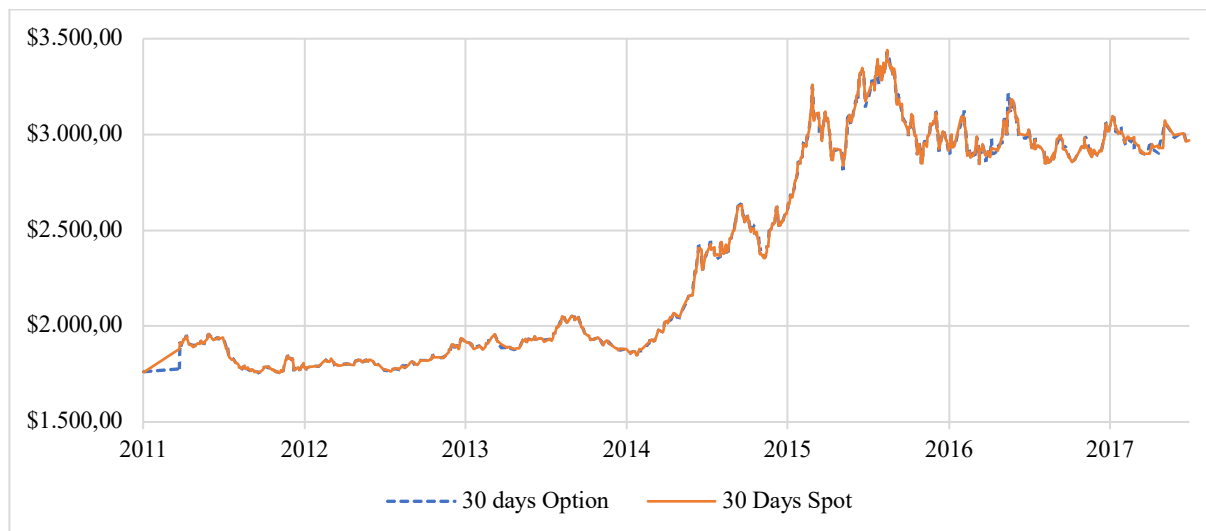
Source: **data obtained from *Set Fx***

In graphic 3, we can see that price behavior of options to 30 days, and the spot price with closing date to 30 days are similar. However, when the differences in graphic 4 prices are calculated, we found a different behavior.

Graphic 4. Differences between Options prices to 30 days and Prices Spot to 30 days.
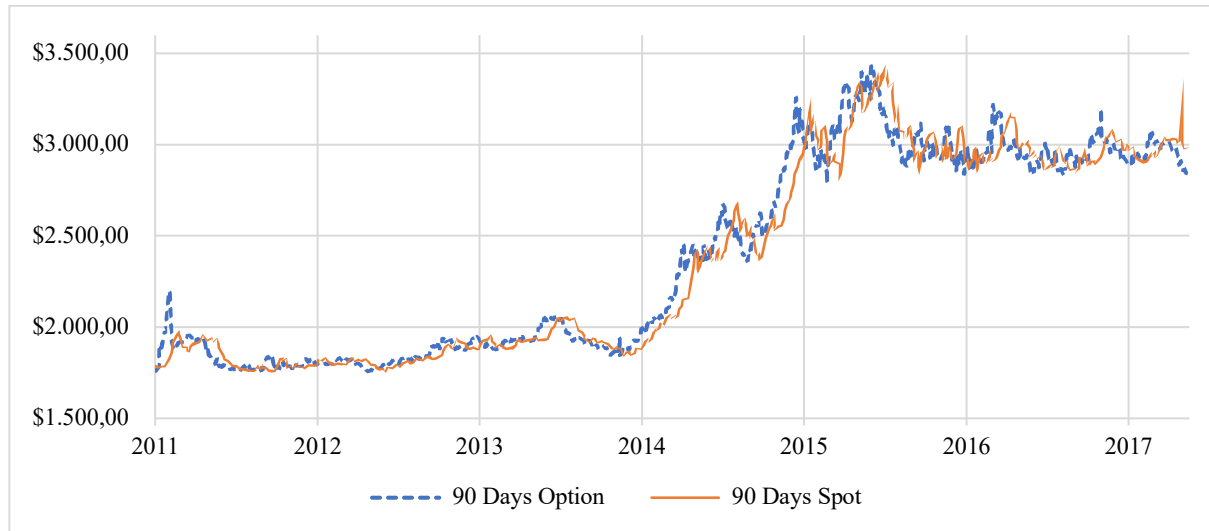

Source: Data obtained from *Set Fx*

In price differences (Option 30 days – closing spot 30 days), we found that in 48% of the times, future contracts in options were effective to face a lower price in the closing spot in the USD/COP rate. Likewise, we found minimal higher differences of -$103,65 and a maximum of $100,18. Indeed, we could observe that from 2014 on, the volatilities in price differences increased.
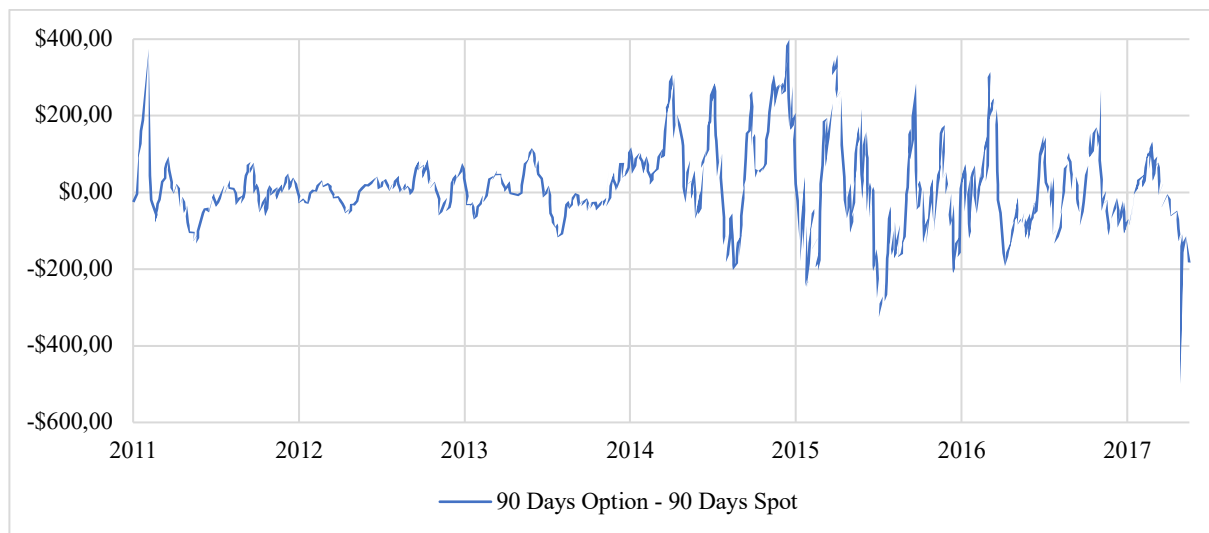
4.2.2. Analysis of Options to 90 days

Graphic 5. Options prices to 90 days and Spot Prices to 90 days.

In graphic 5, we observe that the behaviors of closing spot and options prices to 90 days are clearly different. This shows a higher risk exposure in comparison with the prices to 60 days.

Graffic 6. Differences of Options Prices to 90 days and Spot Prices to 90 days.

In graphic 6, we compare the options prices to 90 days with the prices of closing spot to 90 days. We found more differences than the prices to 90 days and a higher minimum of -$500 as well as a higher maximum of -$382,28 showing a higher risk exposure in the exchange rate. Likewise, in 57% of all cases, the Option price was above the USD/COP closing spot price.

Table 1. Summary of Options prices

Description	Spot	Option 30 days	Option 90 days
Maximum	$ 3.441,00	$ 3.432,00	$ 3.432,00
Minimal	$ 1.746,00	$ 1.755,55	$ 1.756,00
Deviation	$ 533,02	$ 548,81	$ 541,90

Source: data obtained from *Set Fx*

In table 1, by summarizing 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 *spot* price. Hence, it increased the transaction costs in hedging risk operations with this asset.

Lastly, by comparing the closing spot price at the end of *options*, we found a quite low percentage in which the *forward* was lower than the *spot*. This indicates that this hedging asset is optimal for purchase (imports) rather than sales (exports) in dollars.

Table 2. Statisitical data Spot, Option to 30 days and Option 90 days

	Observations	Mean %	Stdev %	Max %	Min %	Skewness	Kurtuosis	Correlation
Spot	*1.706*	*0,027%*	*0,736%*	*4,129%*	*-3,435%*	*0,034*	*3,626*	
30 Days								
30 Days Closing Spot	*964*	*0,026%*	*0,765%*	*4,832%*	*-4,180%*	*0,174*	*8,027*	*0,9997*
30 Days Option	*964*	*0,054%*	*1,097%*	*7,698%*	*-4,509%*	*0,650*	*6,543*	
90 Días								
90 Days Closing Spot	*1.376*	*0,031%*	*0,839%*	*10,688%*	*-10,953%*	*0,325*	*30,141*	*0,9822*
90 Days Option	*1.376*	*0,034%*	*1,080%*	*11,093%*	*-14,450%*	*-0,713*	*35,133*	

Source: data obtained from Set Fx

In table 2, we compare statistical data of standard deviation percentages (Stdev%), the percentage of maximum variation (Max %), the percentage of minimal variation (Min %), skewness, kurtuosis as well as spot prices correlation, closing *spot* prices to 30 and 90 days, and USD/COP *options* derivatives to 30 and 90 days.

From 1.706 observations that were carried out in *spot* prices, we obtained an availability from the *options* to 30 days in 964 occasions, and from the options to 90 days in 1.376 events. This demonstrates the low availability of this hedging instrument in 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 3. VaR and Sharpe Ratios calculation

	VAR	SHARPE RATIOS	$SR_H - SR_U$
SPOT	*1,72%*	*3,67%*	
30 DAYS			
CLOSING SPOT 30 DÍAS	*1,78%*	*3,41%*	*1,54%*

OPTION 30 DAYS	*2,56%*	*4,95%*	
90 DAYS			
CLOSING SPOT 90 DAYS	*2,17%*	*4,04%*	*-0,89%*
OPTION 90 DAYS	*2,52%*	*3,15%*	

Source. data obtained from *Set Fx*

When making the VaR and Sharpe Ratios calculation for USD/COP *Spot* prices in cash to 30 and 90 days, and compared with options derivatives, 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 who 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 of +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 in September 17, 2017.

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

The assets with the highest availability were *options* to 90 days. However, this had the lowest correlation to the closing *spot* 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 exports processes due to the fact that, at least in 56,94% of the reviewed events, closing *options* prices were higher than the closing *spot* 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 a higher liquidity in the *options*. Likewise, it should allow that the brokers of 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.

REFERENCES

Agudelo Rueda, D. A. (2014). *Inversiones en renta variable: Fundamentos y aplicaciones al mercado accionario colombiano*. Medellín: Fondo Editorial Universidad EAFIT.

Banco de la República. (2013). ¿Qué es la tasa de cambio?

Bolsa de Valores de Colombia. (2008). *Guía colombiana del mercado de valores*.

BVC. (2017). *Integración Corporativa DECEVAL - BVC*. Bogotá.

Carbaugh, R. (2016). *Economía internacional* (3rd ed.). México: GENGAGE Learning.

Comisión Nacional del Mercado de Valores. (2015). Los Fondos Cotizados (ETF).

DIAN. (2019). Preguntas frecuentes sobre el control cambiario.

Fradique-Méndez, C. (2014). Guía del mercado de valores.

Garcia, P., & Diez, L. (2014). *Mercados Financieros Internacionales*. Madrid: Delta Publicaciones.

Grath, A. (2016). The Handbook of International Trade and Finance. En *Kogan Page* (4th ed.). London: Kogan Page.

Jesús, R. de, Ortiz, E., & Cabello, A. (2013). Long run peso/dollar exchange rates and extreme value behavior: Value at Risk modeling. *The North American Journal of Economics and Finance*, *24*, 139–152.

Jorion, P. (2007). *Value at Risk* (3rd ed.). NY: McGraw-Hill.

Jorion, Philippe. (1990). The Exchange-Rate Exposure of U . S . Multinationals. *The Journal of Business*, *63*(3), 331–345.

Kozikowski, Z. (2013). Finanzas Internacionales. En *Mc Graw Hill* (3rd ed.). Toluca: McGraw-Hill.

Krugman, P. R., Obstfeld, M., & Melitz, M. J. (2012). *Economía internacional. Teoría y política*.

Laurent L. Jacque. (2014). *International Corporate Finance*. New Jersey: Wiley.

Sharpe, W. F. (1964). Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk. En: *The Journal of Finance*, *19*(3), 425–442.

Superintendencia Financiera de Colombia. (2017). Conformación del Sistema Financiero Colombiano.

Toro Díaz, J., Redondo Ramírez, I., & Díaz Restrepo, C. A. (2015). Riesgo Financiero en las Empresas de la ciudad de Medellín durante el año 2013. *Revista Gestión y Región*, *20*, 139–159.

Uribe, J. (2006). El mercado monetario en Colombia. *Revista del Banco de la Republica*, *LXXIX*(944), 1.

Uribe, J. (2013). El sistema financiero colombiano: estructura y evolución reciente. *Revista del Banco de la Republica*, *LXXXVI(102*.

Wang, Z., Wu, W., Chen, C., & Zhou, Y. (2010). The exchange rate risk of Chinese yuan: Using VaR and ES based on extreme value theory. *Journal of Applied Statistics*, *37*(2), 265–282.

Ye, M., Hutson, E., & Muckley, C. (2014). Exchange rate regimes and foreign exchange exposure: The case of emerging market firms. En: *Emerging Markets Review*, *21*, 156–182.

Zhou, L., Zhang, N., & Chen, Q. (2013). Value-at-Risk Modelling for Risk Management of RMB Exchange Rate. *International Journal of Applied Mathematics and Statistics*, *43*(13), 297–304.