A Study of the EUR/USD Exchange Rate and EUR Call Options

by

Kenneth B. McEwan

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

International business has grown rapidly in recent years as companies seek to take advantage of expanding market and supply chain opportunities. As companies enter into contracts to take advantage of engineering, production, and cost reduction capabilities of the global supply chain, they may be creating a foreign currency exchange rate risk. The purpose of this quantitative study was to endeavor to develop a multiple linear regression EUR/USD forecasting methodology for companies to use when determining when to use currency call options for managing currency risk in accounts payable. The study examined the 60-day EUR/USD exchange rate fluctuation with the conclusion that the variability of the EUR/USD over 60-days does pose financial risk to a company. Multiple linear regression models were created using historical exchange rate data, interest rate data, and Brent crude oil price data. The multiple linear regression models using historical data were not statistically significant in predicting the directional movement of the EUR/USD. This finding aligns with the weak form of the efficient market hypothesis. The study also found that using currency call options to hedge this 60-day exchange rate risk resulted in an overall financial loss as compared to no hedging. The findings suggest that historical data alone cannot be used to predict future EUR/USD directional movements and that purchasing call options to hedge the risk results in a net financial loss. The study did not address the financial benefits of the use of hedging to smooth financial results.

Key words: Exchange rates, payables, EUR/USD, call options, hedging

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Section 1: Foundation of the Study

To capture cost savings opportunities or expand into new markets, many companies have expanded into foreign markets or developed foreign suppliers. These contractual arrangements may have required companies to accept or issue an order in a foreign currency upon which the companies faced a foreign exchange currency risk. In other words, the companies face circumstances where the value of an order from a customer or to a supplier may have changed from the time the order was issued until payment. The company then faced a decision to hedge or not to hedge the foreign currency risk. This paper studies one of the top currency pair used in international trading, the United States Dollar (USD) and the European Union Euro (EUR), to determine when a company should consider using currency options to hedge an exchange rate risk (Galeshchuk & Mukherjee, 2017). Currencies are listed in pairs with the first currency listed standing for one unit of that currency, the second currency is the amount of that currency required to purchase one unit of the first currency. If the EUR/USD exchange rate is listed as 1.3005, then it costs 1.3005 USD to purchase one EUR. The focus of the study was on statistically modeling the EUR/USD movement and the benefit of using call options to hedge 60-day currency risks such as experienced with normal business trading and the creation of a EUR payable. An analysis of the movement of the EUR/USD was completed to determine if the movement can be forecasted such that a company can increase the net benefit of hedging.

Background of the Problem

In 2017, the United States (US) had global trade of approximately $5.2 trillion with $2.3 trillion in exports and $2.9 trillion in imports (US Census Bureau, 2018). The international market is a large and growing part of the U.S. economy and with this growing market comes increased foreign currency fluctuation risks (Abreu, Souza, & Oliveira, 2019; Dinu, 2018; Opie

& Dark, 2015). There are numerous methods to manage currency risk including: options, forwards, futures, foreign direct investment (FDI), factoring accounts, credit card payments, and accepting and/or making deposits. The author analyzed the use of options to hedge currency risks. Currency options have a great deal of flexibility because the buyer of an option has the right, but not the obligation, to exercise the option (VanderLinden, 2014). When using currency hedging instruments, a company is better able to manage risk, and predict its cash flow and earnings. A company that develops a well-constructed currency management plan will likely improve its financial predictability and banking relations (Edens, 2010; Pérez-González & Yun, 2013; Wong, 2017).

The EUR/USD currency pair is the largest traded currency pair (Costantini, Cuaresma, & Hlouskova, 2016; Kim & Seol, 2016). Given the historical volatility of the EUR to the USD, a U.S. based company may be concerned about a 60-day EUR accounts payable. For example, from January 12, 2011 to March 14, 2011 the EUR appreciated by 6.5% against the USD, which would have increased a 1,000,000 EUR payable from $1,313,700 to $1,399,000, a $85,300 increase. A loss of $85,300 in the span of 60 days could negate a profitable transaction. An importer could have hedged this currency risk with a 60-day EUR call option costing approximately $34,300. This study will analyze EUR/USD trading from January 1, 2007 to December 31, 2019. During this period there were 3,244 60-day periods with approximately 33% of the 60-day periods having EUR/USD fluctuations higher than four percent. An importer doing business in EUR, during this time period, encountered an exchange rate risk even over a seemingly brief 60-day time span.

Problem Statement

The general problem is that companies that expanded into a foreign market or contracted with a foreign supplier are likely to face foreign currency exchange risks which can result in significant financial impacts (Bloom & Cenker, 2008; Edens, 2010; Moosa, 2004; Spreckelsen, Mettenheim, & Breitner, 2014; Treanor, Rogers, Carter, & Simkins, 2014; Veestraeten, 2013). Broll and Wong (2015) stated that hedging currency risk exposure is essential for multinational companies. However, many company owners and managers find it more difficult to understand and address financial risks than they do the risks associated with property loss or business liability (Stulz, 2013). The use of foreign exchange options gives companies hedging capabilities that are liquid and easily priced (Spreckelsen et al., 2014). The research on the use of options has tended to focus on the equity market which may not translate to the foreign currency markets which has resulted in a gap in the academic research on the use of currency options to hedge currency risk (Charvin et al., 2014).

The level of currency risk a company faced is based on the amount of money involved, the volatility of the foreign currency in relation to the home currency, and the time frame for the transaction to occur (Stulz, 2013). The proper use of call and put options to hedge currency risks provides the company financial protection from currency fluctuations (Bartram, 2008; Magee, 2013).

The specific problem addressed by this study was: does using a multiple linear regression model of the EUR/USD exchange rate as the basis for purchasing a 60-day EUR/USD exchange rate call option to hedge a EUR accounts payable result in positive net benefits. Companies can attempt to control their cost of hedging by tailoring the hedging based on forecasting models of foreign exchange movements (Albouy & Dupuy, 2017). The focus of this study was on

forecasting the EUR/USD exchange rate movement, the transaction exposure of 60-day accounts payable, and using currency options to hedge this exposure.

Call and put options are traded on the open market, are liquid, and have standard terms and expiration dates (Spreckelsen et al., 2014). For this study, historical data were used when analyzing the premium for call options to determine if the cost of purchasing these options could be less than the benefits of the hedge (Spreckelsen et al., 2014; Stulz, 2013). In other words, actual historical pricing data were used for the call option premiums to determine if the net benefit was favorable. For example, if the EUR/USD exchange rate moves in an unfavorable manner by five percent and the cost of the option hedge is two percent, then the company has a three percent benefit from purchasing the option. The advantages of using currency options to hedge 60-day accounts payable must be considered against the actual premium of the option (Moosa, 2004).

Purpose Statement

The purpose of this quantitative study was to endeavor to develop a multiple linear regression EUR/USD forecasting methodology for companies to use when determining when to use currency call options for managing currency risk in accounts payable. The findings of this research will add to current literature on the variability of, and forecasting of the EUR/USD currency exchange rate. The research addressed gaps in business literature due to the lack of longer-term studies on the movement and predictability of the EUR/USD currency exchange rate (Costantini et al., 2016; Dal Bianco, Camacho, & Perez Quiros, 2012; Dick, MacDonald, & Menkhoff, 2015). The findings of this research will address a broad set of economic conditions by analyzing a 13-year economic period from 2007 to 2019.

The findings of this study will also add to the current literature on the use of options to hedge shorter-term exchange rate risks. Research studies by Charvin et al. (2014), Chen, Hsu, and Lian (2019), Ardoin and Rodriguez (2017), and Spreckelsen et al. (2014) indicated that research gaps exist in the study of options; across an expanded time frame, in relation to currency exchange rates, and in the reliance on theoretical option prices versus actual market prices. This research study encompassed 10 years of actual market-based exchange rate option prices.

Nature of the Study

Discussion of method. There are three primary research methods; the quantitative method, the qualitative method and the mixed method (Creswell, 2014). The research methodology that is used should be aligned to the research problem being study (Creswell, 2014; Stake, 2010).

Quantitative method. This research study is intended to assist an organization in managing the risk of international business where transactions are based on the EUR/USD currency translation. Duță and Duță (2017) stated that "In risk management, the rationale for choosing a quantitative research method is supported by the need for numerical aggregate and detailed estimation calculations to identify, analyze, evaluate, and address risks" (p. 107). Park and Park (2016) stated that quantitative methods are best used when numerical methods and measurable variables are being studied. The numerical data being used in this study can be manipulated and transformed into information which aligns with the quantitative methodology (Bansal, Smith, & Vaara, 2018). Park and Park (2016) said that the characteristics of quantitative research include the independence of the researcher with an impersonal voice using a structured, deductive process including validity testing with the overall purpose of testing a

theory. This study used data from independent organizations such as the Federal Reserve and the CME Group. The author used statistical analysis to test and present the data. The efficient market hypothesis and the stockholder wealth maximization theory were tested.

The author intended to experimentally test the profitability of the use of 60-day call options to address currency fluctuations for 60-day accounts payable. Various hypotheses will be tested by using numerical values for independent and dependent variables (Creswell, 2014). Statistical analyses were used to identify variables that can be used to forecast future exchange rate movements, to assist companies in develop guidelines for purchasing options to hedge the EUR/USD fluctuations (Cenedese, Sarno, & Tsiakas, 2014). In other words, the study used statistical regression analysis to endeavor to develop a forecasting model that could be used as a basis to trigger the use of options to hedge currency risks. Because of the quantitative nature of the problem being addressed, a quantitative method was selected for this research study.

Qualitative method. Qualitative research is usually associated with 'why' questions with data that may include text, words, and visuals (Bansal et al., 2018; Barnham, 2015). The qualitative data may be counted, sorted, and digitized, but often requires interpretations in completing these tasks. Qualitative research is often targeted towards the determination of the meaning of a phenomenon (Williams & Moser, 2019). The characteristics of qualitative research can be described as subjective where the researcher interacts with the research and data, where values and biases are often involved with an inductive process. The accuracy and reliability of the research is validated through verification and most likely not through testing. The primary purpose of qualitative research is often to develop a theory (Park & Park, 2016). In this study, objective data from independent sources were used. The author's values and biases did not

influence the data and the research was validated through testing. The research problem addressed by this study did not align with the qualitative method of research.

Mixed method. A mixed method research study uses both quantitative and qualitative methodologies (Creswell, 2014). A mixed method research would include numeric data and qualitative data allowing a more complete understanding of the problem being studied. Often times a mixed method research study allows a narrative or a description of the experiences of the participants in the study. In this study participants were not included. The qualitative method places emphasis on observations and interpretations where data is gathered within the contextual situation (Park & Park, 2016). The mixed method of research did not align with the research questions examined in this research study.

Summary of the nature of the study. The author determined that the quantitative method of research aligns with the purpose statement and research questions of this research study. Multiple linear regression analysis to develop a forecasting model for the EUR/USD exchange rate was used. This regression-based forecasting model was then used as a basis for purchasing a call option as a hedge against currency risk. Historical option prices for the EUR/USD 60-day call options from 2007 to 2016 were used, along with the corresponding historical EUR/USD currency data. This 10-year timeframe contained both recessionary and expansionary economic conditions, which increases the reliability of the study.

Figure 1 shows the premium for call options that could have been purchased to hedge a 60-day accounts payable liability. The premium escalated during the 2007-2009 recession which was also a period of high levels of economic instability. This increasing premium during a period of economic instability is consistent with theoretical option pricing formula, including the often used Black-Scholes option pricing model (Charvin et al., 2014; Manzur et al., 2010).

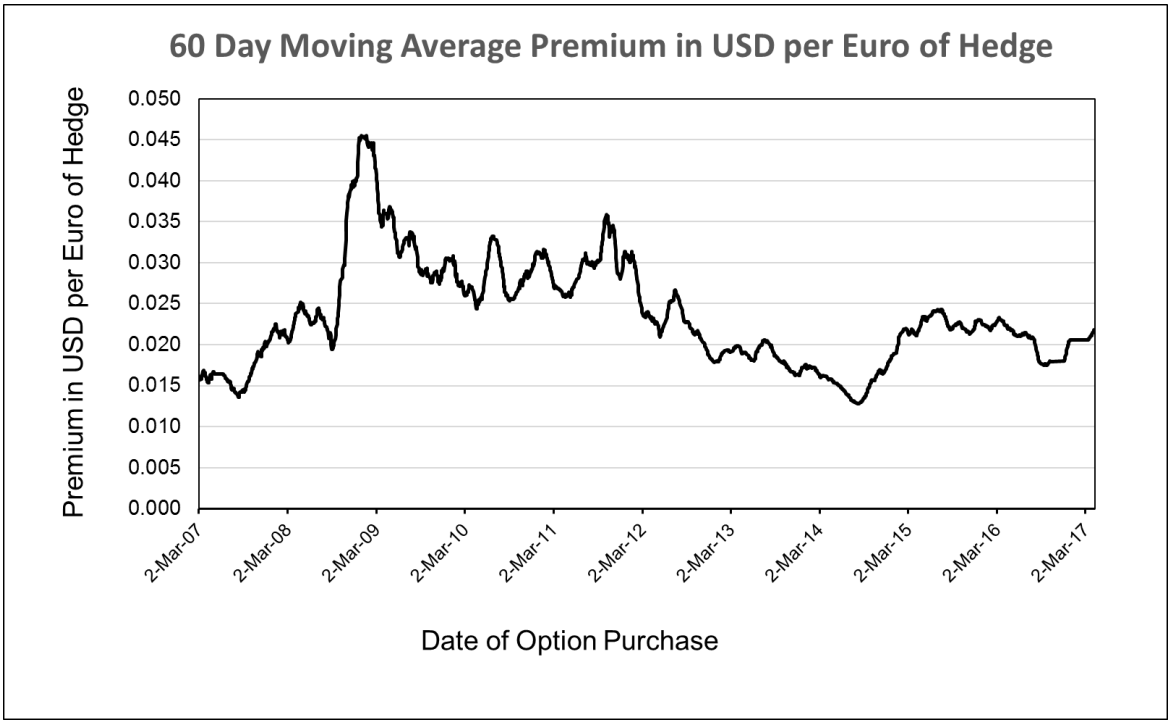

Figure 1. Line plot of the 60-day moving average premium of a EUR call option from March 2007 to March 2017.

Research Questions

The use of 60-day call options that could be used by an international organization to hedge EUR/USD currency fluctuations was examined in this study. Using historical data from 2007 through 2019 on the EUR/USD currency exchange and the corresponding option prices, I examined the net benefit of protecting 60-day accounts payable with call options. Two research questions were examined.

1. Does the 60-day fluctuation of the EUR/USD exchange justify the consideration of taking actions to address this currency risk?
2. Does using a multiple linear regression analysis of the EUR/USD currency fluctuations to trigger the purchase of EUR call options provide a favorable financial benefit (Cheng et al., 2015; Kearney, Cummins, & Murphy, 2018)?

Table 1 illustrates the use of a call option to hedge a 10,000 EUR accounts payable. When the accounts payable was initially created, the EUR was worth 1.0675 USD, which means the organizations owed 10,675 USD. The organization purchased a call option with a strike price of 1.070, for $.0241 per EUR, or $241. The organization now owned an option to exchange 10,700 USD for 10,000 EUR in approximately 60 days. Between when the accounts payable was created and the accounts payable was due, the EUR appreciated by 4.9% which means that an unhedged position would have resulted in the company paying 11,196 USD instead of the original 10,675 USD. The company exercised the option and paid 10,700 USD for 10,000 EUR and then the company used the EUR to close the accounts payable. The net benefit of purchasing the call option was $255.

Table 1

Transactions List and Process Flow for Hedging a EUR Accounts Payable Using a 60-Day Call Option

Transactions	Date	Spot	EUR payable	Option strike	Option cost	USD	Notes
60-day account payable created	3/30/2017	1.0675	€10,000			$10,675	Original values
Purchase Call Option	3/30/2017		€10,000	1.070	0.0241	$241	Call option price
Spot Price	6/9/2017	1.1196	€10,000			$11,196	Payable without option
Exercise Call Option	6/9/2017		€10,000	1.070		$10,700	Exercise call option
Savings on currency fluctuations						$ 496	6/9/17 spot vs call option

Transactions	Date	Spot	EUR payable	Option strike	Option cost	USD	Notes
Cost of option						$ 241	cost of the option
Net Value of the Exercised Call Option						$ 255	Net Benefit of hedging

Hypotheses

All currency exchange rates exhibit variability and significant variances can arise even in the short term (Frishberg & Gobble, 2013). The financial benefit of a foreign currency hedging position depends on the movement of the currencies over the associated time frame. The effectiveness in hedging is based on the value change in the hedging instrument versus the value change in what is being hedged (Bloom & Cenker, 2008).

The variability of the EUR/USD currency exchange rate to determine the likely risk a US based company took when it entered into a 60-day accounts payable in EUR was analyzed. A statistical analysis of the EUR/USD exchange rate using the variability over 60-days was completed using the spot rate when the transaction was initiated versus the spot rate approximately 60 days later. In other words, the movement of the exchange rate over a 60-day period to determine the impact on a payable was analyzed. The study began with null hypothesis $H1_0$ that there is no statistically significant relationship between the independent variables of the EUR/USD exchange rate 60 days earlier (d-60) and the EUR/USD movement during the preceding 60 days (d-60 to d-120) and the dependent variable, the current EUR/USD (d) spot rate. The corresponding alternative hypothesis H1a is that there is a statistically significant relationship between the independent variables of the EUR/USD exchange rate 60 days earlier

(d-60) and the EUR/USD movement during the preceding 60 days (d-60 to d-120) and the dependent variable, the current EUR/USD (d) spot rate.

Central bank interest rate policies and forecasts have been shown to impact exchange rates (Matsuki & Chang, 2016). The initial regression analysis included analysis of the US Federal Reserve (FED) and the European Central Bank (ECD) interest rate policies and forecasts versus the EUR/USD currency movement. The impact on the EUR/USD exchange rate of Brent crude oil prices will also be studied (Cevik, Harris, & Yilmaz, 2017). Based on previous academic studies, a multiple linear regression model is likely to be needed for development of a EUR/USD forecasting model (Kim & Jung, 2018a; Lin & Lee, 2017; Yaganti & Manpuria, 2018). The null hypothesis $H2_0$ is that there is not a statistically significant relationship between the independent variables of interest rates and Brent Crude oil prices, and the dependent variable, the EUR/USD exchange rate. The corresponding alternative hypothesis H2a is that there is a statistically significant relationship between the independent variables of interest rates and Brent Crude oil prices, and the dependent variable, the EUR/USD exchange rate (Plakandaras, Papadimitriou, & Gogas, 2015).

Included in the analysis of the hypotheses was an analysis of the hedging impact of using currency options based on the findings of the hypotheses. For example, if a firm is unable to estimate the EUR/USD currency movement then the firm may want to consider purchasing a currency option to hedge every 60-day payable transaction or if a firm can estimate the EUR/USD currency then the firm should purchase a currency option only when the estimating model indicates an unfavorable currency movement (Ebrahimijam, Adaoglu, & Gokmenoglu, 2018). For example, given that the 60-day multiple linear regression-based forecast is an increase in the value of the EUR, then the company should hedge a payable using a call option.

In other words, the company would only purchase the hedge when the regression analysis forecasts adverse currency movements.

Table 2

Summary of the Null and Alternate Hypotheses

Null Hypotheses	Alternate Hypotheses
$H1_0$ There is no statistically significant relationship between the independent variables of the EUR/USD exchange rate 60 days earlier (d-60) and the EUR/USD movement during the preceding 60 days (d-60 to d-120) and the dependent variable, the current EUR/USD (d) spot rate.	$H1_a$ There is a statistically significant relationship between the independent variables of the EUR/USD exchange rate 60 days earlier (d-60) and the EUR/USD movement during the preceding 60 days (d-60 to d-120) and the dependent variable, the current EUR/USD (d) spot rate.
$H2_0$ There is not a statistically significant relationship between the independent variables of interest rates and Brent Crude oil prices, and the dependent variable, the EUR/USD exchange rate.	$H2_a$ There is a statistically significant relationship between the independent variables of interest rates and Brent Crude oil prices, and the dependent variable, the EUR/USD exchange rate.

Theoretical Framework

Shareholder wealth maximization theory. One of the financial theories explaining why firms exist and what management should strive for, is called the shareholder wealth maximization theory (Queen, 2015; Stulz, 2013). This financial theory states that companies and their employees should strive to maximize the value of the company for shareholders. As part of their wealth maximization duties, company managers must protect the assets of the company from both physical and economic loss. This protection activity is often called risk management with corporate risk management often being a key part of corporate governance (Anju & Uma, 2017; Viscelli, Hermanson, & Beasley, 2017). Active risk management policies and hedging have been shown to increase stockholder wealth (Moosa, 2004; Pérez-González & Yun, 2013; Treanor et al., 2014). As part of risk management activities, companies routinely purchase insurance to protect the company from physical loss of property, product liability claims, and disruption related to the death of key executives. An organization can endeavor to protect itself

from adverse economic and financial movements by purchasing financial derivatives such as futures, forwards, and options (Albouy & Dupuy, 2017; Kang et al., 2016). A firm operating internationally is likely to have contractual arrangements that involve the payment or receipt of foreign currencies. The value of foreign currencies is likely to change during the time from goods receipt or order initiation to actual payment (Campello, Lin, Ma, & Zou, 2011). To protect the firm from unfavorable currency movements, strongly governed firms tend to hedge foreign currency risk (Kang et al., 2016). By using currency derivatives, an organization decreases cash flow volatility which decreases financial stress and may allow firms to pursue additional market opportunities (Hutson & Laing, 2014; Kang et al., 2016). Because hedging against currency fluctuations smooths cash flow and income, the firm is better able to plan its activities (Geyer-Klingeberg, Hang, Rathgeber, Stöckl, & Walter, 2018). By applying the hedging techniques which were studied in this paper, a company may improve cash flow, profitability, and protect itself from foreign currency exchange rate fluctuations, thus increasing shareholder wealth.

Efficient market hypothesis. The efficient market hypothesis basically states that all publicly available information is reflected in the price of financial securities (Kumar & Joshi, 2014; Leković, 2018). In other words, according to the efficient market hypothesis, unless an investor has inside information, a gain higher than the overall market gain is not possible. The efficient market hypothesis has been analyzed and debated in numerous peer reviewed journal articles since being initially proposed by Fama in 1965 (Bush & Stephens, 2016; Leković, 2018). Three forms of the efficient market hypothesis have been proposed: the weak form, the semi-strong form and the strong form (Wickremasinghe, 2016). The weak form of the efficient market hypothesis, when applied to the currency market, says that currency rates reflect

historical information from past currency rate movements. In other words, the weak form of the efficient market hypothesis says that forecasting currency movements based on historical currency movements only will not lead to financial gain. The semi-strong version of the efficient market hypothesis says that the current currency rates include all historical currency rate information and other currency impacting public information such as interest rate policies, gross domestic product forecasts, and government debt obligations.

The strong version of the efficient market hypothesis says that all historical currency movement, all currency impacting public information and all private or inside information is included in the currency prices. Studies have produced mixed results on the testing of the weak and semi-strong efficient market hypotheses in regards to the foreign currency markets (Wickremasinghe, 2016). The null hypothesis $H2_0$ supports the strong version of the efficient market hypothesis by proposing that the addition of currency impacting variables does not result in a regression equation which will improve forecasting accuracy beyond a random walk model.

This paper was based on two theories of business: the shareholder wealth maximization theory and the efficient market hypothesis. The shareholder wealth maximization theory states that the purpose of the firm and its management is to maximize the value of the firm for shareholders. The analysis included in this paper includes an analysis of the financial benefits of hedging a foreign currency risk in 60-day accounts payable. Figure 2 shows the theoretical framework.

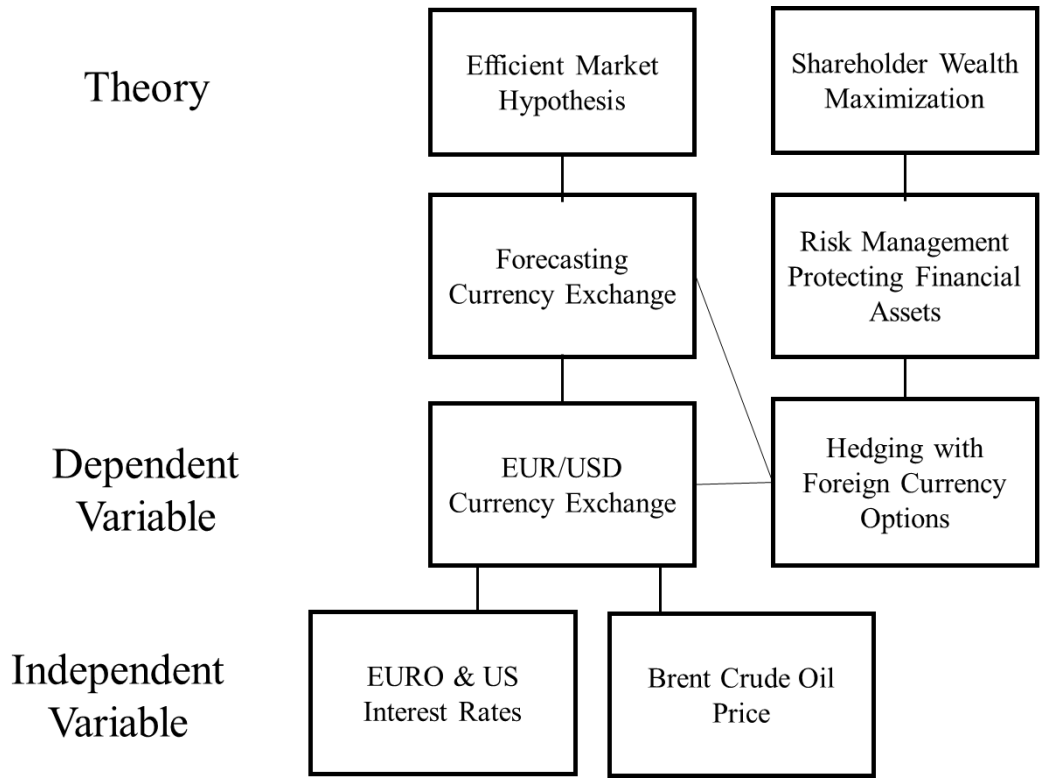

Figure 2. Theoretical Framework.

Definition of Terms

The majority of the terms used in this study are commonly used business terms. The specific terms referenced in this study on currency exchange rates and options are described below.

EUR call option: A EUR call option is defined as the option, but not the obligation, to obtain EUR for a set EUR/USD exchange rate (the strike price) by a selected date (the expiration date).

EUR/USD currency exchange: The EUR/USD currency exchange is the price in USD for one EUR.

Expiration date: The expiration date is the date when the option must be either exercised or the option expires.

Option strike price: An option strike price is the price set in the option for the asset, commodity, or currency. For this study on EUR/USD exchange rates, the strike price is the price within the option for purchasing EUR using USD.

Assumptions, Limitations, Delimitations

Assumptions. For this study the author assumed a 60-day accounts payable term as the basis for this study. This assumption is consistent with various industry reports and studies (Kroes & Manikas, 2014). The author assumed that an organization has the ability to hedge EUR/USD exchange rates using call options. In other words, the author assumed that a firm has the financial acumen and resources to engage in option trading.

Limitations. The study is based on the fluctuations of the EUR/USD exchange rates from 2007 through 2019.

Delimitations. This study is based on the EUR/USD exchange rates as this currency pair is one of the most commonly traded currency pairs (Costantini et al., 2016; Dal Bianco et al., 2012; Kim & Seol, 2016). In other words, this study was bounded by the fluctuations and characteristics of the EUR/USD and the associated call options. The author bounded the study by using EUR/USD options with the strike that is closest to the spot price when the option was purchased (Manzur et al., 2010). For example, on December 30, 2016, there were 28 different call options available for trading with various strike prices, the author chose the call option with the strike price closes to the current spot price. The call option chosen for December 30, 2016 to be included in the analysis had a strike price of 1.0500 while the spot price on December 30, 2016 was 1.0516, a difference of .0016. The author limited the study in this manner to keep the study a reasonable size and to establish a workable methodology for firms to follow to hedge accounts payable. The author choose to limit the quantitative analysis to the time frame of 2007

through 2019. This time frame included both recessionary and expansion economic conditions but did not include the complete history of the EUR/USD currency trading or option trading.

Significance of the Study

Reduction of gaps. The largest and most liquid financial market is the foreign currency exchange market with over five trillion USD traded on a daily basis (Baranga, 2016). International trading is supported by the liquidity in the foreign currency exchange market (Menkhoff, Sarno, Schmeling, & Schrimpf, 2016). Currencies are constantly being purchased and sold in the marketplace and the prices of these currencies are constantly fluctuating (Cevik et al., 2017). Companies doing business in foreign currencies must consider potential mechanisms to reduce risk presented by fluctuating foreign currency exchange rates. Multinational companies have found that using a forward, future, and options contract to hedge foreign currency is effective way to manage foreign currency risk (Broll & Wong, 2015). However, there are gaps in the academic research due to the use of theoretical option prices instead of actual option prices. Additionally, research did not address an extended time period of data analysis. This study intended to reduce these research gaps by using actual option prices and 13 years of EUR/USD currency fluctuations and 10 years of option data.

Implications for Biblical integration. In His holy scriptures, the Bible, God gave mankind two guidelines for how to conduct business: ethical service to others and stewardship of God's creation. First, Peter 4:9-11 says that "Each of you should use whatever gift you have received to serve others, as faithful stewards of God's grace in its various forms" (NIV). In Genesis 1 26:28, when describing the creation of man, God says "Let us make man in our image, after our likeness. And let them have dominion over the fish of the sea and over the birds of the heavens and over the livestock and over all the earth and over every creeping thing that creeps on

the earth" (ESV). Through this Biblical passage, God gave mankind the responsibility of stewardship over the creatures of the earth and over the earth itself. A steward is defined as a person who acts as the surrogate of another or others with the responsibility of managing and protecting such things as property, financial assets, investments and other items of value (Pirie & McCuddy, 2007). When conducting business on an international basis and transacting in foreign currency the organization is taking a risk on foreign currency fluctuations. By using options to hedge currency risks, the organization protects its financial assets. The current stewardship model for business proposes that: the purpose of business is to serve; that the practice of business should follow positive ethics; and that business should act in partnership with other social institutions (Karns, 2016). This stewardship model for business is different than the shareholder wealth maximization model but the two models could be aligned when the stewardship model generates a more profitable and sustainable business in the long run. The Biblically centered stewardship of resources will be appreciated by stakeholders as the firm focuses on protecting its resources (Iheanyi-Igwe & Veach, 2019; Saunders, 2016). The use of options to hedge currency risks protects the financial assets of the organization and increases shareholder wealth by smoothing cash flow and income which allow the organization to better plan its activities.

Relationship to international business cognate. Organizations that conduct business on an international basis are likely to face some level of foreign currency exchange rate risk (Ozturk, Joiner, & Cavusgil, 2015). Companies doing business in a foreign currency require the ability to, competitively and efficiently, convert foreign currency into local currency. When customer or supplier contracts are based on foreign currencies, then the firms are likely facing foreign currency risks. For example, US based companies may outsource a product or service to a foreign firm with payment to the supplier being made in the supplier's regional currency. For

example, if the EUR increases in value relative to the USD during the contract period then the US based company will have to pay an increased price for the product or service. When companies have future payments, costs, or asset purchases planned in a foreign currency then the companies are facing currency risk. This currency risk can have an impact on profitability and cash flow for the multinational firm. Unexpected swings in currency valuation can increase a company's exposure to financial risk and dramatically cut profits and cash flow (Frishberg & Gobble, 2013).

Summary of the significance of the study. By examining EUR/USD fluctuations over the last decade and by analyzing the use of currency options to mitigate the risks of the EUR/USD variations, this study can generate a methodology that a company could apply to address EUR/USD currency risks. When reducing the risks associated with foreign currency exchange rate fluctuations, a firm's management can better manage cash flow and profitability delivering smoother and improved financial performance to the shareholders. A company doing business on an international basis would find it highly valuable to know if foreign exchange options deliver benefits to hedge currency risks (Charvin, Fullwood, & James, 2014). Company managers face challenges understanding and addressing currency risks and would benefit from this study which endeavors to generate a practical tool for forecasting the EUR/USD movements and the benefit of hedging this movement with currency options (Lin & Lee, 2017).

A Review of the Professional and Academic Literature

For this literature review a wide variety of peer reviewed journals were used with emphasis placed on the more recent publications. The literature search included the use of Google Scholar and the EBSCO Business Source Complete literature search electronic platforms. The relevant literature relates to (a) the increased use of global outsourcing, (b) the

foreign currency exchange market and forecasting foreign currency movements, (c) risk managing foreign currency risks, (d) statistical and time series analysis, and (e) option pricing. Businesses pursue outsourcing to improve competitiveness through lower cost, improved capabilities, and increased flexibility. Outsourcing to a foreign supplier may result in acceptance of foreign currency exchange rate risk. The majority of studies on foreign currency exchange rate fluctuations has centered on two theories of exchange rate movement; the interest rate parity theory and the purchasing power parity theory. Models based on either theory have had limited success in predicting foreign currency movements. Additional studies on exchange rate movements have identified additional variables such as oil prices, and Google Trend data. As part of the overall risk management strategy, the use of financial hedging instruments, such as currency options, to manage risk have been shown to smooth earnings and cash flow and generate other benefits. Option prices are typically based on interest rates, underlying asset price volatility, and the time frame of the option.

Outsourcing and Offshoring. Espana (2013) in his journal article "The Real Costs of Offshoring" found that technological progress over the last few decades has enabled the expansion of global markets and outsourcing. Some examples include: the introduction of containerization in the 1950s, which significantly reduced the costs of transportation and the introduction of the first transatlantic phone cable in the 1950s, which improved communications; and now the internet is allowing near instant communication across the globe. Companies can now transact business with remarkable quickness and far flung business locations can be coordinated and managed on a profitable basis. With this increase in international business comes an increase in the risks associated with fluctuating currency exchange rates.

The development of international markets is becoming imperative in today's economy according to a journal article by Ozturk et al. (2015). The question that companies face is determining how company managers should identify and evaluate opportunities in foreign markets. The company managers want to select a foreign market opportunity based on objective criteria using a structured analysis that considers the unique drivers of demand for the company's products. As the economy becomes more globally interconnected company managers are endeavoring to take advantage of opportunities in untapped markets. The authors believe there is a critical need for more research into international market selection which uses primary and secondary data for quantitative research. The authors used secondary historical data from 1999 to 2010 and forecast data from 2011 to 2020 on industry specific consumer expenditures to develop their template for evaluating foreign market opportunities. The template is made up of three steps: country responsiveness, growth potential, and aggregate market measure. To measure country responsiveness, the study focused on income elasticity by consumer expenditure by industry. Growth potential is calculating using likely growth and consumer expenditure by industry. For an aggregate market measure the template uses industry related measures such as the rate of urbanization, gross domestic product growth, and the country's risk score. The authors analyze the meat, automotive, and health care markets to test their template. AJC International is used in the analysis of the meat market, Proton is used in the analysis of the automotive market, and General Electric's health business is used to model the health care market. The foreign market opportunity analysis tool presented in this journal article will help companies identify potential market for entry. The authors conclude that the international market is important for company expansion which confirms the need to analyze foreign currency exchange fluctuations and determine hedging strategies for this currency risk.

Roy and Sivakumar (2012) found that the rapid growth and improvement of information management is allowing the outsourcing of a wide variety of knowledge based work scope including accounting, customer service, engineering, and data processing. The global outsourcing of information based activities such as research and development is causing some public angst and is requiring organizations to spend considerable time and resource protecting proprietary information. Outsourcing knowledge based work requires the organization to also consider how innovation will be pursued and incorporated into the outsourcing relationship (Roy & Sivakumar, 2012). When considering the outsourcing of knowledge based activities, the company must also consider the costs of managing different currencies and the potential impact of currency rate fluctuations.

Innovation offshoring has increased over the last decade and is now a widespread management practice according to a journal article by Rosenbusch, Gusenbauer, Hatak, Fink, and Meyer (2019). Rosenbusch et al. found that innovation offshoring allows firm to access more diverse sources of knowledge, improve flexibility in innovation methods and processes and reduce the risk of becoming complacent in technology innovation. Global firms are increasing their use of offshore outsourcing to improve performance (Choi, Ju, Kotabe, Trigeorgis, & Zhang, 2018). Both academics and consulting firms confirm the benefits of outsourcing. The benefits analysis typically emphasizes cost reduction as the primary driver of outsourcing. Using firm specific and market data, the authors find that offshore outsourcing offers increased flexibility over domestic outsourcing. Yu (2012) stated that global outsourcing is increasingly being used to: reduce costs; expand into new markets; and take advantage of unique skills, resources, or capabilities. Yu (2012) stated that companies are outsourcing many types of activities including (a) part manufacturing, (b) information technology, (c) accounting, (d)

product design, (e) facility management, (f) logistics, and (g) benefit management. Companies are taking advantage of economies of scale by outsourcing activities to companies that specialize in those activities. For example, companies have outsourced call centers to India where they can obtain English speaking representatives for a relatively low cost from an Indian company that specializes in call centers. Companies are globally outsourcing to expand into new markets and this is especially true in countries that require production of product in that foreign country. For example, a helicopter engine manufacturer may be required to agree to produce parts or assemble product in Turkey before the engine will be chosen for a Turkish military application. The emerging market opportunities in countries like China and India are very attractive to companies in developed countries. Pursuing global outsourcing or developing global markets will likely involve some level of exchange rate risk.

In a research study, Feenstra (2018) found that the gains from global trading go well beyond the comparative advantage. The gains from global trading include increased variety, increased productivity, and lower overall markups. The overall gain to an economy engaged in global trade is increased purchasing power. The increase in variety and competition increases Gross Domestic Product (GDP) for the US by approximately 1.1 percent. In a research study, Jain and Swarpup (2011), found that global outsourcing presents an opportunity for firms to obtain materials at lower costs. US, European, and Japanese companies in particular are taking advantage of low cost sources. The US is taking advantage of the opportunities for cost reduction in Mexico and Southeast Asia. When using Mexican sources, the US is taking advantage of a low cost source with relatively low cost transportation. By using global outsourcing a company may limit payment for capacity and resources to only when needed, which improves management flexibility and reduces costs (Doval, 2016). A firm using global

outsourcing can focus on core competencies while seeking low cost global sources with the appropriate quality and delivery capabilities. Global outsourcing allows the firm to minimize fixed costs and maintain a high degree of asset utilization. However, these outsourcing activities may require paying the supplier in a foreign currency and thus currency risks may need to be managed.

Marion and Friar (2012) said that firms are under increasing pressure to complete Research and Development (R&D) projects in less and less time while also reducing costs. By using global outsourcing firms are working to develop a 24 hour per day, research and development capability. A firm can start the design on a part in the US, move the work to India, then Europe, and finally back to the US. This 24 per day cycle time can significantly decrease the overall R&D cycle time. Using advanced computer aided design software, a firm can collaborate across the globe on product design while taking advantage of lower cost engineer and designer costs in other countries. By collaborating on global basis with other companies and cultures, R&D managers can take advantage and learn from different approaches and educational backgrounds. These outside forces can help overcome internal inertia and lead to better designs with shorter lead times and less investment.

Neito and Rodriguez (2011) found that empirical evidence shows a positive relationship between global outsourcing and innovation, with a larger effect on product than on process innovations. Not surprisingly, captive offshoring has a larger impact on innovation than non-captive offshoring because intellectual property protection would favor captive offshoring. These findings, based on an empirical study from 2004 to 2007, lead to a conclusion that global outsourcing can lead to improved innovation performance. To achieve the maximum benefit from global research and development (R&D) outsourcing a firm should select providers and

partners which complement its strategy, apply advanced information technology and prototyping solutions, and use these global resources to reduce fixed costs while increasing capacity and flexibility. The outsourcing of R&D activities will likely require the company to consider the currency fluctuation risks as these types of contracts will likely be based on 60-day accounts payable terms and could be payable in a foreign currency.

Companies are increasingly establishing strategic relations with outside suppliers to deliver improvements in costs, process efficiencies, innovation, and customer services (Ahmed, 2018). This increase in outside supplier contracts has involved manufacturing activities and such traditional in-house activities such as engineering, research and development, administration, and management functions. As a result, the accounting and finance functions have had to adopt new accounting and communication techniques to adequately reflect the financial and risk positions of the companies. The accounting and finance functions must assist the supply chain organization with information on budgeting, auditing, key process indicators, target costing, governance, and risk management. The risk management activities should include exchange rate risk management.

Lewin and Volberda (2011) described how the offshoring of business services began with companies such as Citibank and American Express opening captive call centers in India. General Electric further expanded the concept of globally outsourcing business services with the opening of an engineering service center in Bangalore, India which was eventually spun-off as Genpact. In response to these strategic initiatives, supplier companies are developing a broader range of service capabilities while client companies have become more demanding in terms of cost, quality, and work scope. Interestingly, even with increased global competition, client companies have shown reluctance to change suppliers and contracts are often renewed even

when improvements in cost, quality, and capability are available from other suppliers. With the global development of outsourcing suppliers has come increased size and negotiation power, which likely means that companies outsourcing to these suppliers are having to pay in foreign currencies which means that foreign currency risk is increasing.

The World Trade Organization (WTO) and The General Agreement on Tariffs and Trade (GATT) have helped to create a more favorable and stable environment for global outsourcing. Using advanced enterprise resource planning systems, companies can manage the flow of materials across the globe. As a result of the WTO, GATT, other trade agreements, and improved information technology over 90% of large US firms source on a global basis (Jain & Swarup, 2011). The use of global outsourcing is one of the mainstays of business phenomenon over the last two decades with almost all industries impacted by global outsourcing. Management consultants have reported that the average cost reduction was 17% per globalization initiative (Liu & Nagurney, 2013).

Foreign Currency Exchange Market, Theories, and Forecasting Exchange Rates

As the volume of international business has expanded, the importance of the currency exchange market has increased. The operation of the foreign currency exchange market which changes one currency into another currency has become critical to the global economy. Consequently, the study of the foreign currency market and the prediction of the movements in currency exchange rates are areas of academic study.

The FOREX market is large and liquid with currencies being traded on a constant basis which means that currency fluctuations are common place (Baranga, 2016). Generally, the daily changes in value are minor unless there is a substantial political or economic event. However, over the medium to long term, the movement can be substantial and may pose significant risk or

opportunities. When a currency increases in value relative to another currency it is said to be appreciating. For example, the USD appreciated against the EUR from May 2014 when one USD equaled .73 EUR, to May 2015 when one USD equaled .90 EUR. The USD appreciated by nearly 23% over the period from May 2014 to May 2015.

The valuation of currencies involves a complex set of factors, including economic conditions, interest rates, consumer sentiment, the political environment, taxes, and global trading conditions (Engel, 2016). As with other financial markets, human beings with feelings and emotions are involved in the market place, which can lead to some irrational behaviors. The FOREX market place includes speculators who are trying to profit on currency movements, consumers and business who desire to purchase and sell in the global market place, organizations which are using financial instruments to protect themselves from currency fluctuations, and financial intermediaries who operate as middle men to profit on the transactions (Kumar & Joshi, 2014).

There are at least two theories on how currencies are valued: the purchasing power parity mode, and the interest rate parity model (Bulut, 2018). The purchasing power parity model is based on the theory that goods that are traded on a global basis should cost the same in every market (Bekő & Boršič, 2018). For example, a McDonald's Big Mac which costs $4.00 in the US and costs 2.96 GBP in Great Briton means that one USD = .74 GBP. The purchasing power parity model has been shown to only partially explain currency movement (Gyamfi & Appiah, 2019).

Tkalec, Vizek, and Vuksic (2019) explored the impact of value added tax, labor productivity, and interest rates on real exchange rates in the EUR area. Cuts in employment results in depreciation of real exchange rates because of lower demand for products (Tkalec et

al., 2019). An increase in value added tax results in appreciation of real exchange rates. Both of these impacts are in the short term. Tax policy changes are primarily focused on fiscal goals and objectives, however, Tkalek et al. (2019) concluded that policy makers may want to consider the impact of tax policy changes on exchange rates.

The interest rate parity model is based on the theory that deposits earning interest in one country should earn the same level of return in another country (Engel, 2016). For example, if interest rates are higher in Japan than in the US, investors would move their deposits to Japan to earn the higher interest. This movement of currency would increase the demand and price of JPY and decrease the demand and price of USD. The interest rate parity model says that $1,000 invested in the US at 5% would equal $1,050 after one year, while $1,000 invested in Japan at 6% should also be worth $1,050 after one year after currency exchange rate changes. The interest rate parity model does not fully explain exchange rate movements (Ardoin & Rodriguez, 2017).

Kumar and Joshi (2014) said that exchange rates are one of the most important prices in an economy. Exchange rate movements impact capital flows, the balance of trade, the rates of interest and inflation, and even share prices, unemployment rates, the relative sizes of national economies. There are multiple factors that impact exchange rates including relative price levels, trade policies, productivity, inflation, current account balances, political stability, and order flows (Kumar & Joshi, 2014). In the analysis the authors describe the three forms of market efficiencies which are commonly called the weak form, the semi-strong form and the strong form. The Indian Rupee (INR) versus the USD exchange rate fluctuation is studied to determine the form of market efficiency for this exchange pair. The USD/INR exchange rate follows a weak form of the efficient market hypothesis and the authors conclude that efforts to develop a

forecasting method for short term forecasting is not likely to be beneficial for the USD/INR currency pair. Kumar and Joshi (2014) found that in the long run the movement of oil prices, foreign direct investment, and order flows does impact the USD/INR exchange rate. The authors found that a multiple linear regression model did have explaining power in forecasting quarterly movements in the USD/INR exchange rate. In regards to this paper, Kumar and Joshi's (2014) research supports the use of multiple linear regression to forecast exchange rate movements.

Grossmann, Paul, and Simpson (2017) found support for the purchasing power parity model of exchange rates in their study of the EUR area. The introduction of the common currency in the EUR member states eliminated exchange rate risk and transaction costs while improving price and information transparency. For the southern states, Greece, Portugal, Italy, and Spain, benefits also included lower interest rate. However, lack of fiscal discipline in the southern states when combined with the 2008 global financial crisis resulted in a EUR sovereign debt crisis. In April 2010, the sovereign debt of Greece was reduced to junk status. The vote by the United Kingdom to withdraw from the European Union added to financial concerns about the EUR's stability and long term viability, which resulted in depreciation of the EUR versus the USD and other currencies. Grossman et al. (2017) studied the impact of the EUR and its variations on the EUR member countries by developing equilibrium exchange rates for each member country using purchasing power parity. Grossman et al. found that the northern states due to their relative purchasing power, were well suited to join a single currency while the southern states were not as well prepared. The southern states with their historic volatility and lack of fiscal stability were less suited to a common currency. Additionally, the southern states likely lost some international trade competitiveness due to adoption of a stronger currency. The authors also found that the Greece sovereign debt crisis had an oversized impact on the

EUR/USD exchange rate as Greece is only two percent of the total EUR economy. Sentiment can have an impact on exchange rates which may be measurable using Google Trends (Bulut, 2018).

Using data from January 1995 to September 2013, Wickremasinghe (2016) researched the efficient market hypothesis as it applies to the movement of the Sri Lanka currency (LKR) for four currency pairs. The currency pairs were the LKR/INR, the LKR/USD, the LRK/JPY and the LKR/GBP. Wickremasinghe (2016) used root and co-integration tests to test the efficient market hypothesis for the Sri Lanka currency market. Wickremasinghe's (2016) findings support both the weak form and the semi-strong form of the efficient market hypothesizes in the operation of the Sri Lanka currency market. The author says that the findings are sensitive to the sampling period and the econometric methodology that is being used.

In their article titled "Macroeconomic news, order flows, and exchange rates," Love and Payne (2008) endeavored to determine if order flow impacts exchange rates. Love and Payne (2008) hypothesized that order flow has some impact on exchange rates. Order flow is the difference between buyer and seller trading initiatives. In other words, the research study is analyzing the impact of the difference between buyer and seller volume. Love and Payne (2008) used data from the inter-desk foreign exchange market and three exchange rate pairs; the EUR/USD, the USD and the Great British Pound (GBP) and the EUR/GBP. The exchange rate data covers the time period from September 1999 to July 2000. In economic theory, the impact of publicly released macroeconomic news is incorporated into exchange rates instantly. Love and Payne (2008) found that macroeconomic information impacts order flow and order flow also impacts exchange rates. In other words, publicly released macroeconomic news only partially

explains exchange rate movements. Market participants react to the macroeconomic news with the reaction being measured by order flow and this order flow information is shown to impact exchange rates. Love and Payne (2008) concluded that on average order flow explains approximately one third of the exchange rate movement.

Cevik et al. (2017) stated that literature supports the concept that exchange rate volatility is based on a variety of country and global factors such as interest rates, inflation, economic growth, and fiscal and current account balances. However, these factors do not fully explain exchange rate volatility and as such macro-economic data does not fully explain the changes in exchange rates. The exchange rates move more than what would be expected and may actually generate additional instability. Cevik et al. (2017) examined additional variables such as political, social, and demographic variables which have not been included in previous exchange rate studies. Cevik et al. found that countries with higher levels of social stability have less exchange rate variability.

Using Fourier quantile unit root modeling, Bahmani-Oskooee, Chang, Elmi, and Ranjvar (2018) found evidence supporting the interest rate parity model for forecasting exchange rates. Interest rate parity provides a measurement for the level of financial and economic integration between countries according to the authors. The interest rate parity model says that real interest rates should be equal across nations. In other words, in an environment with interest rate parity, an investor cannot earn higher levels of interest by depositing money in foreign banks. For example, if a bank in France is paying five percent interest and a bank in the US is paying four percent, then the EUR/USD exchange rate, through the movement of the forward rate, should adjust so that the real interest rate is equal between the two deposits. The interest rate parity hypothesis assumes that capital flows between countries are mobile and thus interest rate

arbitrage activities will bring exchange rates into alignment. Bahmani-Oskooee et al. (2018) studied exchange rates and interest rates amongst 21 developed countries and found support for the interest rate parity hypothesis and the efficient market theory. This article supports the use of interest rates to forecast EUR/USD exchange rate movement.

The uncovered interest rate parity hypothesis states that the returns from investments in two countries should be equalized when the returns are converted into the same currency (Ismailov & Ross, 2018). In other words, nominal interest could be used to predict exchange rate movements. However, the research shows that the uncovered interest rate parity does not always hold which is puzzling. Ismailov and Ross (2018) hypothesized that economic uncertainty impacts uncovered interest rate parity and then develop a statistical model to analyze the level of economic uncertainty and the uncovered interest rate parity puzzle. Ismailov and Ross (2018) collected data from 1993 to 2015 on exchange rates using five currency pairs; the CHF/USD, the CAD/USD, the GBP/USD, the EUR/USD, and the JPY/USD. The data for the EUR/USD started when the EUR was issued in 2002. The uncertainty index was based on forecast errors from surveys conducted by Consensus Economics. The authors found that deviations from uncovered interest rate parity are increased in periods of high economic uncertainty and that uncovered interest rate parity holds during periods of low economic uncertainty. Ismailov and Ross (2018) found support for the use of interest rates to forecast exchange rates during periods of low economic uncertainty.

According to a journal article by Matsuki and Chang (2016), business managers and researchers have studied the phenomenon that exchange rate changes and aggregate macroeconomic conditions seem to have a remarkably weak relationship. Matsuki and Chang (2016) studied the movement of the JPY/USD in the post Bretton Woods era to analyze the

impact of several influential economic criteria. Matsuki and Chang (2016) found that nonlinear models may perform better than linear models and that when important economic data is incorporated into the modeling that forecasting exchange rates with a level of accuracy is possible. The authors support the concept that exchange rate forecasting models can before better than a random walk forecasting model.

Kim and Jung (2018a) found that oil price movements and US interest rate changes have an impact on exchange rates. Kim and Jung's (2018a) findings suggest that there are unidirectional spillovers from West Texas Intermediate oil volatility which impacts the exchange rates of oil exporting countries and the interest rate in the US. In today's economy, low oil prices have a favorable impact on oil importing countries but these same low oil prices are negatively impacting oil exporting countries such as Venezuela and Russia. The innovations in oil exploration and extraction over the last decade have caused volatility in the foreign exchange market.

Two convention models for forecasting exchange rate movements are the purchasing power parity model and the interest rate parity model with both of these models having limited success in consistently forecasting the movement of exchange rates according to a study by Bulut (2018). In a journal article, Bulut analyzed the use of Google Trends to forecast exchange rate movements with results that rival the conventional exchange rate forecasting models. The use of internet search data gives a timelier forecast than the use of governmental reporting data. The official government reporting data may be 45 to 60 days later than the data coming from Google Trends. By using search query data on selected words or topics the author developed an exchange rate forecasting model that performed better that models using purchasing price parity

fundamentals. For eight of eleven currency pairs, the author improved on the direction of change predictions.

The aim of a study by Wang, Morley, and Stamatogiannis (2019), was to determine if the use of smooth transition regression in a Taylor rule model would improve the forecasting of foreign exchange rates. Wang et al. (2019) used three exchange rate pairs: the AUD/USD, the GBP/USD, and the Swedish Krona (SEK)/USD. The model is primary based on interest rates, with house prices and stock prices used as indicators of the wealth effect. Wang et al. found that using a nonlinear approach to forecast exchange rates can produce better outcomes that linear forecasts. The inclusion of wealth effects within the forecasting model improves the forecasting accuracy. Wang et al. also mentioned that additional variables should be considered to increase the forecasting accuracy. This paper supports the interest rate parity theory for forecasting exchange rate movements.

In the study titled "Deep networks for predicting direction of change in foreign exchange rates," Galeshchuk and Mukerjee (2017) use of deep networks in forecasting foreign exchange rate movements. Galeshchuk and Mukerjee (2017) stated that accurate forecasting of exchange rates is important for an effective hedging strategy. Galeshchuk and Mukerjee (2017) said that the use of moving average and exponential models are common when trying to predict exchange rates. Galeshchuk and Mukerjee (2017) studied the exchange rate movements of the EUR/USD, the USD/GBP and the USD and the Japanese Yen (JPY) from 2010 to 2015. Moving average predictions provided a reasonable point estimate when predicting exchange rates (Galeshchuk & Mukerjee, 2017). Galeshchuk and Mukerjee (2017) also found that using 30 days of input as the basis for the moving average model was statistically better than using fewer days but that using more days did not improve forecasting. The authors found that using deep networks further

improved forecasting accuracy. This article confirms that using time series analysis for predicting foreign exchange rates is commonly used by companies.

The use of Google Trends for forecasting exchange rates is the topic of an academic study by Reed and Ankoun (2019). Reed and Ankoun (2019) examined how online searches relate to changes in foreign currency exchange rates. The growing of amount research studies on Google Trends indicate that Google queries may be used to predict economic activity. Reed and Ankoun (2019) proposed that search trends can be used to predict exchange rates. There are more than seven billion searches per day performed on Google. Google Trends measures the volume of queries individuals enter into the Google search engine. Studies have indicated that the use of search data is an improvement on survey based methods of data gathering. Reed and Ankoun (2019) utilized Google Trends to analyze the level of interest in three currency pairs, the EUR/USD, the GBP/USD, and the CAD/USD. The authors concluded that using Google Trends data improves the forecasting of exchange rate movements.

The largest financial market in the world is the foreign exchange market with a reported five trillion USD settled on a daily basis (Pilbeam & Langeland, 2015). The exchange market is primarily composed of three related components; forward transactions, derivative contracts and spot transactions. Due to the increasing volume of international trade and the number and value of the associated contracts, multinational firms, trades and financial institutions would benefit from having improved forecasts of exchange rate volatility. Pilbeam and Langeland (2015) used a series of generalized autoregressive conditionally heteroscedastic (GARCH) models to estimate volatility of four different currency pairs: the USD/JPY, the USD/CHF, the USD/GBP, and the EUR/USD. Pilbeam and Langeland's (2015) study found that the GARCH models were not useful in forecasting foreign currency volatility during periods of high or low volatility. The

authors found that the foreign currency options market which has within it an implied volatility component as part of the option pricing mechanism is effective in estimating volatility. In other words, volatility forecasting using GARCH modeling was less effective in forecasting volatility than what was already being priced in the marketplace (Pilbeam & Langeland, 2015). This study suggests that the foreign currency markets are efficient and that unusual profits are not attainable by using GARCH modeling to forecast volatility. The authors conclude that currency options provide a means for firms to hedge currency exchange volatility.

The difficulty of forecasting of exchange rates is well known (Costantini et al., 2016). The challenges associated with the development of macro level exchange rate forecasting models is especially difficult in the short term. Constantini et al. studied the USD and the EUR because both are viewed as reserve currencies and the EUR/USD is the most traded currency pair on a worldwide basis. Constantini et al. varied the forecasting horizon from one month to 12 months and used historical EUR/USD exchange rate data in their testing of forecasting techniques. Constantini et al. used a large number of forecast combinations to develop a new method for forecasting the direction of the EUR/USD exchange rate. Further research on the EUR/USD should be undertaken to help businesses determine the appropriateness of their hedging strategy (Constantini et al., 2016).

The accurate forecasting of exchange rates is an extremely elusive endeavor according to research conducted by Dal Bianco et al. (2012). Academic studies have found it very difficult to explain currency fluctuations. Researchers have found it very difficult to develop structural exchange rate forecasting models, for one month or longer, that beat a random walk forecast. In other words, researchers have difficulty developing a forecasting model that beats a forecast that simply uses the current spot rate. However, there are studies that claim success in forecasting

exchange rate movements especially when the direction of the movement is the critical element and not necessarily the extent of the movement. Dal Bianco et al. (2012) developed an econometric exchange rate forecasting model that explained 90% of in sample variation and also performed well in predicting out of sample variation. This model specifically focused on one to four-week time intervals and performed very well when predicting the direction of the exchange rate. From a financial point of view, especially considering the use of exchange rate options for hedging, the correct prediction of the direction of exchange rates is very beneficial. Dal Bianco et al. found success in their modeling by combining data at different frequencies while advancing the two basic tenets of exchange rate theory, purchasing power and interest rate parity. Dal Bianco et al.'s model uses industrial production growth, short term and long term interest rates, inflation rates and trade balance, at varying frequencies to forecast the EUR/USD exchange rate movement. Dal Bianco et al. proposed that additional data such as order flow when added to their model based on economic fundamentals may improve the forecasting results. This article provides insight into the use of interest rates, inflation, trade balance, and order flow in the forecasting of the EUR/USD exchange rate.

Risk Management and Hedging

As the benefits of global outsourcing and international market development have increased so have the associated risks. Companies operating in the international marketplace often face foreign currency exchange rate risks thus companies need to develop management techniques to deal with exchange rate movements. These risks have been researched and numerous risk reduction techniques have been developed and documented.

When an organization's strategic planning process has a lack of foresight the result can be "catastrophic failure: total failure of an organization that occurs are all levels and cannot be

remedied without major structural corporate transformations" (McMillan & Overall, 2017, p. 273). The predictions about the future holds a level of risk in that the strategic planner cannot be 100% certain about the future. The risk management strategy should consider various risk mitigation alternatives such as hedging instruments and insurance. Most managers have a good grasp on the known. Items such as market share, product line profitability, and customer satisfaction are usually documented and measured within a firm's management system. However, the unknown, such as what could be the competition's reaction to the strategy or what is happening with customer preferences or what is likely to happen in the financial markets also critically important considerations for strategy development. The currency exchange market is a financial market that an international company must consider when developing its risk management plan. This paper will help a company understand and address the risks associated with the foreign currency exchange market.

Ellis (2017) stated that some of the institutional and structural weaknesses of the EUR remain in place even after the crisis with the Greek debt restructuring. The bond ratings across the EUR countries range from AAA for Germany to BBB for Greece which represents a risk to the EUR currency, especially if the European Union enters a recessionary period. The EUR countries are also showing a great divide in addressing government debt loads with some countries reducing debt during periods of economic growth while other EUR countries have expanded government debt during periods of economic growth. The EUR crisis, while it seems to be dormant now, is not over and will likely rear up during the next recession. The implications are that the EUR may not exist indefinitely in its current form. There are risks that members may leave the EUR, which could cause significant EUR/USD exchange rate

fluctuations. Investors and corporate risk managers must carefully monitor risks in the EUR area over the next years and be prepared to address these risks.

In a journal article "Is there a need for hedging exposure to foreign exchange risk?" Moosa (2004) stated that hedging foreign exchange risk is a controversial issue. The buying and selling of foreign currency forwards, futures, and/or options are used to cover short exposures such as payables, or long exposure such as receivables. Firms use currency hedging because: they are risk averse so the take a hedge position regardless of where they think the exchange rates are heading; or they are speculating on exchange rate movements and intend to profit for these movements. Some firms do not use hedges because they believe over the long run hedging does not really help their profitability. A time series analysis to assess the movements of the currencies of Japan, Germany, and Britain against the US dollar shows that when firms have a regularly occurring foreign currency exposure over an extended period, no hedging is necessary. However, if the firm faces a large irregular foreign currency exposure then it should construct a currency hedge. Currency futures, options or forwards should be used to hedge currency risks and not money market instruments.

Magee (2013) in a journal article titled "The effect of foreign currency hedging on the probability of financial distress" studied the connection between using currency derivatives to hedge currency risk and the likelihood of financial distress. Magee reviewed 401 large nonfinancial companies which have foreign currency risks and the use of currency derivatives to manage foreign currency risks. By using a company's distance to default as a proxy for financial distress the author analyzes the impact of using currency derivatives to avoid financial distress. Magee (2013) found that companies that use foreign currency hedging are further from default and have a lower amount of financial distress. The study provides evidence that hedging with

currency derivatives lowers financial distress. Magee (2013) also found that the use of hedging lowered the cost of borrowing and increased a company's capacity to borrow. This paper supports the use of hedging instruments such as options to manage foreign currency exchange rate risk.

Risk managers consider currency exchange rate fluctuations as a significant risk factor which may reduce firm value through the impact on cash flows (Parlapiano, Alexeev, & Dungey (2017). Parlapiano et al. proposed that the impact of currency exchange rate fluctuations varies with firm size, industry sector, and the level of international activity. Even though the creation of the EUR as a currency, reduced foreign currency risk for member countries, the risks were not completely eliminated. The efforts to develop models to forecast exchange rates using macroeconomic data have shown inconsistent results. Parlapiano et al. (2017) stated that across time frames and modeling types, researchers have been unable to develop models that consistently predict future exchange rates. In the short run, hedging activities have been successfully used to mitigate foreign currency fluctuations. This article supports the use of hedging for short term financial transactions such as accounts payable which is the focus of this study. An international company's supply chain may be impacted by currency rate fluctuations according to Mishler (2017). The impact of the currency rate changes could negatively affect the importer, the supplier, or the distribution channel or even the end user. A multinational company can be assisted by a comprehensive exchange rate management strategy especially small and medium sized businesses. An effective currency risk management strategy is executed by both the financial and purchasing organizations. The strategy identifies the risk exposure and determines when and how to mitigate the risks. The use of foreign currency options is a common hedging vehicle.

Managing currency risks is an important part of managing a global corporation (Broll & Wong, 2015). The fluctuations in global currencies are a major concern for multinational companies as profitability can be significantly impacted by currency variations. Trading of hedging instruments between the home currency and the foreign currency helps a multination corporation manage its risk. When an organization trades in multiple foreign currencies, the variety of hedging options expands greatly. Using various models, the authors show that the optimal forward option, is to be over hedged in one currency and under hedged in another currency. Less developed countries and emerging markets may not even have their currencies traded in the futures or forwards markets. For these countries an organization may be able to use a hedging instrument for a traded currency which has movements that are similar to the emerging market currency.

Perez-Gonzalez and Yun (2013) stated that the value of risk management and specifically hedging is a highly debated issue in corporate finance. Theoretical studies have shown that in a frictionless setting, hedging is not relevant for firm value, however, risk management and hedging in particular have experienced rapid growth. The objective of their analysis was to estimate the impact of risk management policies on firm value and the authors use weather derivatives in the form of call and put options in their article. Perez-Gonzalez and Yun (2013) studied the 203 United States based electric and gas utilities to determine the importance of weather derivative to firm values. These firms face weather risk because cooling and heating demands are driven by changes in weather conditions. Nearly, 70% of the users of weather derivatives are in the energy business. Perez-Gonzalez and Yun (2013) found that firms which do not use weather derivatives and are highly exposed to weather volatility exhibit valuations that are lower than firms that use weather derivatives to manage risk. Perez-Gonzalez and Yun

(2013) found that companies with historical high levels of weather exposure are up to three times more likely to use weather derivatives for hedging purposes. Firms which use weather derivatives use more aggressive financing and have higher levels of market valuations (Perez-Gonzalez & Yun, 2013). The authors found evidence that the use of derivatives to manage risk leads to higher firm value and increased investments.

The use of use of hedging instruments such as forwards and futures enhances the reputation of an organization which may result in more favorable terms for other types of financial transactions (Campello et al., 2011). Campello et al. used a web-based search mechanism to gather data about the use of forwards and futures from public companies and analyzed the data to determine the financial benefits of using hedging instruments. The analysis showed that cost of borrowing and investment restrictions are lower for firms that use hedging instruments. One measure of the use of hedging, called hedging intensity is to divide the amount of currency hedging by the total assets in the firm. By increasing the amount of hedging intensity by one standard deviation, the firm may reduce the interest rate on loans by 54 basis points and reduce the odds of having restrictive covenants by 20%. Hedging works as a mechanism that limits the risk of negative cash flows which helps firms get access to external funding. Firms with high risk foreign contracts benefit from lower financing costs when these high-risk contracts are appropriately hedged.

Edens (2010) reviewed the potential impacts of foreign currency volatility on the income statement and balance sheets of corporations. The firm's first challenge is identifying the foreign currency risks that they are facing. The firms must recognize the risks from both supply and customer contracts and need to ensure that purchasing and sales are aware of the risks in accepting contracts based on foreign currencies. Companies who have successfully addressed

the foreign currency risks have more predictable financial results and once the hedging instruments are in-place these companies are able to focus their efforts on more value added activities. By using hedging instruments, companies can narrow the distribution of probable cash flow which lowers the likelihood of financial distress.

In a study of US Department of Defense (DoD) procurement, Gardner, Ritschel, White, and Wallen (2018) found that using statistical analyses to forecast exchange rates as the basis for purchasing options would benefit the DoD. Garnder et al. (2018) found that using several different forecasting models all resulted in benefits to the procurement organization in the short term. This article supports the use of exchange rate forecasting models to purchase exchange rate options. In this paper, Gardner et al. (2018) analyzed the benefit of using simple average calculations in forecasting foreign currency exchange rates for Department of Defense budgeting. Garner et al. found that four methods could be used to forecast the currency exchange rate movements and beat a random walk methodology. The paper recommends using the statistical averaging models to purchase foreign currency futures or foreign currency options to hedge the foreign currency risks. Savings could total over $34 million when using statistical modelling to forecast the exchange rate movements (Gardner et al., 2018).

In a journal article, titled “Is hedging foreign currency bids with options desirable? An applied analysis for small firms” VanderLinden (2014) stated that construction related industries often face currency risks from the time they submit bids until the time of contract award. The time between the date of the bid and the date of award can be several months to a year and during this time the bidding company has exposure to currency fluctuations. VanderLinden (2014) said that for large fixed price contracts, the exposure could be substantial and this exposure is especially concerning during times of exchange rate volatility. The use of put

options to project the business during the waiting period from bid to award could reduce the risk of currency fluctuations. For the study VanderLinden (2014) used two approaches to study the use of put options to hedge the currency risk. First, the author created a stylized distribution of the exchange rate and an option pricing model that assumed an exchange rate of 1.32 USD to 1.0 EUR. VanderLinden (2014) also assumed that the exchange rate had a median volatility of 11% over the study period. Using this information, the author calculated the expected price of a put option with the strike price being set at approximately 95% of the spot price. By using 95% of the spot price, the price of the option was reduced without a substantial increase in risk. The first analysis shows that the use of put options does generate a positive net benefit. In the second analysis VanderLinden (2014) used actual exchange rates and options prices to calculate the net benefit of using put options to hedge currency risk. Both approaches to the analysis, show that by using put options on EUR/USD exchange rates, an organization could have improved its profits margins over the five-year period from 2008 to 2012. This study was limited to a time frame when markets experienced a significant amount of volatility, however, the VanderLinden research does lend itself well to this study in that both studies are analyzing the use of put options. The study uses 30 day put options at a strike less than spot. This study used 60 day call options with the strike price equal to the spot price.

An article titled “Derivatives and hedging: Accounting vs. taxation” by Bloom and Cenker (2008), focused on the accounting and tax treatment of options, forwards, and futures. Bloom and Cenker (2008) used foreign currency exchange contracts in their discussions. Using generally accepted accounting principles (GAAP) accounting, these types or contracts are marked to market, however the tax treatment is not marked to market. This difference creates a reconciliation analysis between the books of record and the books for tax. For GAAP, an entity

that has an investment in futures contracts must treat this investment as if it were sold at its fair market value as of the last day of business. This rule applies, even if the hedge is for a contract that is scheduled to transact several years in the future. The marked to market accounting rules can impact the reported income for businesses and therefore the use of hedging should also be considered from an accounting point of view to include the resources required to manage, value, and report hedging instruments.

Stulz (2013) said that the accounting treatment of hedging instruments may cause volatility in the company's earnings as the instruments are marked to market. Management needs to recognize that adhering to GAAP and using hedging instruments could result in excess profits and losses as exchange rates fluctuate and this earnings volatility will have to be explained to shareholders. The management team has to recognize that the benefits of using hedging may have a cost in terms of complicating the balance sheet and the income statement. The mere mentioning of currency risks and the use of derivatives to may increase stockholder awareness of these risks which could result in decreased stock price (Jankensgård, Hoffmann, & Rahmat, 2014). Investors have been known to strongly focus on the profitability of core operations and the disclosure of foreign exchange risk which clutters the income statement and balance sheet may make investors assume management is taking on more risk instead of reducing risk. Investors may suffer from information overload and discount shares when companies have to explain the mark to market impact of exchange rate derivatives.

The USD and other well-known currencies are called "safe haven" currencies because these currencies are supported by countries with low inflation and low real interest rate (Dobrynskaya, 2015). The USD is considered to be the world's reserve currency. In times of global economic distress there is a flight to quality which strengthens the safe have currencies

and harms the lesser currencies. This flight to quality could hurt the exports of the safe haven countries as their exports increase in price. The countries with lower quality currencies could find that their exports are become cheaper as their currencies depreciate.

When companies have future payments, costs, or asset purchases planned in a foreign currency then the companies are facing currency risk. This currency risk can have a substantial impact profitability and cash flow for the multinational firm (Frishberg & Gobble, 2013). Companies can be exposed to adverse changes in interest rates, commodity prices, and foreign currency exchange rates therefore hedging strategies should be part of the top level strategic plan (McMillan & Overall, 2017). Smaller companies can benefit from the cost savings and increased flexibilities with outsourcing however, these companies often overlook the risks associated with exchange rate fluctuations (Gylling, Heikkilä, Jussila, & Saarinen, 2015). Companies should consider the impact of exchange rate movements on their financial performance and analyze possible hedging techniques.

By studying the management of exchange rate exposure at a large nonfinancial firm, Bartram (2008) has concluded that corporate hedging can help mitigate foreign currency risk exposure. The author studied the cash flows of a large, Germany based, nonfinancial company from 1995 to 1999. The company increased foreign sales from 18% of sales in 1995 to 39% of sales in 1999. The company's policy is to employ operational hedges to reduce the exposure of foreign currency risks. The company takes action to reduce its exposure to its primary trading currencies including the USD. The company used several different strategies including the purchasing of options to manage its currency exposures. Consistent with the analysis of this paper, the author found that currency movements can be significant even in the short term. The author concluded that managers can be successful in reducing currency risks by using hedging

strategies. An appropriate hedging strategy can limit currency risk exposure to such an extent that the exposures are an insignificant part of the company's cash flow.

Schwartz and Gannatti (2014) stated that investors who purchase foreign stocks assume a currency risk exposure as well as the normal exposure to stock price fluctuations. This currency exposure improves returns when foreign currency is increasing in value, but the return suffers when the foreign currency is declining. Investors should consider hedging the currency exposure if they do not have a belief that the foreign currency will remain at the current spot price or appreciate against the home country currency. Investors can invest in mutual funds and exchanged traded funds that have both foreign stock holdings and currency hedges in-place. Investors who have trading accounts with sufficient trading capabilities can also invest in currency hedging instruments such as options and futures.

Firms operating on a global basis face a substantial amount of uncertainty in the marketplace however, firms can reduce the risk associated with this uncertainty by using hedging instruments such as forwards, futures, and options according to a study conducted by Ni, Chu, and Li (2018). Using a game theory model to investigate the use of financial hedging to increase a firm's competitiveness the author's analysis suggests that a firm's value is increased when financial hedging is used to offset risk. Ni et al. (2018) found that effective financial hedging increases a firm's profits, and may lead to improved production and increased market share. Ni et al. mentioned the use of currency options to hedge foreign currency risks.

The trading volume of exchange and over the counter financial derivatives is growing fast which indicates that financial risk management is widespread amongst corporations, according to a study by Besslera, Conlon, and Huanc (2019). Besslera et al. found that the use of hedging instruments for managing foreign exchange risk is especially beneficial to firm value.

Besslera et al. used a meta-analysis approach to draw on research across a large set of articles to synthesize the value enhancing properties of hedging with derivatives. While finding limited benefit from hedging interest rate risk and very little benefit from hedging commodity risks the authors found consistent benefits for hedging foreign currency risks. Besslera et al.'s (2019) research supports this author's research on benefits for using foreign currency options to hedge EUR/USD exchange rate fluctuations.

Fabling and Grimes (2015) studied the hedging decisions of New Zealand firms which were exporting to Australian companies in Australian dollars (AUD). The time period being study was from July 2000 to March 2011. Australia is New Zealand's largest trading partner which is covered by a free trade zone agreement. Fabling and Grimes (2015) hypothesized that a company's hedging decisions are based on these criteria: industry, company size, prior hedging experience, ownership type, financial condition, and the level of foreign exchange market risk. Fabling and Grimes (2015) found that firms with higher levels of hedging experience and/or firms with higher levels of financial uncertainty are more likely to hedge a new position. Additionally, Fabling and Grimes (2015) found that companies tend to increase hedging when volatility in the market place is higher. In other words, companies tend to hedge when there appears to be momentum in the market place. The exchange rate between New Zealand and Australia over the sample period indicates that neither momentum nor mean reverting behavior exists which means that companies are sub optimizing their hedging activities when they base their hedging decisions on momentum. Fabling and Grimes (2015) indicated that analysis of additional currencies and the associated time series analysis would provide clarity of the predictive abilities currency forecasters.

The use of currency options to hedge contingent market opportunities was challenged by Steil in an article titled “Currency options and the optimal hedging of contingent foreign exchange exposure” (Steil, 1993). Steil said that his research studies indicate that currency options have little useful impact on managing foreign currency transactions. Steil (1993) used theoretical data to calculate the option prices and further uses probabilities to estimate the return on the options. In other words, Steil used theoretical option prices not market based prices and uses exchange rate movement probabilities not real market movements. Further the author does not base the hedging decision on a forecast of exchange rate movements. This paper used real market prices and real exchange rate movements while basing the hedging decision on forecasted market movements.

Statistical Analysis and Modeling

In their research paper titled “Old dog, new tricks: a modelling view of simple moving averages,” Svetunkov and Petropoulos (2018) analyzed the use of simple moving average as a forecasting method. Svetunkov and Petropoulos (2018) highlighted the fact that simple moving average is an easy to understand and use forecasting methodology. While having the benefits of being simple and easy, the simple moving average has two primary issues. The first issue involves the difficulty of determining the correct or best prediction interval while the second issue is the lack of a concise statistical model that underlies the simple moving average model. Svetunkov and Petropoulos (2018) stated that academics have tended to ignore the widespread use of simple moving average as a research topic because of the lack statistical verifications and because of the simplicity of simple moving average. However, researchers studying simple models as a forecasting tool have found that simple models perform well when compared to more complex and harder to use forecasting models. In order to address the two drawbacks to

the use of simple moving averages the authors have develop a methodology to select the best time interval based on statistical measures of variance. Svetunkov and Petropoulos (2018) used the sales data from a multinational pharmaceutical company to test the use of simple moving average against other statistical methods to forecast inventory levels. The simple moving average performed well against the other models and generated more accurate point forecasts. This article provides a solid reference and methodology for using and analyzing the use simple moving average to forecast the movement of the EUR/USD exchange rate.

Plakandaras et al. (2015) proposed and tested a daily and monthly forecasting model for five exchange rates. Plakandaras et al.'s model tested the EUR/USD, the USD/JPY, the AUD versus the Norwegian krone (NOK), the New Zealand dollar (NZD) versus the Brazilian real (BRL) and the South African rand (ZAR) versus the Philippine peso (PHP). By using this variety of exchange rates the authors can model high volume currencies such as the EUR/USD and the USD/JPY and lower volume currencies such as the ZAR/PHP. Plakandaras et al. (2015) found that an autoregressive model for forecasting exchange rates worked well with monthly data. For forecasting on a daily basis the authors found a structural model using various variables performed best. For long range forecasting none of the author's models performed better than a random walk model. In other words, Plakandaras et al. (2015) were able to develop forecasting models that were fairly effective in forecasting daily or monthly exchange rate movements, however, none of their models was effective over the longer term.

In the article "Application of time series analysis in big data: practical, research and educational implications," Rezaee, Dorestani, and Alabadi (2018) stated that companies can use time series models and big data analysis to develop predictive models for management use. Rezaee et al. (2018) stated that time series modeling can be used for testing hypotheses and the

interpretation of data but, that the primary use of time series analysis is to develop forecasts. The authors use the behavior of Avis Budget Group's net income to illustrate the use of time series analysis to indicate potential issues with financial reporting. By using time series analysis, the authors were able to detect financial mismanagement significantly ahead of the actual announcement of an investigation by the Security and Exchange Commission. By using appropriate time series modeling for forecasting and predictions a company can detect deviations and red flags for further analysis and actions. This study uses time series analysis to forecast the EUR/USD exchange rate, which is aligned with the finding of Rezaee et al. (2018) that time series can be used for forecasting key financial metrics.

In an article titled "Hypothesis testing: A statistical procedure for testing the validity of claims," Vasilopoulos (2011) stated that one of the greatest applications of statistics is in testing the validity of claims. The evaluation of whether something is correct or true. The researcher establishes a hypothesis and then tests the hypothesis which normally means establishing an assumption that H_0 is true and that H_1 is false and the statistically testing if H_0 is true. Often times the research will also test if H_1 is true. By framing the problem in this way, a researcher can use statistics to calculate an estimated value and the likelihood or confidence that the estimated value will be correct. After establishing the hypothesis, a researcher can use a computer software such as Minitab to test the hypothesis and calculate the descriptive statistics. The use of Minitab for statistical analysis in the research provides guidance on the use of Minitab in this research paper.

The use of time series analysis for financial forecasting is a challenging task for researchers because of the non-linear and non-stationary structural nature according to Sermpinis, Stasinakis, Theofilatos, and Karathanasopoulos (2015) in their research article titled

"Modeling, forecasting and trading EUR exchange rates with hybrid rolling genetic algorithms – support vector regression forecast combinations." Sermpinis et al. (2015) stated that the use of traditional statistical models fails to capture the complexity of the data while non-linear models are often too complex. Sermpinis et al. studied the trading history of the EUR/USD, the GBP/EUR and the EUR/JPY from the period of 1999 through 2012 to conclude that rolling genetic support vector regression forecasting provides the best forecasting method in terms of trading efficiency and statistical accuracy. Sermpinis et al. used 10 day increments to provide the rolling window forecast as a tradeoff between the trading performance of the model and the computational time needed for estimating. Sermpinis et al.'s (2015) research identifies two items for consideration in this paper: the use of 10 days for calculating the rolling moving average forecasts which will be measured against other time frames, and the recognition that simple models are easier to use and are likely to be nearly as accurate at more complex models.

Kılıç and Uğur (2018) in their article titled "Multiresolution analysis of the S&P 500 time series" stated that time series analysis is a critical research topic for researchers studying engineering and scientific problems. Time series analysis is often done to provide the most suitable model to make a good prediction and is especially useful for data analysis of high-frequency components such as financial data. Kılıç and Uğur (2018) studied the daily closing prices of the S&P 500 from the beginning of 1990 to the end of 2011 which includes 5,444 observations. As other financial data researchers have found, the authors found that financial data often shows a non-stationary behavior. Kılıç and Uğur's (2018) findings support the use of wavelets to improve model fitting and forecasting results while confirming the importance of time series analysis to forecast financial results.

In a journal article titled “Mining numerical data for decision making with the help on Minitab,” Vasilopoulos (2010) stated that meaningful business decision making often requires statistical analysis. Vasilopoulos (2010) mentioned the importance of the use of histograms to show the shape of the data, and statistical analysis to measure skewness, kurtosis, mean, median, standard deviation, and other descriptive statistics. Vasilopoulos (2010) mentioned that data set analysis includes mining the data for information that can be used for decision making. Using statistical methods is usually the most effective methodology to use to find the information. The researcher must us a systematic and careful approach to the analysis. The histogram is used to plot the shape of the data using frequency distribution. The use of Minitab software will significantly simplify and speedup the calculations when compared to hand calculations. The author verified the results of the Minitab calculations by performing the same calculations using hand calculations. Once the histograms and statistical information is obtained they can be very useful to decision makers. This article supports the use of Minitab to analyze the EUR/USD exchange rate fluctuations and the prices of both 60-day call and put options.

Option Pricing

In a journal article titled “On performativity: Option theory and the resistance of financial phenomena,” Brisset (2017) examined the widespread use of the Black-Scholes-Merton option pricing model to price options. Brisset (2017) stated that the Black-Scholes-Merton model which is used to price options on a theoretical basis exhibited a high level of correlation to the actual prices being generated in the marketplace until the stock market crash in October 1987. Brisset (2017) stated that the October 1987 stock market crash is proof that the Black-Scholes-Merton model does not entirely fit the real happenings in the financial world. The Black-Scholes-Merton model for pricing options on stocks relies on knowing or assuming these

constants: the short-term interest rate, the stock price follows an exponential Brownian motion, there are no transaction costs, the stock pays no dividend, and there are no penalties for short selling. The Black-Scholes-Merton model assumes a linear relationship between strike prices and volatility. However, a small piece of information can produce a violent price fluctuation in the underlying asset of the option. In other words, the Black-Scholes-Merton option pricing model does not address the fat tails of the financial markets. Brisset (2017) concluded by saying that the Black-Scholes-Merton option pricing model can help traders understand the underlying causes of option price changes however; the model will not necessarily always be useful for pricing options in the real financial market. In a journal article, Heo, Cashel-Cordo, Rhim, and Kang (2017) found that the classical Black-Scholes option pricing formula may produce systematic biases in the valuation of option prices. These journal articles support the use of real world option prices as traded in the financial markets for use in this research.

Manzur, Hoque, and Poitras (2010) in a journal article titled "Currency option pricing and realized volatility" analyzed the relative performance of three models to predict market volatility. Manzur et al. (2010) studied options for three currencies; the EUR/USD, the USD/GBP, and the USD and the Swiss Franc (CHF). Manzur et al used exchanged traded information on daily and intra-daily trading for EUR/USD, the USD/GBP and the USD/CHF to determine if implied volatility, realized volatility, or GARCH based models generated the best prediction of market volatility which was then checked against actual option prices. Manzur et al. (2010) measured the various models by comparing the predictions against actual at the money option prices. The sample period for the testing is from July 22, 2002 to June 30, 2006. The total number of quotations for the three currencies was over 1.3 million for each currency pair for their sample period. All options were written for three months with the strike price equal to

the spot price for that day. Data from the Chicago Mercantile Exchange (CME Group) was used as the source data. Manzur et al. (2010) concluded that realized volatility performs the best when predicting volatility. This paper provides support for using strike prices equal to spot prices when studying options and confirms that data from the CME Group provides important and comparative information.

Hoque (2013) completed a study of option prices during the global financial crisis and concluded that option prices were mispriced during the crisis. In his study Hoque (2013) examined the efficiency of the foreign currency exchange option market for the Canadian Dollar (CAD), Australian dollar (AUD), the CHF, the JPY, the GBP, and the EUR. Hoque (2013) used two time periods: for the global financial crisis the time period from 1 January 2008 to 31 December 2011; for a time period after the global financial crisis from 1 January 2012 to 31 January 2012. To measure the efficiency of the options market the author used the put-call party relationship under conditions of a frictionless market. Hoque (2013) used option prices from the Options Pricing Authority for put-call pairs which mature on the third Friday of each month. Hoque (2013) found that during the global financial crisis all of the major currency options were mispriced but after the crisis the options reverted to being accurately priced. During the global financial crisis, the volatility in the market place was extremely high and a result the prices of exchange options increased which is consistent with the logic that having the ability but not the obligation to exercise the option becomes more valuable. During the global financial crisis, the risk associated with currency movements increased thus the value of shifting currency risk to another party increased. After the global financial crisis subsided the pricing of currency options settled into a more normal steady state.

Low and Zhang (2005) studied the pricing of currency options to explore how the volatility risk premium was included in option pricing. Low and Zhang (2005) stated that generally the price volatility of financial assets demonstrates a stochastic process. The study used a standard currency option straddle which is designed to be neutral on price and maturity date but is very sensitive to market volatility. Low and Zhang (2005) studied foreign currency options for the GBP, the EUR, the JPY and the CHF and found that buyers in the options market pay a premium to the sellers to compensate the sellers for bearing the volatility risk. In other words, the author's study confirmed that the buyers pay the sellers for accepting additional risk. The authors confirmed that the prices for options should increase during times of high market uncertainty. The Low and Zhang (2005) study confirmed that market volatility impacts EUR/USD option pricing which is demonstrated in the increase in option pricing during the global financial crisis. The study does not address the net benefit, if any, from using options as a hedging instrument during times of high or normal volatility.

Summary of the Literature Review

Companies are increasingly looking internationally to expand their markets, obtain critical resources, develop new capabilities, and reduce costs. Firms which have expanded into the international marketplace are likely to face the risks of currency fluctuations and as such they may need to consider how to manage these risks. Active risk management and the use of derivatives have been shown to increase valuation and improve financial results. To prepare for managing currency risks, companies may desire to use statistical forecasting tools which have shown promising results in the shorter term. The forecasting of currency movements has traditionally been based on two theories of exchange rate movements the interest rate parity theory and the purchasing price parity theory. Several new variables have been identified as

predictors of exchange rate movements including order flow, oil prices and Google Trend data. For this study, the researcher will analyze interest rate and oil price data as independent variables that may influence exchange rate movements. The use of options to manage risks and the pricing of these options have been studied, however, the majority of the studies use theoretical option prices not historical option prices. The author used actual option prices as incurred on the Chicago Mercantile Exchange to avoid the errors found in traditional option price calculation. Overall, the literature review supports the increasing use of global suppliers which introduces exchange rate risk into the organization which should be managed through the risk management planning process. The movement, especially the directional movement of EUR/USD exchange rate, should be forecastable using statistical tools. The purchase of exchange rate options to cover the exchange rate risk has been shown to increase the value of companies using such options. The literature supports the study of using a combination of exchange rate movement modeling and timely purchasing of options to mitigate negative exchange rate movements.

Transition and Summary

Preliminary analysis and the literature review indicate that firms have discovered cost improvements and increased sales by expanding internationally. This expansion has increased international business currency risks. Firms utilizing hedging to manage risk are likely to have higher valuations and improved credit terms and the use of currency options may provide a beneficial method to hedge this currency risk. This study analyzed the net benefit of using currency options to hedge exchange rate risk for normal accounts receivable and accounts payable time frames. The next section on the study will further develop the statistical analysis and modeling of the EUR/USD exchange and the use of call and put options to hedge EUR/USD currency risk. Included in the next section are detailed discussions of the EUR/USD and option

data, the data collection techniques and organization, the variables used, the hypotheses, and data reliability and validity.

Section 2: The Project

In search of new markets, cost savings, new capabilities, and increased flexibility companies have expanded into foreign markets. When issuing or accepting contracts in foreign currencies the company is likely facing foreign currency exchange rate risks. This study focuses on the risks a company may face when issuing a supply contract in a foreign currency, specifically the risk associated with accounts payable and the exchange rate fluctuations of the United States Dollar (USD) and the European Union Euro (EUR). The questions of why and how companies, hedge financial risk has been a central part of finance literature since the mid-1980s (Albouy & Dupuy, 2017). The decision by a company to vary its hedging based on its view of the economic conditions and the level of risk is a companion question in the literature (Albouy & Dupuy, 2017). This paper will expand the literature on these questions. A statistical analysis was undertaken to endeavor to develop a forecasting tool to predict the likely movement of the EUR/USD over a 60-day time frame. Based on this forecasting tool, the author then calculated the net benefit of using EUR options to hedge 60-day account receivables.

This section of the study addressed the purpose of the study, the role of the researcher, the participants in the study, the research methods and design, the research population and the sampling methods, how data were collected and organized, the research variables and data analysis, and the reliability and validity of the research. This research focused on approximately 13 years of EUR/USD currency data and 10 years of currency call option data from 2007 to 2019.

Purpose Statement

The purpose of this quantitative study was to endeavor to develop a multiple linear regression EUR/USD forecasting methodology for companies to use when determining when to

use currency call options for managing currency risk in accounts payable. The findings of this research will add to current literature on the variability of, and forecasting of the EUR/USD currency exchange rate. The research will address gaps in business literature due to the lack of longer-term studies on the movement and predictability of the EUR/USD currency exchange rate (Costantini et al., 2016; Dal Bianco et al., 2012; Dick et al., 2015). The findings of this research addressed a broad set of economic conditions by analyzing a 13-year economic period from 2007 to 2019.

The findings of this study will also add to the current literature on the use of options to hedge shorter-term exchange rate risks. Research studies by Charvin et al. (2014), Chen et al. (2019), Ardoin and Rodriguez (2017), and Spreckelsen et al. (2014) indicated that research gaps exist in the study of options; across an expanded time frame, in relation to currency exchange rates, and in the reliance on theoretical option prices versus actual market prices. This research study encompassed 10 years of actual market-based exchange rate option prices.

Role of the Researcher

With this quantitative research, the role of the researcher was to collect and analyze data that was preexistent. The researcher did not influence the data. The EUR/USD exchange rate as the dependent variable and the independent variables such as interest rates and oil prices as well as EUR/USD option prices existed prior to the initiation of this research study. The role of the researcher in this research study was to analyze the data using the appropriate statistical and business modeling tools.

Participants

The exchange rate and option price data used in the quantitative research study were archival data. There were no participants in this research study.

Research Method and Design

Research method. This quantitative study is intended to assist an organization in managing the risk of international business where transactions are based on the EUR/USD currency translation. Duță and Duță (2017) stated that "In risk management, the rationale for choosing a quantitative research method is supported by the need for numerical aggregate and detailed estimation calculations to identify, analyze, evaluate, and address risks" (p. 107). Park and Park (2016) stated that quantitative methods are best used when numerical methods and measurable variables are being study.

The quantitative study examined the historical fluctuation of the EUR/USD currency pair. Statistical analyses was used to develop equations that can be used to forecast future exchange rate movements in order to assist companies in develop guidelines for purchasing options to hedge the EUR/USD fluctuations (Cenedese et al., 2014). In other words, the study used statistical regression analysis to endeavor to develop a forecasting model that could be used as a basis to trigger the use of options to hedge currency risks. The study included an analysis of the net benefit of using foreign currency options when triggered by the forecasting model. This quantitative study will focus the highest traded currency pair, the USD and the EUR (Li, Zhou, & Wu, 2013). The USD and the EUR make up 63% and 20% respectively of the 2017 global foreign exchange reserves (Issing, 2018). As a global means of payment in 2017, the USD makes up 40% while the EUR accounts for 36% (Issing, 2018). The European Union accounted for 35% of global foreign direct investment (FDI) inward flow and 40% of global FDI outward flow in 2014, while the U.S. accounted for 21% of global inward FDI flow and 24% of global outward FDI flow in 2014 (Witkowska, 2017). The USD and the EUR have a dominant role as a global means of payment, as reserve currencies, and in FDI flow.

Research design. The researcher statistically analyzed the EUR/USD currency fluctuations and option price fluctuations using statistical analysis software and developed mathematical models to analyze the net benefit of using call options to hedge the EUR/USD currency fluctuations (Ljung, Ledolter, & Abraham, 2014). The options modeled were approximately 60-day call options which represent a 60-day period between transaction initiation and transaction completion. For example, a call option would be useful for a company which has outsourced a product or service and is expecting to pay in foreign currency. By using data from 2007 to 2016, the study addressed the use of the EUR/USD currency options when the global economy experienced both extreme volatility and relative calm. The author used approxiomately 60-day options to address the relative shorter-term foreign currency risks that companies may experience in accounts payable. Kroes and Manikas (2014) found that average accounts payable days was approximately 60 days.

Population and Sampling

Population. This study used daily EUR/USD currency prices from January 1, 2007 to December 31, 2019. The time period studied included recessionary, expansion, and slow growth economic conditions in both the United States and the European Union. The EUR/USD currency data were matched against the daily trading availability of currency options. Because of the matching of daily currency data to option data, some currency data were eliminated when the option market was closed. The daily trading data was limited to US business days which excluded national holidays and weekends. The US national holidays included New Year's Day, Martin Luther King Jr. Day, President's Day, Good Friday, Memorial Day, Independence Day, Labor Day, Thanksgiving Thursday and Friday, and Christmas Day. Weekends were also excluded because both the foreign exchange market and the options market were closed. The

result was 3,244 EUR/USD closing prices over the time period of January 1, 2007 to December 31, 2019. The closing prices for the EUR/USD currency pair were downloaded from the US Federal Reserve Board of Governors FRED database to Excel (Board of Governors of the Federal Reserve System [US], 2019d).

The EUR/USD currency option prices used in this study are actual prices from January 1, 2007 to December 31, 2016. The option prices include high volatility economic conditions which occurred during the global 2008 recession and the economic recovery. Also, included were option prices when economic conditions were relatively stable. The option prices were obtained from the Chicago Mercantile Exchange (CME Group) which each day of trading data being downloaded and converted into an Excel file. The number of rows of option trading data totaled 83,313, which included call and put options at many different strike prices. The author used Excel formulas and sorting criteria to identify the daily call option with the EUR/USD strike price closest to the daily EUR/USD spot price. An option with the strike price closest to the daily spot price is referred to as an at-the-money option. Hogue and Krishnamurti (2013) and Manzur et al. (2010) used at-the-money options in their research on option pricing. Spreckelsen et al. (2014) found that in-the-money options or at-the-money options are more accurately priced. The author also used Excel to calculate and identify the call option with the option date closest to the required 60-day hedging capability for an accounts receivable. The result was 2,510 call options with an average duration of 74 days. Currency options handled by the CME Group have standard once per month closing dates and the author ensured the 60-day accounts payable currency risk would be adequately hedged in its entirety.

Interest rate data for this study was downloaded from the United States (US) Federal Reserve Board of Governors database to Excel (Board of Governors of the Federal Reserve

System [US], 2019d). The interest rate data included the US Federal Funds rates, the US 90 Day US Treasuries, and the 90-day London Interbank Offered Rates (LIBOR) based on the EUR. The daily interest rates were matched to the EUR/USD currency price and option price data to total 2,510 trading days. The oil price data were downloaded from the US Energy Administration and as with the interest rates the data were matched to the EUR/USD currency price and option price data to total 2,510 trading days. The oil price was based on Brent crude oil which relates to the price of oil in Europe (Kim & Jung, 2018).

Sampling. The 2,510 trading days had a 4.14% EUR/USD currency price standard deviation over a 60-day time period. Using Excel's sample size calculator and the 4.14% EUR/USD currency price standard deviation, with a confidence level of 90% and a sampling error of .5% the result was a recommended sample size of 186. Given a population of 2,510 and a sample size of 186 the average days between samples would be 13.5. The author rounded down and took a sample every 13 records resulting in a sample size of 193. Using the same parameters Minitab calculated a sample size of 120. When calculating sample sizes for foreign exchange rate studies, a 90% confidence interval has been chosen by researchers such as Crowder (2014), Engle (2016), and Kim and Jung (2018b). Dias and Embrechts (2010) and Kang, Kim, and Lee (2016) used equally spaced sampling for exchange rate research. The sample includes the EUR/USD exchange, interest rates, and oil prices for each date selected and will be interpreted as the date for forecasting the movement of the EUR/USD exchange rate and as the date the decision has to be made on hedging a 60-day accounts receivable. Statistical analysis and modeling included in-sample and out-of-sample calculations.

Data Collection

Instruments. Excel and Minitab were the primary instruments used in this study. Excel was used to hold, cull, sort, and analyze the data including EUR/USD exchange rates, interest rates, and oil prices. Excel's graphing capabilities and statistical analysis capabilities were used to analyze the data. Minitab's statistical analysis and graphing capabilities were also used to analyze the data. The data for exchange rates and interest rates were downloaded from the US Federal Reserve's dataset called FRED. The data for Brent Crude Oil prices were downloaded from the US Energy Administration. The data for EUR/USD exchange rates, interest rates, and Brent oil prices were available to the public from the US Federal Reserve and the US Energy Administration. The data were easily downloaded to Excel.

The data for the option prices was obtained from CME Group with each day's trading information contained in a separate zip file. Each zip file was unzipped using a free shareware instrument called 7-Zip and each day's trading data were then combined into an Excel file. Excel's sorting and data tools were used to identify the call option with the strike price closest to the spot price for each day. Excel's sorting and data tools were then used to identify the call option which had an expiration closest to the due date for a 60-day accounts payable. The call option would be used to purchase EURs to pay the accounts payable. The result was an Excel file consisting of 2,510 call options, one for each trading day, with its price, volume, and date of maturity. The original zipped daily files, the Excel file containing the unzipped daily option information and the final Excel file with the call options as specified above are available from the author.

The author did not use special surveys, questionnaires, or other special tools or instruments in this study. No special adjustments or revisions were made to the standard Excel,

Minitab or 7-Zip tools. The 2016 version of Excel and Minitab version 18 were used for the analyses contained in this research.

Data Collection Technique. The EUR/USD exchange rate information was downloaded to Excel from the US Federal Reserve using the FRED reporting system. The US Federal Reserve releases daily rates of exchange for major currencies against the USD on a weekly basis. The data were based on cable transfers payable in the listed currencies in New York and the rates have been certified, as required by section 522 of the amended Tariff Act of 1930, by the Federal Reserve Bank of New York (Board of Governors of the Federal Reserve System [US], 2019d). The effective federal funds rate was downloaded to Excel from the US Federal Reserve using the FRED reporting system. The central interest rate in the US is the effective federal funds rate which influences interest rates such as the prime rate, mortgage rates, and other interest rates (Board of Governors of the Federal Reserve System [US], 2019c). The market determines the effective federal funds rate, however, the Federal Reserve through its open market operations influences the rate by buying and selling Government bonds. The effective federal funds rate is determined by the Federal Reserve's Open Market Committee with the rate being reported on a monthly basis. The 3-Month Treasuries interest rate was downloaded to Excel from the US Federal Reserve using the FRED reporting system. The 3-Month Treasuries interest rate is reported daily and reflects the yield on 3-Month US Treasuries bills in the secondary market (Board of Governors of the Federal Reserve System [US], 2019b). The 90 day London inter-bank offered rate (LIBOR) was downloaded to Excel from the US Federal Reserve using the FRED reporting system. The LIBOR is the interest rate for banks borrowing funds from other banks in the London market and is the most widely used reference rate for short term interest rates (Board of Governors of the Federal Reserve System [US], 2019a). The daily Federal Funds

rate was downloaded from MacroTrends which is a publicly available website. The federal funds rate is the interest rate for banks and credit unions to lend reserve balances to other depository institutions (Federal Funds Rate 62 Year Historical Chart, 2019). The Brent crude oil price was downloaded from the US Energy Information Administration (EIA). The daily price of Brent crude oil is priced in USD and the data is publicly available through the EIA website. The call option price information was purchased from the CME Group. The CME Group is one of the world's leading derivatives marketplace which offers a wide range of products. The CME Group offers future and options for equity indexes, interest rates, foreign exchange, energy and agricultural products (CME, n.d.). The CME Group offers products and services allowing customers to manage risk across the globe. The CME Group publishes option information on a daily basis however, historical data is stored on their servers and must be accessed through an application programming interface (API). The CME Group charges a fee to issue an API access code to gain access to the historical data. The author obtained the option price information from the CME Group and downloaded the daily option price information to a computer. The author unzipped each daily file to create an Excel spreadsheet which combined the daily option price information into one Excel file. The Excel file was used to sort, cull, and store the option price information.

Data Organization Techniques. The exchange rate, interest rates, and oil price data were downloaded to Excel from publicly available sources. The data for the option prices were obtained in zipped daily files which had to be unzipped and collated into Excel. Each daily option file is stored on the author's computer as is the original collated Excel file. Excel is being used as the primary data organization tool. The Excel files and the original option files are backed up eto Google Drive. Excel was used organize, cull, summarize and analyze the data.

The Excel dataset contains 3,244 days of EUR/USD data from January 1, 2007 to December 31, 2019 and 2,862 days of call option data from January 1, 2007 to December 31, 2016. The exchange rate data are composed of daily market close data. For example, the daily EUR/USD currency price is the price as of the close of the US market. The Excel file was used as the basis for the statistical analyzes performed in this study and was linked to Minitab for additional statistical analysis and graphing.

Data Analysis

The EUR/USD exchange rate data along with interest rate data were downloaded from the US Federal Reserve while the Brent oil price data were downloaded from the US Energy Administration. The EUR/USD call option data were obtained from the CME Group through their historical dataset. Excel and Minitab were used as data manipulation tools and statistical analysis tools and no changes were made to these software programs. Google's cloud drive was used to back up the data and the data were password protected by the author's computer and Google passwords. The Microsoft Excel files were linked to Minitab for statistical and graphical analysis.

Variables. The dependent variable for this study is the EUR/USD exchange rate. The EUR/USD exchange rate varies over time and an initial statistical analysis shows that over 60-day time periods, involving 3,244 incidences for 2007 to 2019, the mean change in the EUR/USD exchange rate is .13%. The author statically modeled independent variables, which research has shown may impact exchange rates. The study starts with the null hypothesis $H1_{0,}$ that there is no statistically significant relationship between the independent variables of the EUR/USD exchange rate 60 days earlier (d-60) and the EUR/USD movement during the preceding 60 days (d-60 to d-120) and the dependent variable, the current EUR/USD (d) spot

rate. In other words, there is no statistically significant relationship between the prior exchange rate, the prior exchange rate movement and the current exchange rate. The alternate hypothesis $H1_a$ is that there is a statistically significant relationship between the independent variables of the EUR/USD exchange rate 60 days earlier (d-60) and the EUR/USD movement during the preceding 60 days (d-60 to d-120) and the dependent variable, the current EUR/USD (d) spot rate. In other words, past exchange rate movements can be used to predict future exchange rates. Excel and Minitab were used to statistically analyze the EUR/USD exchange rate movement.

The interest rate parity model says that as interest rates change, exchange rates should also change (Ardoin & Rodriguez, 2017; Bulut, 2018; Dick et al., 2015; Engel, 2016). Based on the interest rate parity model one of the independent variables used in this study will be interest rates. Interest rates have been downloaded from the US Federal Reserve and consist of two sets of interest rates: the US Federal Reserve and the European Central Bank target rates, and the 90-day interest rate on US Treasuries and the 90-day LIBOR interest rates for the European Union. Research has shown that Brent crude oil prices may impact EUR/USD exchange rates (Kim & Jung, 2018a; Mishler, 2017). The daily spot rate of Brent crude oil was downloaded from the US Energy Administration to Excel. Overall, the EUR using countries are dependent on imported oil (Jawadi, Louhichi, Ameur, & Cheffou, 2016; Kim & Jung, 2018a; Mishler, 2017). Since the 2008 recession the Brent crude oil price and the EUR exchange rate linkage has become stronger (Kim & Jung, 2018b). Brent crude oil prices will be an independent variable used in this study. Hypothesis $H2_0$ is that there is not a statistically significant relationship between the independent variables of interest rates and Brent Crude oil prices, and the dependent variable, the EUR/USD exchange rate. The alternate hypothesis $H2_a$ is that there is a statistically significant relationship between the independent variables of interest rates and Brent Crude oil prices, and the dependent

variable, the EUR/USD exchange rate (Plakandaras et al., 2015). Excel and Minitab will be used to statistically analyze the correlation between the EUR/USD exchange rate movement and the movement of interest rates and Brent crude oil prices.

The null hypotheses suggest that the forecasting of EUR/USD currency movements based on historical movements or interest rate and oil price movements is not supported by statistical analysis. A firm should therefore consider the cost of hedging every 60-day EUR payable. However, the use of call options to hedge every 60-day EUR accounts payable may cost more than the benefit of hedge (Fabling & Grimes, 2015; Steil, 1993). However, the alternate hypotheses support the use of a statistical model to forecast exchange rate movements which could then be used as a basis for purchasing currency call options to hedge a 60-day payable.

Currency call option price data were obtained from the CME Group which in one of the world's leading and most diverse derivatives marketplace. The option price data were downloaded in zipped files for each day from the CME Group historical dataset using API instructions from CME Group. In this analysis the author has used Excel to select the call option with the strike price closest to the daily spot price and with the date of maturity being closest to but not under 60-days. The call option data were used to analyze the net benefit of hedging each 60-day accounts payable related EUR/USD exchange rate risk as well at the net benefit of using a multiple linear regression forecasting model to determine when to hedge the EUR/USD exchange rate risk. In other words, the author analyzed the use of call options to hedge every accounts payable EUR/USD exchange rate risk and the use of call options for hedging only when the currency exchange model indicates unfavorable exchange rate movement. There may be a favorable financial impact when a statistical model for the 60-day EUR/USD exchange rate movement as the basis for purchasing 60-day EUR call options to hedge a 60-day EUR payable

(Ebrahimijam et al., 2018). For example, given that the 60-day multiple linear regression-based forecast is an increase in the value of the EUR, then the company should hedge an accounts payable using a call option. In other words, the company would only purchase the hedge when the regression analysis forecasts adverse currency movements. Table 3 shows a summary of the null and alternate hypotheses.

Table 3

Summary of the Null and Alternate Hypotheses

Null Hypotheses	Alternate Hypotheses
$H1_0$ There is no statistically significant relationship between the independent variables of the EUR/USD exchange rate 60 days earlier (d-60) and the EUR/USD movement during the preceding 60 days (d-60 to d-120) and the dependent variable, the current EUR/USD (d) spot rate.	$H1_a$ There is a statistically significant relationship between the independent variables of the EUR/USD exchange rate 60 days earlier (d-60) and the EUR/USD movement during the preceding 60 days (d-60 to d-120) and the dependent variable, the current EUR/USD (d) spot rate.
$H2_0$ There is not a statistically significant relationship between the independent variables of interest rates and Brent Crude oil prices, and the dependent variable, the EUR/USD exchange rate.	$H2_a$ There is a statistically significant relationship between the independent variables of interest rates and Brent Crude oil prices, and the dependent variable, the EUR/USD exchange rate.

Quantitative data analysis. This quantitative study examines two research questions: does the 60-day fluctuation of the Euro/USD exchange justify the consideration of taking actions to address this currency risk; and does using a multiple linear regression analysis of the Euro/USD currency fluctuations to trigger the purchase of Euro/USD options provide a favorable financial benefit. Two hypotheses are proposed to address the research questions.

The null hypotheses $H1_0$ states that there is no statistically significant relationship between the independent variables of the EUR/USD exchange rate 60 days earlier (d-60) and the EUR/USD movement during the preceding 60 days (d-60 to d-120) and the dependent variable, the current EUR/USD (d) spot rate. The alternative hypothesis $H1_a$ is that there is a statistically

significant relationship between the independent variables of the EUR/USD exchange rate 60 days earlier (d-60) and the EUR/USD movement during the preceding 60 days (d-60 to d-120) and the dependent variable, the current EUR/USD (d) spot rate. The null hypothesis $H2_0$ states that there is not a statistically significant relationship between the independent variables of interest rates and Brent Crude oil prices, and the dependent variable, the EUR/USD exchange rate. The alternate hypothesis $H2_a$ states that there is a statistically significant relationship between the independent variables of interest rates and Brent Crude oil prices, and the dependent variable, the EUR/USD exchange rate. The discussion and analysis of the two hypotheses is based on data and sample data extending from January 1 2007 to December 31, 2019. The statistical analyzes in this study, includes common statistical measures such as range, skewness, standard deviation, coefficient of variation, correlation and other measures (Weltman & Eakin, 2018). Range and skewness help in describing the shape of the data while standard deviation and coefficient of variation describe the variability of the data. The strength of the relationship between variables or correlation will also be measured.

Hypothesis H1. The first null hypotheses $H1_0$ states that there is no statistically significant relationship between the independent variables of the EUR/USD exchange rate 60 days earlier (d-60) and the EUR/USD movement during the preceding 60 days (d-60 to d-120) and the dependent variable, the current EUR/USD (d) spot rate. Hypothesis $H1_0$ would support the weak form of the efficient market hypothesis which says that historical data does not have a statistically significant relationship to future exchange rates. The alternate hypothesis $H1_a$ is that there is a statistically significant relationship between the independent variables of the EUR/USD exchange rate 60 days earlier (d-60) and the EUR/USD movement during the preceding 60 days (d-60 to d-120) and the dependent variable, the current EUR/USD (d) spot rate. The data on

EUR/USD exchange rates are from the US Federal Reserve extending from January 1, 2007 to December 31, 2019. The economic conditions addressed in this study range from recession to boom to relatively slow, steady growth. An analysis of the whole 3,244 daily records from the study dataset reveals a mean EUR/USD exchange rate of 1.3122. The range of the daily EUR/USD exchange rate during the time period, January 1, 2007 to December 31, 2019, spanned from 1.5988 to 1.0387. The focus of this study is on the risk a US firm takes in accounts payable contracted in EUR. Research shows that the average accounts payable timeframe is on average approximately 60-days. Excel was used to calculate the change in the EUR/USD over an approximate 60-day time frame. The calculations did not include US holidays and weekends when the markets were closed so the next available business date was used for the calculations. The author used Excel and Minitab to perform the statistical analysis on the EUR/USD exchange rate in the analysis of hypothesis H1. Using Excel and Minitab the author statistically analyzed the variables to determine the applicability of regression modeling for the data. The testing of the data included graphical analysis and statistical analysis such as F-testing, skewness, and kurtosis (Flatt & Jacobs, 2019). Assuming that the data were appropriate, then Excel and Minitab were used to perform a multiple regression analysis to on the EUR/USD exchange rate using interest rates and Brent crude oil prices as the independent variables. The resulting multiple regression analysis were tested using both in sample and out of sample calculations. The regression analysis modeling includes correlation analysis and included R-squared, R-squared adjusted and P-values as measurements (Weltman & Eakin, 2018). The variables for the statistical model are shown in Table 4.

Table 4

Hypothesis 1 Variable Classification

Variable Classification	Variable	Type	Measurement Scale
Dependent	The current EUR/USD spot rate (d).	Numeric	Ratio
Independent	The EUR/USD rate 60 days in the past (d-60)	Numeric	Ratio
Independent	The prior EUR/USD movement (d-120 to d-60)	Numeric	Ratio

Hypothesis H2. The second Hypothesis $H2_0$ is that there is not a statistically significant relationship between the independent variables of interest rates and Brent Crude oil prices, and the dependent variable, the EUR/USD exchange rate. The alternative hypothesis $H2_a$ is that there is a statistically significant relationship between the independent variables of interest rates and Brent Crude oil prices, and the dependent variable, the EUR/USD exchange rate. The dependent variable for this analysis is the EUR/USD exchange rate while the independent variables are interest rates and Brent crude oil prices. Research has shown support for the interest rate parity theory which says interest rate changes should impact exchange rates. (Ardoin & Rodriguez, 2017; Bulut, 2018; Dick et al., 2015; Engel, 2016). According to the interest rate parity theory when interest rates change in either the US or the EU then the EUR/USD exchange rate should also change. If interest rates change and exchange rates do not change then an investor could borrow money in the lower interest rate country and deposit the money in the higher interest rate country and earn extra profit from a riskless investment.

The interest rate parity theory says that this arbitrage opportunity will be quickly eliminated as investors move money to the higher interest rate country which will cause adjustments in the exchange rate. Based on the interest rate parity theory one of the independent

variables used in this study will be interest rates. Interest rates have been downloaded from the US Federal Reserve and consist of two sets of interest rates: the US Federal Reserve and the European Central Bank banking rates, and the 90-day interest rate on US Treasuries and the 90-day LIBOR interest rates for the European Union.

Research has shown that Brent crude oil prices may impact EUR/USD exchange rates (Jawadi et al., 2016; Kim & Jung, 2018b; Mishler, 2017). The EUR countries are dependent on imported oil and therefore when oil prices escalate the EUR countries are negatively impacted which has an effect on the EUR/USD exchange rate. Brent crude oil prices were included in the statistical analysis as an independent variable.

The total dataset consists of 3,244 days of EUR/USD exchange rate, interest rate, Brent crude oil price and 2,510 days of option price data. The statistical analysis is based on a sample size of 193 based on a standard deviation of the whole population of 4.14% and a confidence factor of 90% (Crowder, 2014; Engel, 2016; Kim & Jung, 2018b). Because this is time series data, the author selected every 13 days to include in the samples. Other researchers, such as Dias and Embrechts (2010) and Kang et al. (2016) used a similar sampling technique when analyzing time series data. Using Excel and Minitab, the author statistically analyzed the variables to determine the applicability of regression modeling for the data. The testing of the data will include graphical analysis and statistical analysis such as F-testing, skewness, and kurtosis (Flatt & Jacobs, 2019). Assuming that the data are appropriate then Excel and Minitab were used to perform a multiple regression analysis to on the EUR/USD exchange rate using interest rates and Brent crude oil prices are the independent variables. The resulting multiple regression analysis was tested using both in sample and out of sample calculations. The regression analysis modeling includes correlation analysis and will include R-squared, R-squared adjusted and P-

values as measurements (Weltman & Eakin, 2018). Table 5 shows the variables for the regression model. The null hypothesis $H2_{0,}$ will be tested using regression analysis. Table 5 shows the variables being used to test hypothesis H2.

Table 5

Hypothesis H2 Variable Classification

Variable Classification	Variable	Type	Measurement Scale
Dependent	EUR/USD exchange rate	Numeric	Ratio
Independent	European interest rates	Numeric	Ratio
Independent	US interest rates	Numeric	Ratio
Independent	Brent crude oil price	Numeric	Ratio

The null hypotheses suggest that the forecasting of EUR/USD currency movements based on historical movements or interest rate and oil price movements is not supported by statistical analysis. However, the alternate hypotheses support the use of a statistical model to forecast exchange rate movements which could then be used as a basis for purchasing currency call options to hedge a 60-day payable. From a financial point of view, especially considering the use of exchange rate options for hedging, the correct prediction of the direction of exchange rates is very beneficial (Costantini et al., 2016; Dal Bianco et al., 2012; Galeshchuk & Mukherjee, 2017).

The study consists of 2,510 daily records of EUR/USD call option data spanning January 1, 2007 to December 31, 2016, US holidays and weekends are not included when the option market is closed. The EUR/USD call option prices were obtained from the CME Group and Excel was used to sort and analyze the data. The daily EUR/USD call options were selected for the analysis using two criteria: the daily call option with the EUR/USD strike price closest to the

EUR/USD spot; and the EUR/USD call option with expiration closest to 60 days but not under in most cases. There were a few call options selected with expiration less than 60 days when the next best fit selection was greater than 90 days. For this study, the first opportunity to purchase an option to hedge an accounts payable transaction occurred on January 2, 2007 which means that the 60-day accounts payable would mature on March 2, 2007. The total number of opportunities to purchase and exercise the EUR/USD call options was 2,469.

The CME Group sells EUR/USD call option in 125,000 EUR increments, meaning that one EUR/USD call option covers a 125,000 EUR accounts payable risk. The analysis assumes one EUR/USD call option contract was executed with a strike price closest to the spot price on that day and the expiration was closest to 60 days. For example, on October 7, 2016 the call option selected had a strike price of 1.1200 EUR/USD, when the spot price on October 7, 2016 was 1.1201 EUR/USD with a maturity 63 days later. The cost per EUR of this option was 0.0174 USD so the total cost of this EUR/USD call option for 125,000 EUR was 2,050 USD. To hedge a 125,000 EUR accounts payable on October 7, 2016, the company purchased a 125,000 EUR/USD call option with a strike price of 1.1200 and a maturity in 63 days, the premium on this option was 2,050 USD. On December 6, 2016, when the accounts payable matured the EUR/USD was trading for 1.0719. The EUR/USD call option would not be executed because the company could obtain the EUR for a lower price on the spot market. For this analysis the net benefit on this EUR/USD call option is calculated as a 2,050 USD loss.

Quantitative Reliability and Validity

Reliability. In performing research the reliability and validity of the data and analysis is critical (Creswell, 2014; Jordan, 2018). The researcher used data from well-known and respected sources such as the US Federal Reserve, the European Central Bank, the US Energy

Information Administration, and the CME Group. In quantitative research, the reliability of the research is often measured as the ability to replicate the results of the research (Kiri, Lacetera, & Zirulia, 2018). To ensure replicability, the author has used data and software that are easily obtainable from well-known sources. The author did not change the software being used nor add additional information to the raw data.

Data from the US Federal Reserve has been used in numerous research studies such as: Aguirre and Vázquez (2018), Gaeto and Mazumder (2019), and Miller and Philaire (2018). A search of the term "federal reserve" in the EBSCO research database generated over 3,000 journal articles since 2013. The research division of the Federal Reserve Bank of St. Louis houses the FRED data base that was used to gather exchange rate and interest rate data. The FRED website is available to the public 24 hours per day and seven days per week and is widely used and updated regularly. Data on exchange rates and interest rates were downloaded from the US Federal Reserve and is available to other researchers.

The European Central Bank (ECB) is the central bank of the 19 European Union countries which have adopted the euro (ECB, n.d.). The primary purpose of the ECB is to maintain price stability in the EUR area and protect the purchasing power of the EUR. A search of the term "ECB" in the EBSCO research database generated over 900 journal articles since 2013. The ECB collects and provides economic data to the ECB governing board and provides data to the public on an open access platform. Data on interest rates were downloaded from the European Central Bank and are available to other researchers.

The US Energy Information Administration (EIA) is an agency within the US Department of Energy. EIA collects, analyzes, and disseminates independent and impartial energy information to promote sound policymaking, efficient markets, and public understanding

of energy and its interaction with the economy and the environment (EIA, 2019). The data on Brent crude oil prices were downloaded from the EIA and are available to other researchers through the EIA website. The CME Group is a global leader in the market for financial derivatives (Callahan, 2013; Ivanović, Mitić, & Obradović, 2014). The call option price data were obtained from the historical datasets maintained by the CME Group for a nominal price.

The quantitative researcher should examine themselves for the biases, values and experiences they are bringing to the research findings and interpretations (Creswell & Poth, 2018). I strived to download, sort, and analyze the data as they unfolded. The researcher had no connection to the Federal Reserve, the European Central Bank, the US Energy Information Administration, or the CME Group.

Validity. The validity of research studies is often divided into two components: external validity and internal validity (Chaplin et al., 2018; Keiding & Louis, 2016). The researcher ensured the validity of this study as described below.

External validity. The external validity of a research study is based on the applicability of internal to the study findings, to the greater universe (Chaplin et al., 2018; Keiding & Louis, 2016). To address external validity, the researcher has used exchange rate, interest rate, oil price data, and option prices spanning a greater than 10-year time frame. This greater than 10-year time frame included a global recession, a global expansion, and relatively stable economic growth. The researcher gathered the data from well-known public and private sources and consolidated and analyzed the date using commercially available software which was not customized. To address external applicability to other currency pairs the researcher studied the EUR/USD currency pair which is one of the highest traded global currency pairs (Li et al., 2013). The researcher statistically analyzed the findings with in the sample and out of sample

calculations. The data were not manipulated to meet a previously conceived thought or motivation. The study was limited to the EUR/USD currency exchange rate, the 2007 through 2019 timeframe, and the option prices as previously described. The recommendations for future research addressed ways to increase external validity.

Internal validity. The internal validity of a research study refers to the confidence that independent variables influence the dependent variable (Chaplin et al., 2018; Creswell, 2014; Keiding & Louis, 2016). The dependent variable in this study is the EUR/USD currency exchange rate and the independent variables are interest rates and Brent crude oil prices. Researchers have studied the relationship of currency exchange rates and interest rates and have found support for the interest rate parity theory which says interest rate changes should impact exchange rates (Ardoin & Rodriguez, 2017; Bulut, 2018; Dick et al., 2015; Engel, 2016). The researcher will use linear regression to measure the correlation between interest rate changes and EUR/USD exchange rate movements. Researchers have found that Brent crude oil prices may impact EUR/USD exchange rates (Jawadi et al., 2016; Kim & Jung, 2018b; Mishler, 2017). Brent crude oil prices will be included in the statistical analysis as an independent variable. Using multiple regression analysis, the author will measure the correlation between interest rates and Brent crude oil prices as independent variables and the EUR/USD currency exchange rate as the dependent variable. The EUR/USD currency exchange rate, the interest rates, and the Brent crude oil prices were downloaded from publicly available sources while the option price data were obtained from the CME Group which provides archival data for a fee. The researcher used Excel and Minitab for the analysis with no special coding or software changes.

Transition and Summary

This section of the research study described the project that is being completed by this research study. The researcher described the role of the researcher, the research methods and design, the data population and the sample, how the data were collected, the sources of the data and how the data will be analyzed. The author also discussed how each hypothesis was analyzed. Included in this section was a description of the reliability and validity of the research. The next section of the study developed the statistical analysis and modeling of the EUR/USD exchange and the use of call and put options to hedge EUR/USD currency risk. In the next section of the research the author presented the findings of the study, described how to apply these findings to the professional practice, and made recommendations for action and further study. Reflections on the research, a summarization, and conclusion of the study were added.

Section 3: Application to Professional Practice and Implications for Change

In today's global economy, companies in search of new capabilities, capacity and cost saving opportunities often enter into contracts with foreign suppliers. These contracts may require payment in foreign currencies. This study focuses on the risks a company may face when issuing a supply contract in a foreign currency, specifically the risk associated with accounts payable and the exchange rate fluctuations of the United States Dollar (USD) and the European Union Euro (EUR). The previous sections of the paper have addressed: the background of the problem, the purpose of the study, a review of the academic literature, a description of the dependent and independent variables, the data and software being used in the study, the reliability and validity of the research and the process for analyzing the data. This section of the paper will present the findings of the study, describe how to apply these findings to the professional practice, and make recommendations for action and further study. The author will also add reflections on the research, then summarize, and conclude the study. The purpose of this quantitative study is to endeavor to develop a multiple linear regression EUR/USD forecasting methodology for companies to use when determining when to use currency call options for managing currency risk in accounts payable. This research focuses on 13 years of EUR/USD currency data and 10 years of currency call option data spanning 2007 to 2019.

Overview of the Study

Companies which have contracts with a foreign firms in foreign currencies are likely facing foreign currency exchange risks which can result in significant financial impacts (Bloom & Cenker, 2008; Edens, 2010; Moosa, 2004; Spreckelsen et al., 2014; Treanor et al., 2014; Veestraeten, 2013). Hedging currency risk is essential for multinational companies according to Broll and Wong (2015). This quantitative research was undertaken to address two business

research gaps: the lack of longer-term studies on the movement and predictability of the EUR/USD currency movements and the lack of longer-term studies on the use of currency options to address 60-day currency fluctuations risks typical of accounts payable liabilities. This study examines two research questions as shown below.

Does the 60-day fluctuation of the EUR/USD exchange rate justify the consideration of taking actions to address this currency risk?

Does using a multiple linear regression analysis of the Euro/USD currency fluctuations to trigger the purchase of Euro/USD options provide a favorable financial benefit (Cheng et al., 2015; Kearney et al., 2018)?

The author proposes two hypotheses H1 and H2 for this study. The null hypotheses $H1_0$ states that there is no statistically significant relationship between the independent variables of the EUR/USD exchange rate 60 days earlier (d-60) and the EUR/USD movement during the preceding 60 days (d-60 to d-120) and the dependent variable, the current EUR/USD (d) spot rate. The alternative hypothesis $H1_a$ is that there is a statistically significant relationship between the independent variables of the EUR/USD exchange rate 60 days earlier (d-60) and the EUR/USD movement during the preceding 60 days (d-60 to d-120) and the dependent variable, the current EUR/USD (d) spot rate. The null hypothesis $H2_0$ states that there is not a statistically significant relationship between the independent variables of interest rates and Brent Crude oil prices, and the dependent variable, the EUR/USD exchange rate. The alternate hypothesis $H2_a$ states that there is a statistically significant relationship between the independent variables of interest rates and Brent Crude oil prices, and the dependent variable, the EUR/USD exchange rate. The discussion and analysis of the two hypotheses is based on data and sample data extending from January 1, 2007 to December 31, 2019. The statistical analyzes in this study,

includes common statistical measures such as range, skewness, standard deviation, coefficient of variation, correlation and other measures (Weltman & Eakin, 2018). Range and skewness help in describing the shape of the data while standard deviation and coefficient of variation describe the variability of the data. The strength of the relationship between variables or correlation will also be measured.

By using the statistical and graphical analysis capabilities of Excel and Minitab the author has successfully examined each of the hypotheses and addressed the two research questions. The period covered by the study spans from 2007 to 2019 which incorporates a global recession, global recovery, and slow growth economic conditions. The presentation of the research finding regarding each hypothesis are discussed in the following paragraphs.

Presentation of the Findings

60-day fluctuation of the EUR/USD exchange rate. This paper analyzes two research questions, the first research question is; does the 60-day fluctuation of the EUR/USD exchange rate justify the consideration of taking actions to address this currency risk? The author analyzed the variability of the EUR/USD over a 60-day time frame because research shows that the average accounts payable timeframe is approximately 60-days (Kroes & Manikas, 2014). The data on EUR/USD exchange rates is from the US Federal Reserve FRED database extending from January 1, 2007 to December 31, 2019. Using Excel and Minitab the author calculated the change in the EUR/USD over an approximate 60-day time frame. The calculations do not include US holidays and weekends when the markets are closed so the next available business date was used for the calculations. As shown in Figure 3.1, the percentage change over a 60-day timeframe was fairly aligned with a normal distribution. Using the data from the 13-year time

period from 2007 to 2019, a company could be 95% confident that the 60-day currency exchange rate would move between -8.2% to +8.2%.

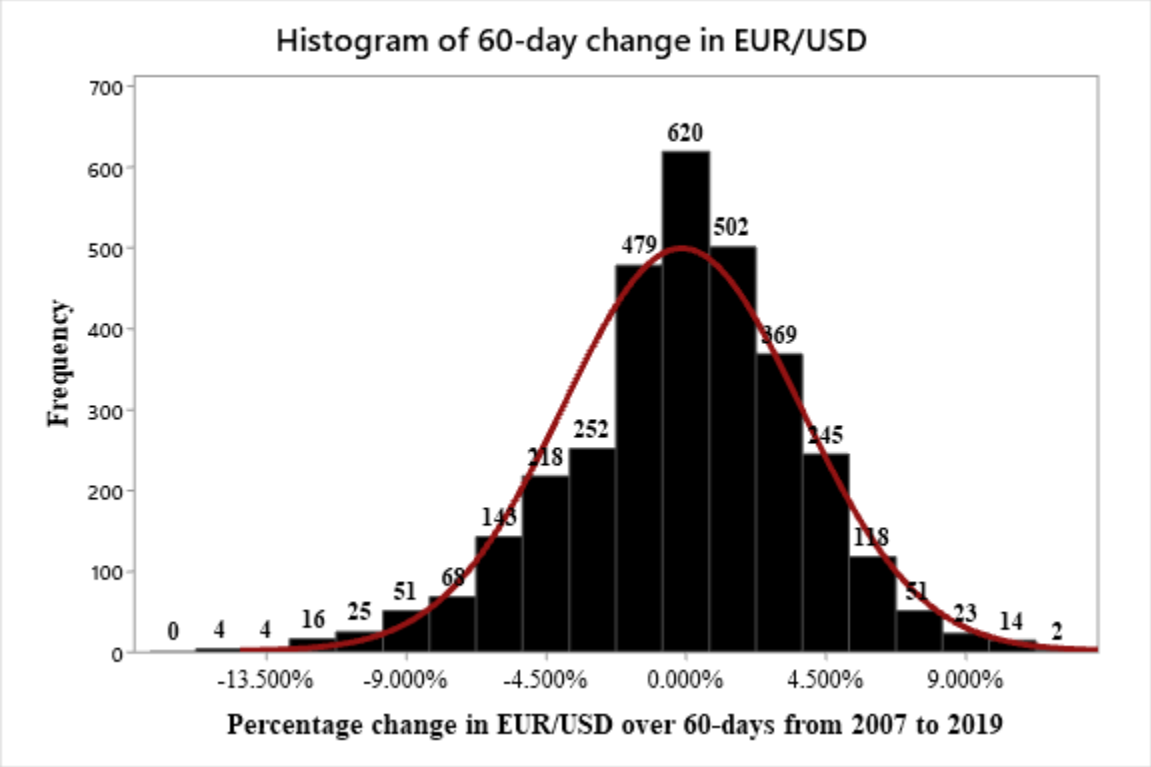

Figure 3. Histogram of the 60-day percentage change in the EUR/USD exchange rate overlaid with a normal curve.

The statistical analysis of the whole dataset shows that from January 2, 2007 to December 31, 2019, the average 60-day change in the EUR/USD exchange rate was minus .13%. During this timeframe, on average, the EUR was depreciating. The EUR/USD currency exchange rate was downloaded from the Federal Reserve database system which is a publicly available source and the research time frame includes a global recession, recovery and steady growth. The researcher used Excel and Minitab for the analysis with no special coding or software changes. The statistical analysis indicated that skewness was -.39 and kurtosis was .64 which indicate that the data generally fits a normal curve (Aljarrah, Famoye, & Lee, 2019). A visual review of the data also indicates that a normal curve fits the data reasonably well

(Saundage, Cybulski, Dharmasena, & Keller, 2016). The standard deviation of the 60-day change was 3.83% with a maximum depreciation of the EUR versus the USD of 15% and a maximum appreciation of 12%. A firm could expect that 32% of the time the variance of 60-day accounts payable would be higher than 3.83%. In the worst-case scenario, during the study period, a firm could have incurred an increase of 12% in expense for a payable liability over a 60-day period. This research shows agreement with Bessler, Conlon, and Huan (2019), Crowder (2014), Frishberg and Gobble (2013), and Mishler (2017) that foreign currency exchange rate risk is significant and that hedging should be considered for this risk even considering a relatively short timeframe such as 60-days. Table 6 shows the descriptive statistics for the EUR/USD fluctuations over a 60-day time frame.

Table 6

Descriptive Statistics for the EUR/USD Change Over an Approximate 60-Day Time Frame

Statistic	Values
Average EUR/USD exchange rate	1.2737
N	3,204
Mean	-.13%
Minimum	-15%
Maximum	+12%

Analysis of hedging the exchange rate risk. As discussed in the previous section a firm should consider hedging a EUR/USD exchange rate risk even over the relative short time frame of a 60-day accounts payable transaction. Using actual currency call option data, the author studied the time period, 2007 to 2016. The currency call option data were limited to 2007 to 2016 due to the cost of purchasing additional call option data from 2017 to 2019. Currency call

options give the firm the right but not the obligation to obtain EUR for a set price, called the strike price, on a specific date. For this risk protection the firm pays a fee for the option which is called the premium. The analysis uses 2,510 daily records of EUR/USD call option data spanning January 1, 2007 to December 31, 2016. US holidays and weekends are not included when the option market is closed. The daily EUR/USD call options were selected for the analysis using two criteria: the daily call option with the EUR/USD strike price closest to the EUR/USD spot; and the EUR/USD call option with expiration closest to 60 days but not under in most cases. This methodology of selecting the strike price and time frame for the option hedging instrument was used by Manzur et al. (2010), while VanderLinden (2014) used a similar methodology for selecting the options for analysis, setting strike equal to 95% of the current spot price.

For this study, the first opportunity to purchase an option to hedge an accounts payable transaction occurred on January 2, 2007 meaning that the 60-day accounts payable would mature on March 2, 2007. The last opportunity to purchase a call option would be November 2, 2016 with the accounts payable maturing on December 30, 2016. The total number of opportunities to purchase and exercise the EUR/USD call options was 2,469.

Assuming that a EUR/USD call option for 125,000 EUR was purchased for each of the 2,469 possible transactions, the total premium would have been 7,261,563 USD to hedge a total of 308,625,000 EUR accounts payable. The average cost to hedge 125,000 EUR was 2,931 USD. Using the average exchange rate of 1.3122 for the study period, the USD value of the 125,000 EUR hedge would have been on average 164,025 USD which calculates to premium costs of approximately 1.79% (2,931 USD/164,025 USD).

The buyer of a call option has the right but not the obligation to exercise the option. The buyer of the call option would only execute the option if execution provided financial gain. For this study, the EUR call option would only be executed when the current spot price of the EUR is above the strike price. The study shows that approximately, 49% of the call options would be exercised which means that approximately 51% of the options would not be exercised. The overall loss on this level of hedging would be 1,613,513 USD. The total value hedged would have been 308,625,000 EUR or using the average price of the EUR of 1.3122 USD, the value of the hedge would have been 405,022,488 USD. The overall loss for this hedging policy would have been .4% (1,613,513 / 405,022,488). During the study period an unhedged position would have netted 1,218,963 USD or .3% due to the overall movement of the EUR/USD during this time frame. Although the policy of hedging every EUR payable over this time frame would have resulted in a negative net transactional cost, the firm would have avoided 215 instances where the non-hedged position would have a currency exchange loss of greater the 5%. The company would have to consider the ramifications of a greater that 5% currency loss on 8.7% of its EUR payables transactions. Currency hedging instruments allow a company to better manage risk and predict cash flow and earnings. Studies have shown that a firm with a well-constructed currency management plan will likely improve its financial predictability and banking relations (Edens, 2010; Pérez-González & Yun, 2013; Wong, 2017).

The results of the analysis are consistent with previous option price research studies such as Charvin et al. (2014), and Vanderlinden (2014). The study shows that hedging every 60-day accounts payable transaction with a currency call option, during the study period, 2007 to 2016, will result in a negative net transactional benefit to a company.

Transition to hypothesis analysis. The findings illustrate, that EUR/USD currency fluctuations present financial risks to a firm even over a relatively short time frame such as is likely with a 60-day accounts payable. EUR/USD currency call options may be purchased as hedging instruments however, the premium to purchase the call options as the hedging instrument is more than the direct financial benefit of the hedge over the time frame of the study, 2007 to 2019. These findings are based on purchasing a currency call option for every potential 60-day accounts payable opportunity during the study time frame and are consistent with the findings of Hoque (2013).

Hypotheses H1. The null hypotheses $H1_0$ states that there is no statistically significant relationship between the independent variables of the EUR/USD exchange rate 60 days earlier (d-60) and the EUR/USD movement during the preceding 60 days (d-60 to d-120) and the dependent variable, the current EUR/USD (d) spot rate. In other words, the movement of the EUR/USD exchange rate prior to the issuance of a EUR payable has no predictive property for the movement of the EUR/USD after the issuance of a EUR payable. The alternative hypothesis $H1_a$ is that there is a statistically significant relationship between the independent variables of the EUR/USD exchange rate 60 days earlier (d-60) and the EUR/USD movement during the preceding 60 days (d-60 to d-120) and the dependent variable, the current EUR/USD (d) spot rate. The alternative hypothesis $H1_a$ would support a predictive property of prior EUR/USD movements towards future EUR/USD movements.

Using Excel's sample size calculator and the 3.83% EUR/USD currency price standard deviation, with a confidence level of 90% and a sampling error of .5% the result was a recommended sample every 13.5 records. The author rounded down and took a sample every 13 records resulting in a sample size of 242. The 90% confidence interval and equally spaced

sampling for time series data is supported by researchers such as Crowder (2014), Engle (2016), Kim and Jung (2018b), Dias and Embrechts (2010), and Kang et al. (2016).

The Minitab regression analysis using the EUR/USD as the dependent variable and the independent variables of the EUR/USD exchange rate 60 days earlier (d-60) and the EUR/USD movement during the preceding 60 days (d-60 to d-120) for n = 242, generated regression equation (1).

EUR/USD exchange rate = .1007 + 0.9199 d-60 exchange rate 60 days earlier (1)
+ 0.6613 exchange rate movement d-120 to d-60.

Equation 1 has an R squared of 93.5% and an adjusted R squared of 93.4%. Equation 1 had an n=242 with the sample starting on the January 19, 2007 and finishing on December 19, 2019. The analysis identified 18 records with unusual X values or with large residuals with 12 of those records associated with the period of the 2008 great recession and the beginning of the European debt crisis, and spans October 2008 to April 2009. The 2008 great recession and the European debt crisis created volatility in the exchange rate market explaining many of the unusual X values and large residuals. Table 7 shows data on the coefficients for (1).

Table 7

Descriptive Statistics for the Coefficients of (1), n=242, 2007 to 2019

Term	Coefficient	SE Coefficient	T-Value	P-Value
Constant	0.1007	0.213	4.72	0.000
d-60 Exchange Rate 60 days earlier	0.9199	0.0166	55.37	0.000
exchange rate movement d-120 to d-60	0.6613	0.0397	16.65	0.000

Given the relatively high value of R squared, the author choose to make no changes to the sample which means (1) includes the impact of the 2008 recession and the European debt crisis.

The regression analysis supports the rejection of the null hypotheses $H1_0$ which states that there is no statistically significant relationship between the independent variables of the EUR/USD exchange rate 60 days earlier (d-60) and the EUR/USD movement during the preceding 60 days (d-60 to d-120) and the dependent variable, the current EUR/USD (d) spot rate. The high R squared level indicates that the alternative hypothesis $H1_a$ which states that there is a statistically significant relationship between the independent variables of the EUR/USD exchange rate 60 days earlier (d-60) and the EUR/USD movement during the preceding 60 days (d-60 to d-120) and the dependent variable, the current EUR/USD (d) spot rate should be accepted.

The high R squared value indicates that (1) could possibly be successfully used to forecast the EUR/USD exchange rate, however from a business perspective the equation should be tested for its ability to predict the future directional movement of the EUR/USD from the current spot rate (Costantini et al., 2016; Sang, Cashel-Cordo, Rhim, & Jun, 2017). For this study, the author is examining the impact of EUR/USD movement upon 60-day EUR payables. When (1) predicts an appreciation of the EUR, then a firm should consider hedging the EUR payable. Conversely when (1) predicts a depreciation of the EUR then a hedge should not be pursued.

Equation 1 was tested for business validity by analyzing the predictions of (1) to initiate the purchase of EUR call options. When (1) predicted that the EUR would appreciate and thus cause a 60-day EUR payable to increase, an option would be purchased to hedge the transaction. No hedge would be put in place if (1) predicted a EUR depreciation. To validate (1), the author tested the equation in the complete dataset, which extends from January 1, 2007 to December 31, 2019. For example, on May 14, 2007, with the current spot rate of 1.3542 EUR/USD, (1) predicted that the rate in 60 days would be 1.3610, or an appreciation of the EUR, which would

indicate that a hedge should be put in place. The spot rate approximately 60 days later was 1.3803 EUR/USD. Equation 1 correctly predicted an appreciation of the EUR. However, on September 22, 2016 with a spot rate of 1.1207 EUR/USD, (1) predicted a EUR/USD rate of 1.1210 in 60 days, meaning that a hedge should be pursued. The spot rate approximately 60 days later was 1.0626 EUR/USD or a depreciation of the EUR. Equation 1 incorrectly predicted an appreciation of the EUR. Overall, (1) correctly predicted the movement of the EUR/USD 52% of the time when applied to the complete dataset. The author concludes that (1), with its high R squared value is fairly accurate in predicting the future value of the EUR/USD currency. The high R squared value is likely the reflection of the overall stability of the EUR/USD exchange rate. However, (1) is not useful in predicting the directional movement of the EUR versus the USD because the directional forecasting ability of (1) at 52% is not statistically better that a random model which would be expected to be approximately 50%.

Summary of Hypothesis H1. The regression analysis found a statistically significant relationship between the independent variables of the EUR/USD exchange rate 60 days earlier (d-60) and the EUR/USD movement during the preceding 60 days (d-60 to d-120) and the dependent variable, the current EUR/USD (d) spot rate, which means that hypothesis $H1_0$ is rejected. The regression equation developed to analyze hypothesis H1 fairly accurately estimates the future value of the EUR/USD exchange rate however, the equation is not effective in estimating the directional movement of the future exchange rate from today's spot rate. An accurate prediction of the directional movement is the critical element in determining when to purchase an option as a hedging instrument. For hedging 60-day payable transactions, the author concludes that using the regression equation based on historical movement of the EUR/USD

exchange rate, as a method to make hedging decisions does not result in improved business results when compared to hedging every transaction or even to no hedging at all.

Hypotheses H2. The null hypothesis $H2_0$ states that there is not a statistically significant relationship between the independent variables of interest rates and Brent Crude oil prices, and the dependent variable, the EUR/USD exchange rate. The alternate hypothesis $H2_a$ states that there is a statistically significant relationship between the independent variables of interest rates and Brent Crude oil prices, and the dependent variable, the EUR/USD exchange rate. The interest rate parity model is based on the financial theory that deposits earning interest in one country should earn the same level of return in another country (Engel, 2016). For example, if interest rates are higher in Europe than in the US, investors would move their deposits to Europe to earn the higher interest. This movement of currency would increase the demand and thus the price of EUR and decrease the demand and price of USD which means that US investors would pay a higher price for the EUR, thus negating the earnings from the higher interest rates. The interest rate parity model has been researched extensively, with studies both supporting and rejecting the interest rate parity model (Ardoin & Rodriguez, 2017; Bahmani-Oskooee et al., 2018; Chortareas, Kapetanios, & Magkonis, 2018; Engel, 2016; Ismailov & Rossi, 2018; Kim & Seol, 2016).

Research studies have identified a correlation between Brent crude oil prices and the EUR/USD exchange rate (Jawadi et al., 2016; Kim & Jung, 2018a; Mishler, 2017). The theory supporting the use of oil prices to estimate EUR/USD exchange rate movement is that because most of Europe imports oil, an increase in the price of oil harms the European economy. Additionally, oil is traded in USD, therefore when oil prices increase the European countries require more USD to purchase oil which increases the demand in Europe for USD. For this

study, the author used the Brent crude oil price as published by the US Energy Information Agency. The daily closing price was downloaded from the US Energy Information Agency website.

Using Excel's sample size calculator and the 3.83% EUR/USD currency price standard deviation, with a confidence level of 90% and a sampling error of .5% the result was a recommended sample every 13.5 records. The author rounded down and took a sample every 13 records resulting in a sample size of 242. The 90% confidence interval and equally spaced sampling for time series data is supported by researchers such as Crowder (2014), Engle (2016), Kim and Jung (2018b), Dias and Embrechts (2010), and Kang et al. (2016). The sample includes the EUR/USD exchange, interest rates, and oil prices for each date selected and will be used as the date for forecasting the movement of the EUR/USD exchange rate and when the decision has to be made on hedging a 60-day accounts receivable.

The Minitab regression analysis using the EUR/USD exchange rate as the dependent variable and FED daily interest rates, ECB daily interest rates and Brent crude oil prices as independent variables for n = 242 generated the equation shown below.

EUR/USD exchange rate = 1.0781 + .002323 Brent crude

- 0.02831 FED Daily Rate + 0.06613 LIBOR Daily Rate. (2)

Equation 2 has an R squared of 75.6% and an adjusted R squared of 75.3%. Equation 2 had an n=242 with the sample starting on the Jan 19 2007 and finishing on Dec 19 2019. In the analysis 22 records were identified with large residuals with all of those residuals occurring between record 1 and record 59. These large residuals are associated the period of the 2007/2008 great recession and the beginning of the European debt crisis, and spans January 2007 to January 2010. The 2008 great recession and the European debt crisis created volatility in the exchange

rate market explaining many of the large residuals. Table 8 shows data on the coefficients for (2).

Table 8

Descriptive Statistics for the Coefficients of (2), n=242, 2007 to 2019

Term	Coefficient	SE Coefficient	T-Value	P-Value
EUR/USD	1.0781	0.0158	68.44	0.000
Brent crude oil	0.002323	0.000182	12.73	0.000
FED daily rate	-0.02831	0.00434	12.73	0.000
LIBOR daily rate	0.06613	0.00410	16.14	0.000

To test possible improvements in the R squared for the forecasting equation, the volatile time frame was removed from the sample. The time period removed was from 2007 through 2010 which removes the recession of 2008 and the major events surrounding the European debt crisis from the sample. The new sample extends from 2011 to 2019 which was a time of stable economic conditions. The new sample size is 171 covering January 2011 through December 2019.

The Minitab regression analysis using the EUR/USD exchange rate as the dependent variable and FED daily interest rates, ECB daily interest rates and Brent crude oil prices as independent variables for n = 171 generated the equation shown below.

EUR/USD exchange rate = 1.0125 + 0.002750 Brent crude oil

- 0.00568 FED Daily Rate + 0.0767 LIBOR Daily Rate. (3)

Equation 3 has an R squared of 87.3% and an adjusted R squared of 86.9% with a sample size of 171 starting in January of 2011 and ending in December of 2019. The Minitab analysis shows

three observations with large residuals and four with unusual Xs. Because of the relatively high R squared the author did not make additional adjustments to the sample.

Table 9

Descriptive Statistics for the Coefficients of (3), n=171, 2011 to 2019

Term	Coefficient	SE Coefficient	T-Value	P-Value
EUR/USD	1.0125	0.0141	71.68	0.000
Brent crude oil	0.002750	0.000163	16.84	0.000
FED daily rate	-0.00568	0.00497	-1.14	0.254
LIBOR daily rate	0.0767	0.0120	6.39	0.000

The regression analysis supports the rejection of the null hypotheses $H2_0$ which states that there is not a statistically significant relationship between the independent variables of interest rates and Brent Crude oil prices, and the dependent variable, the EUR/USD exchange rate. The regression analysis supports the alternate hypothesis $H2_a$ which states that there is a statistically significant relationship between the independent variables of interest rates and Brent Crude oil prices, and the dependent variable, the EUR/USD exchange rate. For hypothesis H2 two regression equations were generated using Minitab, (2) and (3). Equation (2) was based on a sample size of 242 addressing January 2007 to December 2019 while (3) was based on a sample size of 171 addressing January 2011 to December 2019. Equation (2) has an R squared of 76% while (3) has an R squared of 87%. The higher R squared of (3) is supported by the removal of the volatility associated with the 2008 recession and the European debt crisis.

Equations (2) and (3) both show a statistical relationship between the independent variables of interest rates and Brent Crude oil prices, and the dependent variable, the EUR/USD exchange rate. However, both (2) and (3) are measuring the statistical relationships of the

current interest rates and the current Brent crude oil prices to the current EUR/USD spot rate. The regression models were not initially developed to test the relationships of the historical movements of interest rates and Brent crude oil prices, the EUR/USD exchange rate 60 days in the past and the current spot rate. The regression models must be revised to create a model that can be tested for the capability to predict future EUR/USD directional movements.

The author used a similar approach and terminology used in Hypothesis H1 to analyze the ability of the independent variables used in H2 to predict the directional changes of the EUR/USD currency movements. The author will test the statistical relationships between the independent variables of the exchange rate 60 days in the past, the movement of interest rates from 120 days past to 60 days past and the movement of Brent crude oil prices from 120 days past to 60 days past. The regression model will be limited to the post 2008 recession and the European debt crisis so the analysis will be from 2011 to 2019. The author chose this time frame to give the analysis the best chance to show prediction capabilities. The regression model forecasts the exchange rate today based on the exchange rate 60 days ago (d-60), impacted by the movement of interest rates from 120 to 60 days ago (d-120 to d-60) and the movement of Brent crude oil prices from 120 to 60 days ago (d-120 to d-60). The regression equation is shown below.

EUR/USD Exchange Rate = 0.1050 + 0.9104 Exchange rate d-60

+ 0.001117 d-120 to d-60 change in Brent crude oil

- 0.0004 d-120 to d-60 change in the FED rate

+ 0.0062 d-120 to d-60 change in LIBOR rate. (4)

Equation (4) has an R squared of 89% which indicates a statistical relationship between the independent variables and the dependent variable the EUR/USD exchange rate. Table 10 shows the descriptive statistics for (4).

Table 10

Descriptive Statistics for the Coefficients of (4), n=171, 2011 to 2019

Term	Coefficient	SE Coefficient	T-Value	P-Value
Constant	0.1050	0.0322	3.26	0.001
EUR/USD exchange rate d-60	0.9104	.0260	35.08	0.000
Brent crude oil change d-120 to d-60	0.001117	0.000315	3.54	0.001
FED interest rate change d-120 to d-60	-0.0004	0.0258	-0.01	0.988
LIBOR interest rate change d-120 to d-60	0.0062	0.0210	0.293	0.770

The high R squared value indicates that (4) could possibly be successfully used to forecast the EUR/USD exchange rate, however from a business perspective the equation should be tested for its ability to predict the future directional movement of the EUR/USD from the current spot rate (Costantini et al., 2016). For this study, the author is examining the impact of EUR/USD movement upon 60-day EUR payables. When (4) predicts an appreciation of the EUR, then a firm should consider hedging the EUR payable. Conversely, when (4) predicts a depreciation of the EUR then a hedge should not be pursued.

Equation 4 was tested for business validity by analyzing the predictions of (4) to initiate the purchase EUR call options. When (4) predicted that the EUR would appreciate and thus cause a 60-day EUR payable to increase, an option would be purchased to hedge the transaction. No hedge would be put in place if (1) predicted a EUR depreciation. To validate (4), the author tested the equation against the time period of January 1, 2011 to December 31, 2019 because this was the time period for the development of the regression model. Overall, (4) correctly

predicted the movement of the EUR/USD 54% of the time. The author concludes that (4), with its high R squared value is fairly accurate in predicting the future value of the EUR/USD currency. The high R squared value is likely as the reflection of the overall stability of the EUR/USD exchange rate. However, (4), is not useful in predicting the directional movement of the currency. Additionally, (4) correctly predicted only 51 of the 117 times the EUR appreciated over 5% during the study time frame from January 1, 2011 to December 31, 2019.

Summary of Hypothesis H2. The regression analysis found a statistically significant relationship between the independent variables of the EUR/USD exchange rate, Brent crude oil prices, the FED daily interest rate and the LIBOR daily interest rate. The regression equation developed to analyze hypothesis H2 fairly accurately estimates the future value of the EUR/USD exchange rate however, the equation is not effective in estimating the directional movement of the future exchange rate from today's spot rate. An accurate prediction of the directional movement is the critical element in determining when to purchase an option as a hedging instrument. For hedging 60-day payable transactions, the author concludes that using the regression equation as a method to make hedging decisions does not result in improved business results when compared to hedging every transaction or even to no hedging at all.

Summary of the Presentation of Findings. This paper pursues the answers to two research questions and the testing of two hypotheses. The first research question was; does the 60-day fluctuation of the EUR/USD exchange justify the consideration of taking actions to address this currency risk? A statistical analysis of the fluctuation of the EUR/USD currency exchange rate indicates that a hedging strategy should be considered when entering into contracts with a EUR payable.

The second research question was; does using a multiple linear regression analysis of the Euro/USD currency fluctuations to trigger the purchase of Euro/USD options provide a favorable financial benefit? The analysis of this question included two hypotheses. The first null hypothesis $H1_0$ states that there is no statistically significant relationship between the independent variables of the EUR/USD exchange rate 60 days earlier (d-60) and the EUR/USD movement during the preceding 60 days (d-60 to d-120) and the dependent variable, the current EUR/USD (d) spot rate. The author found that there was a statistically significant relationship between the independent and dependent variables for H1. The analysis supported the alternative hypothesis $H1_a$ which that there is a statistically significant relationship between the independent variables of the EUR/USD exchange rate 60 days earlier (d-60) and the EUR/USD movement during the preceding 60 days (d-60 to d-120) and the dependent variable, the current EUR/USD (d) spot rate. The null hypothesis $H2_0$, is that there is not a statistically significant relationship between the independent variables of interest rates and Brent Crude oil prices, and the dependent variable, the EUR/USD exchange rate. The corresponding alternative hypothesis H2a, is that there is a statistically significant relationship between the independent variables of interest rates and Brent Crude oil prices, and the dependent variable, the EUR/USD exchange rate (Plakandaras et al., 2015). The analysis indicated that there is a statistically significant relationship between the independent variables and the dependent variable for H2. The analysis shows support for $H2_a$.

Proceeding with the pursuit of the answer to question 2, the author used the regression models generated in the analysis of H2 to determine if using a multiple linear regression analysis of the Euro/USD currency fluctuations to trigger the purchase of EUR call options provides a favorable financial benefit. The analysis found no transactional net benefit for using the

regression models as a basis for purchasing EUR call options. Other researchers such as Bayas (2019) have developed regression models that generate financial benefit, however those other models have different study criteria such as the use of 30 day average EUR/USD exchange rates, 30-day payables, and different time frames such as five years. For this study, the author used daily exchange rates because a payable is created on a particular day, 60-day payable due dates because that number of days in supported by academic research, and a 13-year time frame to capture multiple economic conditions.

These finding supports the weak model of efficient market hypothesis. Regarding the second research question, the research findings suggest that using a multiple linear regression analysis of the Euro/USD currency fluctuations to trigger the purchase of Euro/USD options does not provide a favorable financial benefit?

Application to Professional Practice

Treasurers, Finance and Purchasing Executives. The international market is a large and growing part of the U.S. economy and with this growing market comes increased foreign currency fluctuation risks (Abreu et al., 2019; Bayas, 2018; Dinu, 2018; Opie & Dark, 2015). Firms are entering into contracts with foreign suppliers to reduce costs, take advantage of international skills and capabilities, and meet obligations for host country sourcing requirements. These international contracts may require payments to be made in foreign currencies which introduces foreign currency exchange rate risks to the firm.

The first research question was; does the 60-day fluctuation of the EUR/USD exchange justify the consideration of taking actions to address this currency risk? This paper statistically analyzed the exchange rate fluctuations, from 2007 to 2019, for the highest traded currency pair, the EUR/USD (Li et al., 2013). The findings show that EUR/USD currency fluctuations, even

over the relatively short time frame such as 60-days, are large enough to justify consideration of a hedging strategy. The statistical analysis shows that from January 2, 2007 to December 31, 2019, the average 60-day change in the EUR/USD exchange rate was minus 0.13%. During this timeframe, on average, the EUR was depreciating. The standard deviation of the 60-day change was 3.83% with a maximum depreciation of the EUR versus the USD of 15% and a maximum appreciation of 12%. A firm could expect that 32% of the time the variance of 60-day accounts payable would be higher than 3.83%. In the worst-case scenario, during the study period, a firm could have incurred an increase of 12% in expense for a payable liability over a 60-day period. This research shows agreement with Bessler et al. (2019), Crowder (2014), Frishberg and Gobble (2013), and Mishler (2017) that foreign currency exchange rate risk is significant and that hedging should be considered for this risk even considering a relatively short timeframe such as 60-days. Bessler et al. (2019) found that firms hedging currency risks have improved firm value creation.

In dichotomy to the research studies supporting hedging foreign currency risks, firms may choose not to hedge foreign exchange rate risks. The use of hedging instruments adds costs and possibly staff with the expertise to develop and execute the hedging plan. Firms may also create a natural hedge for a foreign currency payable by selling goods and services in the same foreign currency. As this research study shows, the net impact of the EUR/USD movement was a slight improvement in the financial results, which indicates that over the longer-term EUR/USD exchange rate variations may have little impact on the financial results.

The paper also examines the use of EUR call options to hedge a 60-day EUR payable. The structure of a call option is that the buyer of the option has the right but not the obligation to exercise the option. To analyze the hedging of every payable created during the study time

period, the author assumed that the firm purchased a call option with a strike price closest to the current spot price and an expiration closest to 60-days as available in the options marketplace. The study shows that approximately, 49% of the call options would be exercised which means that approximately 51% of the options would not be exercised. Options are only exercised when the option has a positive transactional benefit. The overall loss for this hedging policy would have been 0.4%, compared to 0.3% gain from an unhedged position. Although the policy of hedging every EUR payable over this time frame would have resulted in a negative net transactional cost, the firm would have avoided 241 instances where the non-hedged position would have a currency exchange loss of greater the 5%. Treasury, finance and purchasing executives have to consider the ramifications of a greater that 5% currency loss on 8% of the EUR payables transactions. Research has shown that companies with a strategic currency management plan will improve financial predictability and banking relations (Edens, 2010; Pérez-González & Yun, 2013; Wong, 2017).

The second research question was; does using a multiple linear regression analysis of the Euro/USD currency fluctuations to trigger the purchase of Euro/USD options provide a favorable financial benefit? The research shows that there is not a multiple linear regression model based on historical 60-day currency movements that can be used to accurately forecast the future 60-day directional movement of the EUR/USD exchange rate. Using a regression equation based on historical EUR/USD movements to forecast future 60-day currency movements, to trigger the purchase of EUR options, does not result in a statistically better financial result than purchasing EUR options for every transaction.

The research also shows that there is not a multiple linear regression model based on 60-day interest rate and Brent crude oil price movements that can be used to predict the future

directional movement of the EUR/USD. Using a regression equation based on interest rates and Brent crude oil price movements to forecast 60-day EUR/USD currency movements, to trigger the purchase of EUR options, does not result in improved financial results versus a strategy that uses EUR options to hedge every payables transaction. Bayas (2019) found that a multiple linear regression model based on 30-day EUR/USD currency exchange rate averages and 30-day movements, generated positive economic benefit.

For treasury, finance, and purchasing executives and managers this study shows that the EUR/USD does fluctuate over a 60-day time frame with enough volatility to justify the consideration of a hedging strategy. The study also shows that currency options can be used to hedge the currency risk however, the cost of the hedge is greater than the net benefit. During the study time frame from 2007 to 2019, a firm which did no hedging would have experienced a 0.3% currency gain on a 60-day accounts payable. A firm using a EUR option to hedge every payables transaction would have experience a 0.4% overall loss on currency movement due to the premium (cost) of the hedging instrument which agrees with the findings of Bayas (2019). However, a firm using options to hedge the EUR/USD currency risk could have benefited from more consistent financial reporting and cash flow (Edens, 2010; Wong, 2015).

Biblical Framework. Through His holy scriptures, God gave mankind two guidelines for how to conduct business: ethical service to others and stewardship of God's creation. 1st Peter 4:9-11 says that "Each of you should use whatever gift you have received to serve others, as faithful stewards of God's grace in its various forms" (NIV). In Genesis 1 26:28, when describing the creation of man, God says "Let us make man in our image, after our likeness. And let them have dominion over the fish of the sea and over the birds of the heavens and over the livestock and over all the earth and over every creeping thing that creeps on the earth" (ESV).

Through these and other Biblical passages, God gave mankind the responsibility of stewardship over the creatures of the earth and over the earth itself. A steward is defined as a person who acts as the surrogate of another or others with the responsibility of managing and protecting such things as property, financial assets, investments and other items of value (Pirie & McCuddy, 2007). A steward overseas the interests of stakeholders over the long run and seeks to maximize the real worth of the entrusted resources (Liang, 2011).

The current stewardship model for business proposes the purpose of business is to serve, the practice of business should follow positive ethics, and business should act in partnership with other social institutions (Karns, 2016). The Biblically centered stewardship of resources will be appreciated by stakeholders as the firm focuses on protecting its resources (Iheanyi-Igwe & Veach, 2019; Saunders, 2016).

When conducting business on an international basis and transacting in foreign currency the organization is taking a risk on foreign currency fluctuations. The analysis in this paper indicates that even the highest traded currency pair, the EUR/USD, has enough volatility to warrant consideration of a hedging strategy. A firm's treasurer, finance and purchasing leadership should consider the variability of the EUR/USD exchange rate when planning the business. The analysis further indicates that correctly predicting the directional movement of the EUR/USD is not possible using historical data. A good steward should consider a risk mitigation plan to reduce the risk of exchange rate fluctuations. The use of options to hedge currency risks protects the financial assets of the organization and may improve stakeholder well-being by smoothing cash flow and income which allow the organization to better plan its activities. As Proverbs 14:15 says "the simple believe anything, but the prudent give thought to their steps" (NIV). Treasurers, financial and purchasing executives as good stewards should carefully

consider the steps they take in addressing exchange rate risks contained in the firm's contracts even over the relatively short such as experienced with payables.

Recommendations for Action

The results of this study indicate that a firm should recognize the exchange rate risks it may be establishing within 60-day EUR or USD payables contracts. The EUR/USD exchange rate, over the study time frame, 2007 to 2019, had a standard deviation of 3.83% with a maximum depreciation of the EUR versus the USD of 15% and a maximum appreciation of 12%. In the worst-case scenario a firm could have incurred an increase of 12% in expense for a EUR payable liability over a 60-day period. This research shows agreement with Bessler et al. (2019), Crowder (2014), Frishberg and Gobble (2013), and Mishler (2017) that foreign currency exchange rate risk is significant and that hedging should be considered for this risk even considering a relatively short timeframe such as 60-days. Treasurers, finance and purchasing executives should make employees, especially buyers, aware that currency volatility could impact the firm's financial results and that risk mitigation actions such as currency hedging should be considered (Bessler et al., 2019). Both the USD and the EUR are considered as reliable, stable currencies yet the EUR/USD exchange rate has demonstrated significant volatility.

As a hedging strategy, treasurers and finance professionals may make use of currency options. Currency options have a great deal of flexibility because the buyer of an option has the right, but not the obligation, to exercise the option (VanderLinden, 2014). The buyer of an option only exercises the option when there is financial benefit. Option contracts may be used to protect the firm from downside risks however, this protection does have a cost through the premium that is charged for the purchase of an option. Treasurers and financial professionals

may also consider other options for hedging EUR/USD currency risks such as futures, forwards, advanced payments, deposits and selling product into the other currency regime.

When negotiating contracts which require foreign currency payments, supply chain management professionals must recognize the volatility of the EUR/USD exchange rate and notify and work with their finance counterparts to develop a hedging strategy. Then the financial implications of the hedging strategy should be included as part of the supplier selection process. The analysis indicates that the cost of hedging a foreign currency risk should be considered when comparing domestic versus foreign suppliers. This study indicates that the premium for purchasing EUR call options is approximately 1.8% which could be incorporated into a firm's supplier evaluation process. The USD and the EUR are highly traded currencies and as such the premium for purchasing call options is likely lower that for other currencies. Therefore, supply chain professionals may need to research the costs of hedging other currencies when analyzing and negotiating supply contracts.

Recommendations for Further Study

The research and findings in this study add to the current literature regarding the exchange rate risks associated with 60-day foreign currency payables and the use of options to hedge shorter-term exchange rate risks. Research studies by Charvin et al. (2014), Chen et al. (2019), Ardoin and Rodriguez (2017), and Spreckelsen et al. (2014) identified research gaps in the relatively short term frame of previous exchange rate studies and the use of theoretical option prices instead of market based option prices. The research in this study covers a relatively long time frame, 13 years of EUR/USD exchange rate data, and uses market price data for calculating the financial benefit of the use of options for hedging exchange rate risk. The following are recommendations for further study.

First, for forecasting the EUR/USD exchange rate movement the use of data regarding the EUR/USD futures market and/or EUR/USD options market could be included as additional independent variables in the regression modeling. By including EUR/USD futures market and/or EUR/USD options market data, the regression models could possibly be improved as the models could capture market sentiment from market participants. The market participants through their EUR/USD futures or options purchasing actions could be indicating the future directional movement of the EUR/USD exchange rate. For example, if the futures market data indicates that market participants expect the EUR to appreciate against the USD, then this indicator could be incorporated into the regression modeling. The same logic applies for incorporating data from market participants in the EUR/USD options market.

Second, for forecasting the EUR/USD exchange rate movement the use of interest rate or Brent crude oil futures or options could incorporated as additional independent variables. This futures and/or option pricing data would incorporate market sentiment from market participants which could possibly improve the regression modeling of the future EUR/USD direction movement. Additionally, gross domestic product (GDP) growth data could possibly be added as an independent variable to improve the capability of the models to predict the directional movement of the EUR/USD.

Third, the focus of this study has been on the highest traded currency pair, the EUR/USD. Additional research into the movement of other currency pairs add to the existing research. Research into other highly traded currency pairs such as the USD and the Chinese Yuan (CNY), the USD and the Great British Pound (GBP) and the CNY and the EUR would expand the literature on exchange rate modeling.

Lastly, the criteria of the currency option selection could be varied. In this study the author choose the option with the strike price closest to the current spot price which impacts the cost of the option. An option sectional criterion that accepts more risk but searches for options with lower premiums may provide a lower cost hedging methodology. For example, a hedger could choose an option that limits the risk to 5% which would likely reduce the cost of that option.

While larger multinational companies often have the capability to create foreign currency exchange rate hedges by selling or purchasing in the opposite currency and depositing cash or taking loans in the foreign currency. Small companies may not have these capabilities and would benefit by the development of a statistically significant prediction model which incorporates the additional variables mentioned in this section on recommendations for future studies.

Reflections

As with every endeavor, a quality process and robust results, are the goals of research studies. From the inception of the research question, to data collection, to analysis and presentation of the research findings, the researcher should strive for high quality (Ali & Yusof, 2011). Both the qualitative and the quantitative researcher should examine themselves for the biases, values and experiences they are bringing to the research findings and interpretations (Creswell & Poth, 2018). All researchers should strive to take the information as it unfolds and avoid bending the information to confirm a preconceived idea. When I originally started this study, I believed that an analysis of historical data for the selected variables could be used to accurately predict the directional movement of the EUR/USD however, the data analysis and

regression modeling did not support this belief. The author used quantitative data analysis techniques to avoid false confirmation of the preconceived ideas.

The demonstration of reliability and validity of a research study is part of the overall determination of the quality of the research. Keller (2012) wrote that "there may be no better way to love your neighbor, whether you are writing parking tickets, software, or books that to simply do your work. But only skillful, competent work will do" (p. 67). The researcher should ensure skillful and competent work is taking place. According to 2nd Chronicles 2, when building the temple, King Solomon hired Huram who was able to make all kinds of engravings and was able to execute any design assigned to him and he was capable to work with the skilled workers assigned to build the temple (NIV). The Bible emphasizes skilled workmanship in building the temple, King Solomon's house, and the building and rebuilding of the wall around Jerusalem. Skilled craftsmen are known for their quality and productivity, for producing beautiful works, pleasing to their customers. The Christian worker should recognize that work is ultimately an act of worship to the God who equipped them to do the work (Keller, 2012). Christians should think deeply about the work they are doing and the products they are delivering and does this work and product honor God (Keller, 2012). Colossians 3:23 says that "whatever you do, do your work heartily, as for the Lord rather than for men" (NASB). Pursuing quality, productivity, and continuous improvement would seem to be doing work heartily for the Lord. Throughout this research study the author has endeavored to work to high quality and validity standards.

Persistence to completion of this research study, has been an issue for the author which is a common issue for doctoral students. In a research study, Barclay (2013) found that doctoral students in the US tend to progress well while in classes because of the requirements of meeting

due dates and submitting class assignments. Additionally, during classes the student benefits from the support of cohorts, colleagues, and family. However, once the dissertation process starts the student's support group may be reduced as the cohort disbands and each of the students follow their own dissertation topics and schedules (Barclay, 2013). The motivation to complete the grind of the dissertation process can decline as time slips by and other issues pop up. In an effort to stay motivated to persist to completion of the research study the author: chose an interesting research topic, worked to complete the intermediate milestones contained in the Liberty University dissertation classes, and celebrated progress with the author's support group.

Summary and Study Conclusions

In this study, which includes 13 years of data, the author examined the variability of the EUR/USD exchange rate during a 60-day period. The EUR/USD is one of the top currency pair used in international trading (Galeshchuk & Mukherjee, 2017). The author found that the 60-day EUR/USD exchange rate movement resembles a bell-shaped curve with a standard deviation of 3.83%, with a maximum depreciation of the EUR of 15% and a maximum appreciation of 12%. These findings suggest that a company should consider the currency risk exposure in payables involving EUR/USD currency conversion. This research is in agreement with Bessler et al. (2019), Crowder (2014), Frishberg and Gobble (2013), and Mishler (2017) that foreign currency exchange rate risk is significant and that hedging should be considered for this risk even considering a relatively short timeframe such as 60-days.

The author constructed multiple linear regression models using historical exchange rate movement data and using historical interest rate and Brent crude oil price movements. The linear regression models were statistically significant in the prediction of the 60-day position of the EUR/USD exchange rate. However, the models did not provide statistically significant

directional movement predictions. The regression models had a high R-squared coefficient, due to the fairly stable EUR/USD rate, thus a prediction of, for example, of a -1% change when the actual change is +1% change, while fairly accurate, results in a loss to the company that could have been prevented. This result, that historical data alone, is not capable of predicting EUR/USD exchange rate directional movement, is consistent with the weak-form of the efficient market hypothesis.

The author also studied the use of EUR call options to hedge a 60 day EUR payable. Consistent with option pricing theory the premium on EUR call options increased during the 2007/2008 global financial crisis. Financial option prices increase during times with high levels of volatility. The author found that the premium for purchasing EUR call options is approximately 1.8% of the value of the contract. The premium on the option could be incorporated into a firm's supplier evaluation process. The USD and the EUR are highly traded currencies and as such the premium for purchasing call options is likely lower that for other currencies. Therefore, supply chain professionals may need to research the costs of hedging other currencies when analyzing and negotiating supply contracts. The author found that hedging every 60-day payable with a EUR call option from 2007 to 2016, would have resulted in an approximate 0.7% loss compared to an unhedged position. However, the overall financial results would have been smoothed and more consistent with avoidance of 241 instances where the non-hedged position would have a currency exchange loss of greater the 5%.

The findings in this study can be used by finance and purchasing managers to consider the implications of contracts which require payment involving EUR/USD currency exchange. Additionally, this findings add to the current literature by studying the EUR/USD currency

fluctuations over a 13 year time frame with various economic conditions and the study of EUR/USD currency options using market based prices and a long term study time frame.

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