AN EXAMINATION OF ALTERNATIVE TRADING TECHNIQUES USING INTRADAY EUR/USD CURRENCY PRICES

by

Brock Vaughters

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Business Administration

Liberty University

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Abstract

Global financial institutions provide a mechanism for multinational corporations to hedge against exchange rate risk via currency futures contracts and spot exchange rates. Currency managers working at these global financial institutions overseeing EUR/USD spot currency traders lack adequate data to determine if alternative trading tools could increase net gains for their respective firms. The purpose of this quantitative study was to examine the net gains from alternative trading techniques that can be utilized by currency managers working for international banks and hedge funds when trading the EUR/USD currency on an intraday basis. A buy and hold strategy, sell and hold strategy, and a Bollinger Band strategy were applied to tick level sample data gathered from 2009 to 2016 to determine net gains from each strategy. The results of an ANOVA test indicate there is a statistically significant difference, however the Bollinger Band strategy produced an overall net loss from trading. The findings suggest that using an alternative trading strategy, Bollinger Bands, on an intraday basis does not increase net gains from trading activity.

Key words: Currency trading, intraday, alternative trading, Bollinger Bands

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Section 1: Foundation of the Study

In this paper, the researcher examined the net gain and losses of currency transactions using technical trading tools that international banks and hedge funds can employ to positively impact currency trading activities. The currency transactions that were studied are concentrated on the EUR/USD, a major currency pair as determined by trading volume and will be used in conjunction with the technical trading tool known as the Bollinger Band. Usage of alternative trading strategies by financial firms has been researched extensively in the stock market and futures market (De Bondt & Thaler, 1985; Duvinage, Mazza, & Petitjean, 2013; Hong & Stein, 1999; Kudryavtsev, Cohen, & Hon-Snir, 2013; Lakonishok, Shleifer, & Vishny, 1994; Lo, 2004). Much of the existing research in the currency markets uses end-of-day prices or weekly prices to determine the effectiveness of alternative trading strategies to produce positive net gains in the foreign exchange market. However, the use of Bollinger Bands as a means to increase the net gain of currency trades made by trading teams working for global financial firms have been scarcely researched. Additionally, no previous research has been found which focuses on both Bollinger Bands and intraday currency trading.

Background of the Problem

Global commerce continues to expand as many countries implement the fundamental ideas of open markets and free trade (Cetorelli & Goldberg, 2012; Meschi, Taymaz, & Vivarelli, 2016). The global expansion has been aided by advances in technology and communication systems that allow companies to access information from around the world almost instantaneously (Edoho, 2013). A key factor that supports global commerce is a well-functioning currency market (Opie & Dark, 2015). Specifically, currency markets provide a mechanism for converting the profits made in a local currency into home country monies

(Allayannis, Ihrig, & Weston, 2001). Currency markets, country-specific monetary policy, and international banks all work together to support the growth of global commerce by servicing global companies and their needs to conduct business in local currencies (Chong, Chang, & Tan, 2014; Georgiadis, & Mehl, 2016). It is this need for local currencies that may expose international firms to exchange rate risk (Siow, 2013).

Transaction risk, commonly known as exchange rate risk, is a major factor in determining the exposure that companies have to currency volatility (Dhargalkar, 2015). Transaction exposure is common to all international firms that enter into contracts that obligate the making of payments or the receiving payments in foreign currencies (Khindanova, 2015). The movement of currency values makes it difficult for a company to accurately predict their expenses or liabilities in other countries and the profit that foreign subsidies earn in the originating country's currency (Song, 2015). Consequently, the fluctuation of foreign exchange rates should be addressed by multinational corporations to reduce risk in global transactions.

The challenge for many international firms is that currency markets are essential in the conducting business transactions but are also a source of volatility and risk for all participants (Wong, 2016). Global financial institutions provide a mechanism for multinational corporations to hedge against exchange rate risk via currency futures contracts and spot exchange rates (Chien, Lee, Tai, & Liao, 2013). Global financial institutions can take on the role of broker, dealer, and speculator. As a broker or dealer, financial institutions sell currency derivative products, for a fee, to their clients who need to hedge against transaction risk (Kamau, Inanga, & Rwegasira, 2015). International financial institutions and hedge funds also speculate in currency markets as a means to increase profits of their existing currency positions (Aktan, Chan, Žiković, & Evrim-Mandaci, 2013; Shen & Hartarska, 2013). The role of currency traders, whether they

are working for multinational financial institutions or hedge funds, is to engage in currency activities that increase the net gain per currency transaction for their respective firms (Fiedor & Holda, 2016; Kamau et al., 2015).

Currency traders working for international banks and hedge funds use both fundamental analysis and technical analysis when engaging in currency transactions (Eiamkanitchat, Moontuy, & Ramingwong, 2017). Fundamental analysis, in the context of currency trading, involves macro-level factors such as interest rate movements, default risk, budget surpluses and deficits, and government manipulation (Abby & Doukas, 2015; Bitvai & Cohn, 2015; Kim & Song, 2014). Technical analysis or chart analysis is based on past price movements, volume, and a number of specific trading rules (Metghalchi, Kagochi, & Hayes, 2014). Several researchers (Kuang, Schroeder, & Wang, 2014; de Zwart, Markwat, Swinkels, & Van Dijk, 2009) show that combining technical trading rules and fundamental analysis can improve the net gain of currency trading activities. Technical analysis tools such as the Bollinger Bands can be used by currency traders and may support increased net gains realized from their foreign exchange trading activity (Coakley, Marzano, & Nankervis, 2016; Chen, Chen, & Chuang, 2014; Lubnau & Todorova, 2015).

Problem Statement

International financial institutions and hedge funds utilize multiple methods to support the trading activities of their currency traders (Thinyane & Millin, 2011). Two of the most common methods are fundamental analysis and technical analysis (Chen et al., 2014; Eiamkanitchat et al., 2017). Several researchers have indicated that financial firms that utilize alternative trading tools can potentially increase the net gain from trading activities (Savin, Weller, & Zvingelis, 2007; Zarrabi, Snaith, & Coakley, 2017). Other researchers argue that net

gains generated using alternative trading techniques are inconclusive activities (Coakley et al., 2016; Hsu & Taylor, 2013; Kuang et al., 2014; Neely & Weller, 2003). These contradictory findings leave currency managers uncertain of the effectiveness of alternative trading strategies to improve net gains from currency trading activities (Duvinage et al., 2013; El Ouadghiri & Uctum, 2016; Galariotis, 2014).

The general business problem was that international financial institutions were not utilizing alternative trading tools which could potentially result in net trading gains for the firm due to the inconclusive evidence from researchers. The specific business problem was some currency trading managers overseeing EUR/USD spot currency traders lack adequate data to determine if alternative trading tools could increase net gains.

Purpose Statement

The purpose of this quantitative study was to examine the net gains from alternative trading techniques that can be utilized by currency managers working for international banks and hedge funds when trading the EUR/USD currency on an intraday basis. The results may provide additional insights for currency managers with regards to the use of alternative trading strategies on an intraday basis within the currency markets. The findings of the research may have a direct application to the business problem of increasing the net gain from foreign currency transactions undertaking by currency management teams and currency traders within global financial institutions and hedge funds. Also, this examination will add to the current literature on technical analysis and help fill in the gap with regards to intraday time frames.

Nature of the Study

Discussion of method. There are three core research methods available for the research to choose from: the qualitative method, the quantitative method, and the mixed method. When

conducting a study, the researcher needs to identify and select the research methodology that will align with and support the research questions (Yin, 2006). Therefore, determining the proper research method at the beginning of this study helps to ensure that all the information supports the research questions.

Qualitative method. Qualitative research is a method that has a "reliance on human perceptions and understanding" (Stake, 2010, p. 11). Scholars using qualitative research often attempt to explain a particular social behavior or way of thinking (Yin, 2011). Multiple sources of data can be collected in the qualitative research approach to explore the specific context that may help explain a particular observed behavior (Creswell, 2014). Researchers using a qualitative study approach seek to contribute insights from existing concepts or attempts to develop new concepts (Yin, 2011). Qualitative research was not an appropriate research method for the problem identified because analyzing personal experiences would not be appropriate to address the research questions.

Mixed method. The mixed method approach incorporates both qualitative and quantitative research methods. Researchers employing a mixed method approach attempt to provide a more thorough and complete understanding of the research problem by those employing this method (Stake, 2010). By combining both methods, the researcher hopes to gain greater clarity than either the qualitative or the quantitative approach can provide on their own (Creswell, 2014). The mixed method approach was not an appropriate research method for the problem identified in this study. The qualitative portion of the mixed method would not be appropriate to address the research questions.

Quantitative method. Researchers using quantitative studies seek to examine various hypotheses by testing the relationship between numerical variables (Creswell, 2014).

Quantitative researchers tend to gather objective, historical, numerical sample data and then analyze these sample sets using statistical tools. Researchers then gain insights based on the results of the statistical analysis (Stake, 2010; Yin, 2011). The quantitative research method supports the nature of the data collected for this study. More importantly, since the purpose of this research is to determine if there is any correlation between net gain within foreign exchange transactions and various trading techniques, the quantitative research method will be used (Creswell, 2014).

Discussion of design. There are multiple research designs used in quantitative research: experimental, quasi-experimental, descriptive, and correlation. Selecting the appropriate research design is important to ensure the research question is addressed. Choosing a proper research design will depend upon the problem to be addressed, the research questions, and the nature of the data available (Parylo, 2012).

***Experimental and quasi-experimental*.** Researchers using experimental and quasi-experimental design strive to conclude if a specific treatment (independent variable[s]) can influence the result (dependent variable) of a specific test. Experimental research can be accomplished when a researcher provides a specific treatment to one group and withholds the treatment from another group to determine how both groups performed during the experiment (Creswell, 2014). Experimental design is the only research approach that can support a direct cause and effect relationship given that researchers can manipulate and control certain variables in the testing (Cash, Stankovic, & Storga, 2016). Experiments can further be broken down into quasi-experiments, which use non-randomized sample sets to make inferences about the population, and true experiments, which use randomized sample sets to make inferences about the population (Keppel, 1991). The key factor in experimental design is the use of a control

variable. Due to the inability to control and manipulate independent variables, neither the experimental design nor the quasi-experimental design was selected for this study.

Descriptive. Descriptive research design within quantitative methods seeks to describe and explain what is occurring. Surveys and other observational data gathering tools are often used in descriptive statistics, but no attempt is made to control or influence any variables (Spector, Merrill, Elen, & Bishop, 2013). This research design was not selected given that the variables and data used in this study have already been defined and described.

Correlation. Correlation research design typically uses sample data gathered from a population to determine if there is any relationship between the variables being tested (Cash et al., 2016). Additionally, within correlation studies, there is no attempt by the researcher to control any variables used in the study (Meyers, Gamst, & Guarino, 2016). Sample data for this study were gathered from foreign currency markets over an eight-year period, and no attempt to control any of the variables in the sample set were made. The dependent variable, the net gain from trades, has been documented by several other researchers (Menkhoff & Taylor, 2007; Metghalchi et al., 2014; Bitvai & Cohn, 2015). Three different trading techniques were the independent variables. These techniques were applied to the data to determine if a specific trading technique had a higher positive correlation with net gains and to determine if there was a statistical difference between the different group means. Given the nature of the data and problem statement, conducting a correlation study was justified as the purpose of the study was to determine if there was a relationship between net gain and two different trading strategies.

Summary of the Nature of the Study

In summary, the focus of this research is to examine if currency trading managers at international banks and hedge funds experience a greater net gain from currency transactions

when employing a traditional trading approach (long and short strategies) as compared to an alternative trading strategy when trading the EUR/USD spot market on an intraday period. A quantitative study was selected for this study to examine the relationship between net gain from currency trading and alternative trading strategies using Bollinger Bands. Net gains from trading will be the dependent variable. The traditional trading strategy of buy and hold, a strategy of shorting the EUR/USD, and the alternative trading strategy will be the independent variables. Net gains as a dependent variable are documented by other researchers (Menkhoff & Taylor, 2007; Metghalchi et al., 2014; Bitvai & Cohn, 2015). These variables relate directly to the specific problem to be addressed in this study, which is some managers of currency traders are unclear if using alternative trading strategies on an intraday basis can increase the net gains from currency trading.

Research Questions

Research Question 1: Do currency trading managers at international banks and hedge funds experience a difference in net gain from currency transactions when employing a traditional trading approach as compared to an alternative trading strategy when trading the EUR/USD spot market on an intraday period?

Hypotheses

Null and Alternative Hypotheses for Research Question 1:

$H1_0$: There is no statistically significant difference between net gains generated and the use of an alternative trading strategy on an intraday basis for the EUR/USD spot currency market as compared to the traditional buy and hold strategy.

$H1_a$: There is a statistically significant difference between net gains generated and the use of an alternative trading strategy on an intraday basis for the EUR/USD spot currency market as compared to the traditional buy and hold strategy.

$H2_0$: There is no statistically significant difference between net gains generated and the use of an alternative trading strategy on an intraday basis for the EUR/USD spot currency market as compared to the sell and hold strategy

$H2_a$: There is a statistically significant difference between net gains generated and the use of an alternative trading strategy on an intraday basis for the EUR/USD spot currency market as compared to the sell and hold strategy.

Theoretical Framework

According to Creswell (2014), the theoretical framework for research studies is used to provide a foundation for which the research can be built. The two theoretical frameworks found in the financial literature that will serve as the foundation for this quantitative correlation study are (a) the efficient market hypothesis and (b) the adaptive market hypothesis. The modern financial market theory is based on the seminal work of Eugene Fama who developed the efficient market hypothesis (EMH) in 1970 (Fama, 1970). More recently, Andrew Lo (2004) has proposed the adaptive market hypothesis (AMH) which includes elements of behavioral finance as a means to explain prices, volatility, and profits in financial markets.

Efficient market hypothesis. The premise of the efficient market hypothesis (EMH) is that the current price of a financial asset reflects all publicly available information and that engaging in any speculative trading activity in an efficient financial market should produce a net gain of zero (Westerlund & Narayan, 2013). The EMH lists three distinct forms, or states of the market. The weak-form of the EMH assumes that the current price of a financial asset already

includes all historical information about that asset and market participants cannot achieve consistent excess returns using technical analysis (Kofarbai & Zubairu, 2016). Financial assets prices in a semi-strong efficient market will reflect all known historical and all currently available information (Bitvai & Cohn, 2015). Finally, the strong-form of the EMH states that the value of an asset reflects all information to include historical price information, current public information, and non-public information (Fama, 1970). The strong form indicates that it is impossible to earn excess profits from the market even using insider information (Degutis & Novickyte, 2014). The EMH concludes that no individual can consistently outperform market returns when risk, trading costs, and luck are appropriately factored (Duvinage et al., 2013). For this research, I will study the weak-form of the EMH by examining a specific correlation between historical price information and net gains in the foreign currency market. According to the weak-form of the EMH, the net gain from using historical price information should be zero. The results of this study might show evidence that is contra to the weak-form EMH.

Adaptive market hypothesis. A growing number of research articles introduced certain behavioral elements as a way of explaining the financial market activity (Lo, 2004). Various behaviors manifest themselves via different individual investment approaches when trading financial instruments (Duvinage et al., 2013). The main behavioral approaches have focused on momentum investing (Hong & Stein, 1999); contrarian behaviors (Lakonishok et al., 1994); behavior biases (Kudryavtsev et al., 2013); news-driven behavior (De Bondt & Thaler, 1985); and over-reaction or under-reaction (Hong & Stein, 1999). Many of these behaviors are identified by traders using technical analysis tools.

Technical analysis. Technical analysis uses historical price data and other historical market data to predict future price movement (Coakley et al., 2016). Various technical trading

tools are commonly used by currency traders as a means to increase net gains for their respective companies (Neely, Weller, & Ulrich, 2009). It can be reasoned that even the slightest advantage of just a few pennies, or even a few seconds, can provide currency traders with a significant advantage in the market over time (Narayan, Mishra, Narayan, & Thuraisamy, 2015). That is why these predictive tools are so critically important to the financial sector and currency traders specifically (Antinolfi & Kawamura, 2008).

Furthermore, extensive academic research has been devoted to determining the effectiveness of the various predictive tools (Bitvai & Cohn, 2015). Much attention has been given to the study of these mathematical models for two primary reasons. The first is due to the enormous sums of money that can be made in the currency markets if there is a tool that can increase net gains. The second reason is that if traders can earn excessive risk-adjusted profits in the financial markets, this would provide significant evidence against the efficient market hypothesis (Neely et al., 2009).

The combination of the efficient market hypothesis, specifically the weak-form, and the adaptive market hypothesis, specifically technical analysis, provides the theoretical support for this study. Currency managers working for global financial institutions and international hedge funds should use every method at their disposal to increase the net gains from foreign currency transactions as a means to maximize shareholder value (Morck, 2014). These efforts should include the use of alternative trading techniques if those techniques prove to increase the net gain from trading activities.

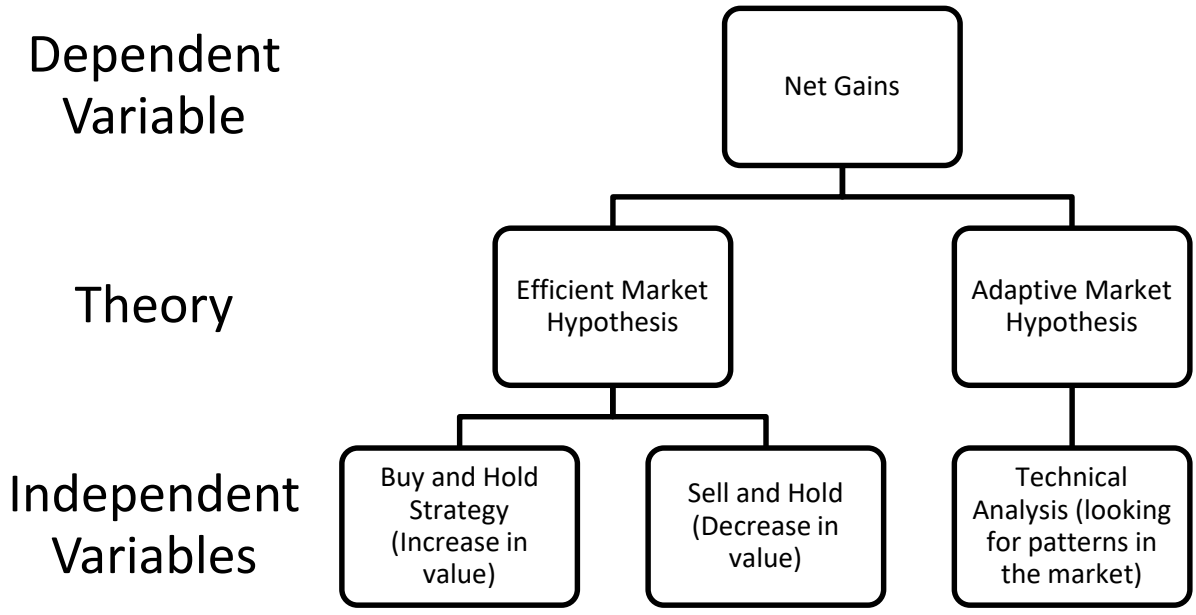

Figure 1. Relationships between theories and variables.

Discussion of relationships between theories and variables. The premise of the efficient market hypothesis (EMH) is that the current price of a financial asset reflects all publicly available information and that engaging in any speculative trading activity in an efficient financial market should produce a net gain of zero (Westerlund & Narayan, 2013). Therefore, the dependent variable selected for this study was net gain from trading activity. Additionally, the weak-form of the EMH assumes the current price of a financial asset already includes all historical information about that asset and market participants cannot achieve consistent excess returns using technical analysis. Based upon this understanding of the weak-form of the EMH one independent variable was the technical analysis tool known as Bollinger Bands. Two more independent variables that directly relate to the EMH were the buy and hold strategy and the sell and hold strategy. The buy and hold type strategy represented those market

participants who believed values will increase, and the sell and hold strategy represented those market participants that take a contrarian view of the market believing values will decrease.

Summary of the Conceptual Framework

The combination of the efficient market hypothesis, specifically the weak-form, and the adaptive market hypothesis, specifically technical analysis, provides the theoretical support for this study. Currency managers working for global financial institutions and international hedge funds should use every method at their disposal to increase the net gains from foreign currency transactions as a means to maximize shareholder value (Morck, 2014). These efforts should include the use of alternative trading techniques if those techniques prove to increase the net gain from trading activities.

Definition of Terms

Alternative Trading Strategies: This refers to trading tools and strategies that attempt to "time the market" with regards to entry and exit trades. This strategy relies on technical trading tools to assist with decision-making (Coakley et al., 2016).

Bollinger Bands: This technical trading tool consists of three bands. The middle band is based upon the moving average of the currency pair, and the lower band and the upper band are two standard deviations from the moving average (Abby & Doukas, 2012).

Bubbles: Financial anomalies that represent extended deviations from rational fundamental valuations of assets (Brock, Hommes, & Wagener, 2009; Phillips & Yu, 2011).

Buy and Hold Strategy: An investment strategy where an asset is purchased with the belief the value of the asset will increase over time creating a net gain (Cohen & Cabiri, 2015).

Forex or FX: These are abbreviations for the foreign currency exchange market which operates as an over-the-counter market without a centralized clearing exchange (Neely et al., 2009).

Net Gain: The total aggregate realized profits, inclusive of transaction costs, from trading using either alternative trading strategies or traditional buy and hold strategies (Bitvai & Cohn, 2015).

Noise Trader: A financial market trader who makes buy and sell decisions based upon idiosyncratic information as opposed to fundamental or economic information (Aabo, Pantzalis, & Park, 2017; Li, 2016).

Over-the-counter market: A highly decentralized financial market consisting of dealers that simultaneously buy and sell assets to investors (Duffie, Gârleanu, & Pedersen, 2007; Lester, Rocheteau, & Weill, 2015).

Short and Hold Strategy: An investment strategy where an asset is sold to the market at a high price with the belief that the value of the asset will decrease over time and can be bought back at a lower price creating a net gain (Mohamad, 2016).

Tick-level data: Financial data recorded every time there is a change in price regardless of the timeframe. In currency trading, tick-level data are gathered any time there is a price change of 0.000001 or more (Drachal, 2016; Kuo, Chen, & You, 2017).

Assumptions, Limitations, Delimitations

"Bias, the lack of objectivity, is by definition a predisposition to error…" (Stake, 2010, p. 164). The following is a discussion of the assumptions, limitations, and delimitations used in this research project. This information is key to providing readers with an additional perspective on the findings of the study (Yin, 2011).

Assumptions. Assumptions made in this research study include the accuracy of historical intraday data examined. The Forex market is a globally decentralized over-the-counter market (Ackerman, 2016; El Ouadghiri & Uctum, 2016). This means that there is no single source for all currency data transactions. Data for this study were obtained from a third party data provider, TickData, LLC. TickData, LLC overcomes the issues of decentralization and over-the-counter execution by aggregating currency quotes from several contributing institutions. Each contributor provides primary, secondary, and tertiary data. This process provides data that is isolated, redundant and geographically diverse. Through a proprietary data system, TickData, LLC compares all three levels of currency exchange prices and synthesizes all information into a single data item free from errors and omissions (TickData, 2017). Additionally, the parameters used to test the Bollinger Band tool are assumed to be consistent throughout the period examined in the study. Finally, the research questions for this study sought to determine if there is a correlation between the use of Bollinger Bands and an increase in net gains. Given that Bollinger Bands are based on historical price data, the study assumes the weak-form of the efficient market hypothesis is not constantly valid and the adaptive market hypothesis is applicable.

Limitations. The findings of the study are limited to the time period tested. Sample data for this study will be gathered from January 2009 through December 2016 for the currency pair of EUR/USD. Any statistical difference that might be identified in this study between the buy and hold strategy, sell and hold, and the Bollinger Bands tool, may not carry over to future time periods or other currency pairs. The confidence level chosen for this study is 90% and the confidence interval is 10% based upon the sample size. Given these levels, the results from the sample may not be generalizable to the entire population. Finally, there is a limited number of

research studies that have tested intraday currency data. Although there is a great deal of academic research that utilizes daily prices and various technical tools together, there are none that are known to this researcher which have used intraday price changes to test technical indicators.

Delimitations. There are hundreds of currencies traded within the Forex markets (Fong, 2013). For this study, the EUR/USD currency pair, one of the most common currency pairs, was selected. According to the Bank of International Settlement, the USD and the EUR account for the largest portion of exchange turnover volume in the spot market (April, 2016). The EUR/USD was chosen because of the significant volume that these two currencies represent in the overall Forex market.

Both the euro and United States dollar are all currencies that are free from government intervention or manipulation (Satterlee, 2014). Stated differently, the currencies chosen for this study are free-floating currencies allowed to fluctuate with the supply and demand of currency market participants. Free floating currencies will provide results that have a minimal influence of individual monetary policy objectives of specific nation states. The time frame selected for this study was 2008 through 2012. This period includes the global financial crisis, the recession that followed, and the beginning of economic recovery. The timeframe was selected to provide a robust understanding of the correlation between trading techniques in a variety of market conditions.

Significance of the Study

Reduction of Gaps. Currently, there seems to be a gap in the literature relating to intraday trading and technical analysis (Ozturk, Toroslu, & Fidan, 2016). Much of the current literature focuses on the end of day price changes of currency pairs and does not focus on

intraday price changes (Hayes et al., 2016; Narayan et al., 2015; Poti et al., 2014). Additionally, most studies that have tested Bollinger Bands and other reversion-to-the-mean technical trading tools have focused on individual stocks, ETFs, or indices without much focus on specific foreign currency trading (Brock, Lakonishok, & LeBaron, 1992; Lento, Gradojevic, & Wright, 2007; Duvinage et al., 2013; Metghalchi et al., 2014). In this study, the researcher attempted to add to the scholarly body of knowledge by focusing on intraday price changes and the application of Bollinger Bands to currency trading.

Implications for Biblical integration. As a believer in the teachings of the Bible, it is important to integrate the understanding of stewardship into all areas of life. The biblical view of stewardship is traditionally defined as using and managing the resources God provides for the glory of God and the betterment of his creation (Botha, 2014). Stewardship can further be understood as entrusting someone with resources and acting on behalf of another's interest (McCuddy & Pirie, 2007). Currency traders working for hedge funds and international banks have a responsibility to make decisions that are in the best interest of the business owners and clients of the firm (Morck, 2014). By utilizing the best tools available, currency traders can provide the greatest level of value maximization to clients and owners (Osiyevskyy & Biloshapka, 2017). This project is focused on increasing the net gains from currency trading activities and therefore engaging in the practice of stewardship by ensuring the greatest net gains for clients and owners.

Finally, the role of the global financial institutions must fit into God's design. "There are different kinds of service, but the same Lord. There are different kinds of workings, but the same God works all of them for all men" (1 Corinthians 12:5-7, NLT). Global financial traders and business professionals can fulfill God's purpose by providing resources for God's creation to

flourish with the understanding that these goods and services are beneficial to God's people. Positive net gains are vital to any for-profit organization, but within God's design, making money provides a means to serve God's creation rather than being the ultimate pursuit of the organization (Van Duzer, 2010). All people are responsible for the resources they control, and wasted resources quickly yield no fruit (McCuddy & Pirie, 2007).

Ensuring good stewardship within the foreign exchange markets for international banks and hedge funds includes the exploration of alternative investment methods. These organizations need to make sure they are employing the most effective tools that will maximize the return for shareholders, who can then use these funds to further the work of God on Earth.

Relationship to field of study. Increased global commerce has given rise to the importance of foreign currency exchange markets (Harvey, 2013). Multinational firms engage in business activities that are outside of their home country and must adapt products, services, and pricing to each local market to be successful (Devereux, Dong, & Tomlin, 2017). The local currency is the easiest way for local consumers to make purchases from international firms (Satterlee, 2014). These global companies then rely on the services of international banks to exchange the foreign currency for the currency of the home country. Due to the growth of globalization, the foreign exchange market has increased exponentially. The foreign exchange market (Forex or FX) is the largest financial market in the world with an estimated 5.3 trillion dollars of turnover every single day (Menkhoff, 2015). All trading takes place between the world's largest banks, who act as market makers, and all other market participants (NASDAQ, 2016). This large, liquid market also attracts hedge fund traders and investors looking to increase their net gains (Fong, 2013). Currency trading is an essential function of all

international businesses, a key service for international banks, and a vital source of profitability for international hedge funds.

Summary of the Significance of the Study

Currently, there seems to be a gap in the literature relating to intraday trading and technical analysis (Ozturk et al., 2016). Much of the current literature focuses on the end of day price changes of currency pairs and does not focus on intraday price changes (Hayes et al., 2016; Narayan et al., 2015; Poti et al., 2014). In this study, the researcher attempted to add to the scholarly body of knowledge by focusing on intraday price changes and the application of Bollinger Bands to currency trading. Increasing the net gains from currency trading activities engages the practice of stewardship by ensuring the greatest net gains for clients and owners. Finally, due to the growth of globalization, the foreign exchange market has increased exponentially. Currency trading is an essential function of all international businesses, a key service for international banks, and a vital source of profitability for international hedge funds.

A Review of the Professional and Academic Literature

The focus of this study is to examine the relationship between net gains and alternative trading techniques that can be utilized by currency managers working for international banks and hedge funds. There are five elements to this literature review. First, this literature review contains a review of the existing structure of currency markets. Second, this literature review contains an analysis of the related research as it pertains to market theories which will serve as the theoretical basis for this study. This portion includes a comparison and contrast of the different scholarly findings regarding the ability of financial market participants to increase the net gains from trading activity. Third, this literature review contains a concise summary of the relevant aspects about currency trading techniques and which trading strategies have been found

to increase net gain from trading activity. Many of these strategies and trading tools have been tested in various types of quantitative studies. Fourth, this literature review presents support for the use of the research variables of net gains and alternative trading strategies used in this study. Finally, this literature review is based on scholarly peer-reviewed journals and sound academic articles.

The literature review contains an extensive review of scholarly work about currency trading, market efficiency, currency markets, and various market analysis techniques. The scholarly peer-reviewed literature includes academic journal articles, with the vast majority being published within the last five years. Books, textbooks, whitepapers, and conference materials were also included as part of this literature review. This literature review contains approximately 299 different sources, and over 75% of the citations used in this literature review have been published within that last 3-5 years. The volume of literature on this topic provides an indication the level of interest in the financial markets of both academics and practitioners.

Foreign currency exchange market. An exchange rate is defined as the price of one currency stated in terms of another currency (Chadwick, Fazilet, & Tekatli, 2015). The foreign exchange market is the most heavily traded financial market in the world with roughly $5.3 trillion exchanged daily (Evans, Pappas, & Xhafa, 2013; Zarrabi et al., 2017). According to Coakley et al. (2016), the global currency market is highly liquid and daily transaction volume is "several times greater than the combined transaction volume of largest stock exchanges" (p. 273). The foreign currency market also referred to as FX or Forex, is a decentralized, over-the-counter, worldwide market that operates 24 hours a day, five days a week (Ackerman, 2016; El Ouadghiri & Uctum, 2016). The over-the-counter Forex market is an unregulated market, unlike a regulated exchange like the New York Stock Exchange. Instead, oversight for the Forex

market occurs via independent market makers and various worldwide electronic networks (Baranga, 2016; Powers, 2016). Financial centers around the world serve as a marketplace for transactions between various buyers and sellers, and most transactions occur between private parties (Ackerman, 2016; Powers, 2016). However, not all currency transactions occur equally distributed around the world. The Bank of International Settlements (2001, 2004, 2007, 2010) reports that nearly 50% of all currency turnover or volume, occurs in New York and London giving these financial centers considerable influence in the currency markets (Harvey, 2013).

There are two distinct levels of trading within the Forex market. The first level is considered retail trading (Rime & Schrimpf, 2013; Sager & Taylor, 2006). Retail trading takes place between a financial institution and an individual. Individuals, in this case, did not refer to a person, but rather a non-bank which could be a government entity, corporation, institutional investors, hedge funds, or high net worth clients (Rime & Schrimpf, 2013; Sager & Taylor, 2006). The next tier of FX transactions is the wholesale level which occurs between financial institutions (Bleaney & Li, 2016; Powers, 2016). Banks that have a large number of orders to buy or sell a currency can leverage the interbank dealer network to satisfy their client demands (Bleaney & Li, 2016; Powers, 2016). Central banks take on the role of market makers and must be ready to buy and sell currencies from member banks to ensure the Forex market functions smoothly (Krapl & Giaccotto, 2015; Langfield & Soramäki, 2016). Currency traders working for international banks or hedge funds will trade currencies in the near-term on the spot Forex market, as opposed to the FX futures market.

The foreign exchange market plays an important role in global financial markets. Currency traders working for hedge funds and global financial institutions find considerable volume and liquidity in the FX market. High transaction volume and significant liquidity both

help currency traders enter and exit positions on an intraday basis. Currency traders can engage in currency transactions in the futures market or the spot market (Bleaney & Li, 2016; Kraple & Giaccotto, 2015; Powers, 2016). The focus of this study will be on the spot exchange market. Next is a discussion of the spot currency market examining some of the spot markets unique characteristics.

Spot market. Trading in the spot currency market is done by buying and selling currency pairs (Talebi, Winsor, & Gavrilova, 2014; Pintar et al., 2016). Currency traders speculate, or place trades, on the changing price of currencies between two countries. Throughout the entire trading period that the FX market is open one currency will fall (rise) as another currency rises (falls) in relation to each other. The FX spot market, also known as the cash market, is the currency market for immediate delivery with all trades settling within two days of the transaction (Powers, 2016; Rzepczynski, 2008). The spot market does not include trades of financial instruments but instead is an exchange of one currency for another at the current exchange rate or spot rate (Gerber, 2016; Kamau et al., 2015). In contrast, the futures market includes the same current pairs, but the exchange will take place on some date in the future (Pintar et al., 2016). The spot market is used by corporations, government entities, and financial institutions to speculate currency trades and to hedge currency risks. The speculation and hedging activities by these significant global institutions are what provide the transaction volume and liquidity in the FX market (Akerman, 2016; Powers, 2016; Talebi et al., 2014).

Spot currency trading includes two currencies that are simultaneously traded (Ackerman, 2016; Pintar et al., 2016). Simultaneously trading two currencies at the same time is known as pairs trading. Powers (2016) provides an example of a spot currency transaction where Bank X agrees to sell 100 million euros to Bank Y for U.S. dollars at a spot rate of 1.10. In this example,

Bank X will receive 110 U.S. dollars by supplying 100 million euros. The process of spot currency trading is roughly identical to the mechanics found in all other markets except for the fact that FX traders are always short one currency and simultaneously long in another (Abildgren, 2014; Powers, 2016). Finally, the spot FX market is self-regulated and no single agency has authority over it. Much of the regulation of the FX market occurs as a byproduct of oversight and laws that govern banks in each country (Ackerman, 2016; Talebi et al., 2014). This lack of unified oversight and the sheer size of the FX market makes the Forex unique as compared to all other financial markets (Ackerman, 2016; Baranga, 2016; El Ouadghiri & Uctum, 2016).

The spot currency market for currency contracts that will be settled in the near term, typically within two days. The volume in the spot market is provided by global financial institutions, governments, international corporations, and speculators. These individuals trade the spot market for different reasons but each is concerned with the very short-term and intraday currency prices. Understanding intraday currency price movement is an important aspect to this research study.

Intraday currency prices. Currency traders and currency managers make their trading decisions over multiple time horizons to include annually, monthly, daily, hourly, and down to the minute level (Abbey & Doukas, 2015; Hsu, Taylor, & Wang, 2016). Many financial experts support the premise that fundamental economic data does not provide any predictive power in the short-term but have found evidence of exchange rate predictability over a several year period of time (Andersen, Bollerslev, Diebold, & Vega , 2007; Boudoukh, Richardson, & Whitelaw, 2008). The most significant issue with attempting to predict short-term (second-by-second) changes in exchange rates with fundamental economic data is the economic data does not change

that quickly (Dal Bianco, Camacho, & Perez Quiros, 2012, Mcmillan & Speight, 2012). New economic data are typically released on a monthly, quarterly, or annual basis as compared to currency prices that fluctuate on a second by second basis (Boudoukh et al., 2008; McMillan & Speight, 2012).

As a means to better predict the price movement of currency pairs, previous researchers have used various statistical methods and tick-level-data to identify intraday periodic patterns based upon the macroeconomic news releases (Andersen & Bollerslev, 1997; Barunik, Krehlik, & Vacha, 2016).

The study of intraday price movements is relatively new (Rosch, Subrhmanyam, & Van Dijk, 2017). Tick-level data are the recording of price changes as they occur in the market (Curato & Lillo, 2014). In contrast, intraday currency prices on a minute time frame records the currency exchange rate every minute. Tick-level data are gathered anytime there is a price change regardless of the time frequency (Bréhier, 2013). This information was not readily obtained nor was there computing power available to process vast amounts of financial data before the year 2000 (Hau, Massa, & Perress, 2010; Mende & Menkhoff, 2006; Ranaldo, 2009; Rosch et al., 2017). Previous researchers have focused on the day of the week effect in Forex markets (Ke, Chiang, & Liao, 2007; Ito & Hashimoto, 2006; Serbinenko & Rachev, 2010), but few researchers examined the foreign exchange market on an intraday basis. Popovic and Durovic's (2014) study examined intraday pricing anomalies between the USD and EUR currencies and discovered that there is a profitable arbitrage opportunity on Friday afternoons. Elaut, Frömmel, and Lampaert (2016) researched intraday patterns in the Russian Ruble and revealed that trading momentum was likely driven by risk aversion to holding Rubles overnight. Kablan and Ng (2011) studied intraday FX prices to develop an adaptive neuro-fuzzy interface

for learning to predict currency movements at the tick level. Several studies find order flow occurring in intraday currency prices to detect patterns in trader behavior Ben Omrane & Hussain, 2016; Breedon & Ranaldo, 2013; Fuertes, Kalotychou, & Todorovic, 2015; Rime, Sarno, & Sojli, 2010). Many of the conclusions reached by the researchers previously cited support the premise that currency traders making trading decisions on an intraday basis have the potential to increase net gains from trading activity. There are several articles that study the Forex market on an intraday basis. However, no previous research has specifically examined the intraday day price movement of the EUR/USD and Bollinger Bands. This gap in the literature is intriguing given the fact that many practitioners make trading decisions throughout the trading day and not just based on the end of day prices.

Currency traders and managers should understand the foreign exchange market to compete with other traders and increase their net gains from trading (Akerman, 2016; Powers, 2016; Talebi et al., 2014). Understanding the market conditions, market participants, operating procedures, timeframes for trading, and the overall function of the market is essential to successful trading (Hau et al., 2010; Mende & Menkhoff, 2006; Ranaldo, 2009; Rosch et al., 2017). Additionally, for currency traders to increase their net gain from trading, they must be able to accurately predict the movement or direction of currency prices in the near term (Elaut et al., 2016; Kablan & Ng, 2011; Popovic & Durovic, 2014). Given the importance of accurately predicting price movements, the next section presents several financial market theories developed over the past half-century that have attempted to explain the movement of asset prices.

Financial market theory. Financial markets present a mechanism to facilitate the movement of capital from savers to borrowers (Brigham & Houston, 2015). These markets can

provide traders with an opportunity to make significant profit and net gains for those traders who can correctly predict the direction of financial markets (Harvey, 2013; Poti & Siddique, 2013). Two main financial theories have been developed to explain the movement of financial markets. These two financial theories found in the financial literature that will serve as the foundation for this quantitative correlation study are (a) the efficient market hypothesis and (b) the adaptive market hypothesis. The efficient market hypothesis and the adaptive market hypothesis are the two prevalent market theories that attempt to explain how financial markets move (Lo, 2004; Rosch et al., 2017; Talebi et al., 2014). The modern financial market theory is based on the seminal work of Eugene Fama who developed the efficient market hypothesis (EMH) in 1970 (Fama, 1970). More recently, Andrew Lo (2004) has proposed the adaptive market hypothesis (AMH) which includes elements of behavioral finance as a means to explain prices, volatility, and net gains in financial markets. These EMH and the AMH were selected for this study because these market theories directly relate to the purpose of this study and the research questions.

Other market related theories exist but do not directly relate to the research question or purpose of this study. Portfolio theory, for example, examines the appropriate mix of various investment assets to produce the highest return for a given level of risk (Fu & Blazenko, 2015; Fu & Blazenko, 2017; Hou, Xue & Zhang, 2014). The Arbitrage Pricing Theory (APT) attempts to explain the financial returns, or net gains, of assets as a function of the risk factors and also considers how financial markets price these factors (Huberman, 1982; Rebeschini, & Leal, 2016). The APT is used exclusively in equity markets and was therefore not appropriate for this study, as the researcher examined the currency markets. The put-call parity is a financial theory that deals directly with various European style options, their prices, and the value of the

respective underlying asset (Cerreia-Vioglio, Maccheroni, & Marinacci, 2015; Plott, & Pogorelskiy, 2017; Stoll, 1973). The put-call parity deals specifically with option prices and is therefore not directly related to the research questions nor the purpose of this study. After reviewing these various theories, the researcher has determined that the EMH and the AMH are the most relevant theories to the research questions and the purpose of this study.

Traditional market theories. The EMH indicates that market participants cannot achieve net gains above the overall market returns in the long run because a developed financial market efficiently disseminates information such that there is no sustainable financial advantage allowing individuals to earn excess returns (Fakhry, 2016; Fama, 1970). Andrew Lo (2004), first proposed the AMH. Lo theorized that markets are not in a constant state of efficiency. The AMH is constructed on three findings. First, financial market efficiency is not a steady state, and therefore alternative or technical trading rules can be employed to achieve significant net gains. Second, competition and currency traders desiring net gains will drive market participants to learn and change over time. These "adaptive" processes will gradually erode profitable trading opportunities over time. Finally, more complex technical trading strategies should persist longer than simple trading strategies that can be replicated by market participants (Coakley et al., 2016).

The EMH presents an argument that currency traders cannot earn excess market returns. The AMH indicates that traders can earn excess returns but can do so at a diminishing rate as other market participants erode profitable trading strategies over time. In this literature review, the researcher provided a basis of support for further study of the weak form of the EMH and the AMH using previous academic research. The researcher intends to add to the body of scholarly literature regarding the AMH and the weak form of the EMH in the intraday currency markets. By examining the relationship between alternative trading strategies and net gains, the findings

of this study might lend support for the AMH. If there is no correlation between historical prices using alternative trading strategies and net gains in the currency markets, then this might support the EMH. Because the findings of this study might support either the AMH or the EMH, both of these theories play an important role in the conceptual framework of this study. The next sections discuss the EMH and the AMH in greater detail.

Efficient market hypothesis. The EMH is used as part of the therortical framework for this study. The EMH implies that the net gains from attempting to forecast future asset prices would result in zero profits and is not consistently forecastable (Chen & Diaz, 2013; Fleming & Remolona, 1999; Malkiel, 2005; Mobarek & Fiorante, 2014; Timmermann & Granger, 2004). In this study the researched examined if there is a correlation between historical currency price movements and net gains from trading activity. The findings presented in this study may be contra to the EMH. The findings may indicate that historical prices can be used to increase net gains from trading in the currency market.

The premise of the efficient market hypothesis (EMH) is that the current price of a financial asset reflects all publicly available information and that engaging in any speculative trading activity in an efficient financial market should produce a net gain of zero over time (Hsu et al., 2016; Westerlund & Narayan, 2013; Kofarbai & Zubairu, 2016). The EMH indicates that prices of financial assets will immediately reflect the fundamental value of the asset. Additionally, the EMH assumes a highly competitive market where participants are profit maximizing, risk-minimizing, and 100 percent rational individuals (Fakhry, 2016). There was early empirical evidence for the EMH. Jensen (1978) stated “there is no other proposition in economics which has more solid empirical evidence supporting it than the efficient market hypothesis” (p. 167). The EMH implies that market participants cannot realize profits in excess

of overall market return and future prices are not forecastable from historical prices (Chen & Diaz, 2013; Fleming & Remolona, 1999; Malkiel, 2005; Mobarek & Fiorante, 2014; Timmermann & Granger, 2004).

The EMH lists three distinct forms, or states, which include (a) the weak-form, (b) the semi-strong form, and (c) the strong-form (Fakhry, 2016; Jensen, 1978; Malkiel & Fama, 1970). The weak-form of the EMH assumes the current price of a financial asset already includes all historical information about that asset and market participants cannot achieve consistent excess returns using technical analysis (Kofarbai & Zubairu, 2016). Financial asset prices in a semi-strong efficient market should reflect all known historical and all currently available information (Bitvai & Cohn, 2015, Kristoufek & Vosvrda, 2016). Therefore, based on the EMH, market participants cannot realize profits from using historical or current information (Popovic & Dorovic, 2014; Rosch et al., 2017). The semi-strong form of the EMH indicates that investors and traders cannot earn a return that exceeds the market consistently over time (Chen & Diaz, 2013; Manahov & Hudson, 2014; Mobarek & Fiorante, 2014).

Finally, the strong-form of the EMH states that the value of an asset reflects all information to include historical price information, current public information, and non-public information (Fama, 1970). The strong-form indicates that it is impossible to earn excess profits from the market even using insider information (Degutis & Novickyte, 2014; Manahov, Hudson, & Gebka, 2014). The EMH concludes that no individual can consistently outperform market returns when risk, trading costs, and luck are appropriately factored (Duvinage et al., 2013; Manahov & Hudson, 2014). According to Fakhry (2016), the EMH indicates that the financial markets consist of market participants that are perfectly rational, risk-averse and profit-maximizing at all times. Given the rational, risk-averse, profit-maximizing participants, the goal

of traders should not be to attempt to outperform the market but instead attempt to maximize the level of return given the level of risk (Bitvai & Cohn, 2015; Malkiel, 2005). Eugene Fama was the first to put forth a concise theory regarding the movement of the market. Since 1970, when Fama proposed the EMH, many researchers provided substantial evidence for and substantial evidence against the EMH.

Support of the EMH. Around the 1900s, the French mathematician named Louis Bachelier (1900) observed the stock market prices follow a Brownian motion. This Brownian motion is better known today as randomness or the random walk. Fama (1963, 1965, 1970, and 1995), measured the statistical properties of market prices and concluded that market prices follow a random walk pattern. From this evidence, Fama proposed the three forms of the EMH that is (a) the weak-form, (b) the semi-strong form, and (c) the strong form. The foundation of the EMH is that a financial market is largley comprised of rational, profit-maximizing, risk-averse, and well-capitalized investors (Manahov & Hudson, 2014; Tsang, 2017). Additionally, the current market price of assets is firmly grounded in the fundamental value of those assets and prices only experience change when new information about the fundamental value is introduced to traders (Fiebig & Musgrove, 2015; Popovic & Dorovic, 2014). Several researchers, analyzing the price movement of various financial assets such as U.S, equities, international equities, ETF's, mutual funds, commodities, and futures, have found evidence in support of the EMH (Jawadi, Jawadi, & Cheffou, 2015; Kumar, 2013; Majumder, 2013; Mobarek & Fiorante, 2014; Papadamou & Markopoulos, 2014; Thompson, 1978).

Thompson (1978) and Brauer (1988) found evidence in support of the strong-form of the EMH researching closed-end mutual funds indicating that prices tend to move in a random fashion and traders could not consistently outperform the market return over the long-term.

Other researchers have conducted studies in the options market (Galai, 1978), the futures market (Oliven & Rietz, 2004; Westerlund & Narayan, 2013; Westerlund, Norkute, & Narayan, 2015), the U.S. equity markets (Chen & Diaz, 2013; Ito, Noda, & Wada, 2016; Narayan, 2006), the commodities market (Kristoufek & Vosvrda, 2016; Papadamou & Markopoulos, 2014) and various international equity markets (Jawadi et al., 2015; Kumar, 2013; Majumder, 2013; Mobarek & Fiorante, 2014) and found similar random price movements indicating the existence of an efficient market. These researchers have used various statistical methods to vary the randomness of the price movements in each of these markets. The findings of these researchers lend support to the conclusion that markets are in one of the three forms of the EMH as described by Fama (1970).

The focus of this research is to examine if currency markets are efficient, specifically weak-form efficient as described by the EMH. The weak-form EMH presents the conceptual framework for testing the research questions by stating that historical pricing data are not effective in helping currency traders increase net gains from trading activity. Researchers concluded that markets will operate efficiently over the long run. In this research, the researcher examined intraday prices over a longer period of several years. Additionally, researchers conclude that markets operate efficiently if the pricing data appears to follow a random pattern. These random pricing patterns imply that currency traders cannot consistently outperform the market return. In this study, the researcher examined if currency prices can help currency traders predict near-term price movements.

In this section reviewing the literature in support of the EMH, there appears to be considerable support early on for the theory, from 1970 until early 2000. More recently, scholars are finding evidence against the EMH and tend to challenge the EMH instead of support EMH.

The following section will examine the scholarly research that challenges many of the assumptions of the EMH.

Challenging the EMH. The foundation of the efficient market hypothesis (EMH) is that the current price of a financial asset reflects all publicly available information and asset prices follow a random pattern (Fama, 1970). If prices are random and asset prices reflect all available information, then engaging in any speculative trading activity in an efficient financial market should produce a net gain of zero over time (Hsu et al., 2016; Westerlund & Narayan, 2013; Kofarbai & Zubairu, 2016). However, Grossman and Stiglitz (1976, 1980), question the premise of informationally efficient markets from a theoretical and practical viewpoint. Grossman and Stiglitz found that market participants typically pay for information and therefore prices cannot perfectly reflect all information (1976, 1980). Kay (2013) stated that if market prices reflect all available information about the value of an asset, traders and investors would have no incentive to obtain that information in the first place because they could observe it in the price of the financial asset. Various researchers (Condie & Gangulie, 2011; Kovalenkov & Vives, 2014; Mele & Sangiorgi, 2009; Vivies, 2014) have attempted to answer the Grossman-Stiglitz paradox by creating a variety of theoretical models dealing with noise traders and finite population assumptions. Many researchers have agreed that they could not overcome the fact that market participants do spend resources obtaining information and rely on this information in making trading decisions (Kovalenkov & Vives, 2014; Vivies, 2014). This practice tends to violate the instantaneous information symmetry of the EMH (Condie & Gangulie, 2011; Grossmand & Stiglitz, 1980).

Another important assumption of the EMH is rational behavior on the part of market participants (Fama, 1970). Various behavior patterns, other than entirely rational behavior, have

been observed in financial markets. These various behaviors present themselves via different individual investment approaches when trading financial instruments (Duvinage et al., 2013; Nofer & Hinz, 2015). The primary behavioral approaches have focused on (a) momentum investing (Foltice & Langer, 2015; Hong & Satchell, 2015; Hong & Stein, 1999), (b) contrarian behaviors (Lakonishok et al., 1994; Sobaci, Sensoy, & Erturk, 2014; Stefanescu & Dumitriu, 2016), (c) behavior biases (Chang, Huang, Chang, & Lin, 2015; Jacobs & Hillert, 2016; Kudryavtsev et al., 2013), (d) news-driven behavior (De Bondt & Thaler, 1985; Lachanski & Pav, 2017), and (e) over-reaction or under-reaction (Hong & Stein, 1999; Kleinnijenhuis, Schultz, Oegema, & Atteveldt, 2013). These researchers have observed that significant movement in asset prices can be attributed to behavior that can be considered irrational (Nofer & Hinz, 2015). Therefore, the findings presented in these studies are contrary to the assertion of the EMH that individuals act rationally. In summary, many scholars find support of irrational market participant behavior which is inconsistent with the assumptions of the EMH.

Other researchers have questioned whether financial markets are mainly efficient with periods of inefficiency or are financial markets mainly inefficient with periods of efficiency (Neely, Weller, & Dittmar, 2009; Pukthuanthong, Levich, & Thomas, 2007)? Based upon these continually changing and competing forces "convergence to equilibrium is neither guaranteed nor likely to occur at any point in time" (Tsang, 2017, p. 468). In this way, markets vary over time, and the efficiency of markets vary over time, never existing in a constant continuous state of efficiency (Alvarez-Ramirez, Rodriguez, & Espinosa-Paredes, 2012; Menkhoff & Taylor, 2007; Menkhoff, Sarno, Schmeling, & Schrimpf, 2016; Neely et al., 2009; Pukthuanthong et al., 2007). These findings lend support to the idea that financial markets are always moving back and forth between states of efficiency and inefficiency.

Researchers have found evidence that the Forex market deviates substantially from information efficient markets and rational market behavior as outlined in the EMH (Levich & Poti, 2015; Neely et al., 2009; Poti & Siddique, 2013). Beginning in the 1970s, around the inception of the EMH, empirical evidence has shown that various technical trading rule can result in statistically significant net gains in currency markets (Dooley & Shafer, 1975; Popovic & Durovic, 2014; Poti, Levich, Pattitoni, & Cucurachi, 2014; Poti & Siddique, 2013). There is a large number of research studies that presented evidence of statistically significant profits in the currency markets by using simple technical trading rules such as moving average crossovers and support and resistance (Chang & Osler, 1999; LeBaron, 1999; Schulmeister, 2006). Furthermore, in developing nations, which do not have laws ensuring systematic, efficient information flow and a large number of well-capitalized investors, there are signs of predictability of price movements (Menkhoff et al., 2016; Nwachukwu & Shitta, 2015). These factors provide traders the opportunity to earn excess profits (Nwachukwu & Shitta, 2015) above the typical market return. Interesting to note that researchers have found evidence of diminishing profitability of some technical trading rules over time (Menkhoff & Taylor, 2007; Menkhoff et al., 2016; Neely et al., 2009; Pukthuanthong et al., 2007) lending support for the idea that markets change, and traders are continually adapting to changing markets, economic conditions, change sentiment, and then reacting to the actions of other traders.

The existing research on the subject of EMH is vast and diverse. Interestingly, even the developer of EMH, Eugene Fama (1995) and supporters (Malkiel. 2003, 2005; Jensen, 1978) acknowledge that all financial markets can have short periods of time where traders are not entirely rational and predictable patterns can emerge. Examples of such irrationality occur in bubbles, market crashes, and recessions. Andrew Lo (2004, 2005), in an effort to accommodate

the research findings that support EMH and the empirical evidence questioning the validity of the EMH, proposed a new theory known as the adaptive market hypothesis (AMH).

Adaptive market hypothesis. Lo (2004) suggested that the AMH is a means to reconcile the EMH with the observed behavioral biases in financial markets. He suggests that markets are complex, adaptive, and influenced continuously by individual bias, competition, selfishness, and other environmental factors (Lo, 2004). Lo was not the first to recognize how markets adapt over time. The term adaptive efficiency was first used by Kent Daniel and Sheridan Titman (1999). These authors observed investor over-confidence or investor irrationality in the U.S. equity markets and determined that profits could be made from the momentum generated by over-confidence. However, the financial market displayed an adaptive efficiency whereby the profit opportunities diminished as more and more traders realized the opportunity (Daniel & Titman, 1999). Adaptive efficiency referred to the observation of pricing anomalies that disappear as more and more investors take advantage of the discrepancy (Daniel & Titman 1999; Menkhoff & Taylor, 2007). These researchers also found evidence of abnormal and persistent net gains from specific investor portfolios which should not be possible under the EMH (Cohen & Hon-Snir, 2013; Daniel & Titman, 1999; Stefanescu & Dumitriu, 2016). The findings of these researchers indicate that there are opportunities for currency traders to increase net gains from trading activity. This lends support to the conceptual framework of this study as the researchers provide evidence of the possibility of net gains from trading activity in the financial markets.

Others scholars (Lo, 2012; Kay 2013; Vives 2014) question the ability of well-capitalized arbitrage traders to counter the irrational behavior of market participants. These authors find support for the belief that well-capitalized investors typically join into market exuberance and market crashes as demonstrated in market booms and market busts. The findings of these

researchers are important to the conceptual framework for this study as they provide evidence of the possibility of net gains from trading activity in the financial markets.

The AMH is based on four essential concepts (Lo, 2002; Tsang, 2017). First, market efficiency is not a steady state, and therefore technical trading rules can be employed to achieve significant profits (Lo, 2004; Urquhart & Hudson, 2013). Second, competition and the desire for profits will drive market participants to learn and change over time. These "adaptive" processes will gradually erode profitable trading opportunities over time, but give an opportunity for new profitable trading strategies. More recent studies have shown that these simple trading rules are not as profitable as they once were (Neely et al., 2009). Advanced technical trading rules, however, have proved to produce statistically significant profits in currency markets in the recent past (Coakley et al., 2016). These findings lend support to the Adaptive Market Hypothesis (AMH) proposed by Lo (2004). Third, the relationship between risk and reward is not universal from one investor to the next and that each will define optimal net gains differently (Dhankar & Shankar, 2016; Poti et al., 2014). Finally, more complex technical trading strategies should be able to return positive net gains for extended periods of time as compared to simple trading strategies that can be quickly learned by market participants (Coakley et al., 2016; Levich & Poti, 2015).

AMH and EMH combined. As previously mentioned, many researchers have found evidence in support of the EMH while other researchers have found support for the AMH. Still, some researchers believe that there is room for a co-existence of the AMH and the EMH and that these theories are not mutually exclusive. The AMH alters the EMH and Lo further suggests that the forces of learning, competition, and evolutionary selection pressures drive prices to their efficient level (Manahov & Hudson, 2014; Shalini, 2012). These same forces then create new

profitable trading opportunities until they are discovered and traders begin to adapt. Additionally, Lo (2004, 2005) theorizes the rational, profit-maximizing, well capitalized, and risk-averse investor is not always present or dominant in financial markets. The AMH offers a mechanism to reconcile the empirical findings of researchers regarding the predictability of asset returns with the concepts of the EMH (Levich & Poti, 2015; Shalini, 2012). That is, the AMH helps merely to explain the anomalies that other researchers have observed regarding the predictability of asset returns, but over time market efficiency will eliminate these sources of profit (Charles, Darne, & Kim, 2012; Pintar et al., 2016; Pukthuanthong et al., 2007), but changing conditions will create new opportunities, and the cycle starts over again.

Hiremath and Kumair (2014) agreed with the basic foundations of the AMH but advise that further study is necessary given the relative newness of the theory. These authors conclude that empirical studies must be performed as a means of building the necessary academic support for such a hypothesis. It is essential to keep in mind that there is no formal statistical test that can directly test the AMH (Hiremath & Kumair, 2014; Noda, 2016). These are not criticisms of the AMH, but rather serve as cautionary observations which lead to a conclusion of "wait and see" before declaring the AMH as the singular market hypothesis which can explain the price patterns of financial assets (Coakley et al., 2016; Levich & Poti, 2015).

The researchers that recently tested the AMH concluded that the AMH provides an accurate description of market behaviors (Ghazani & Araghi, 2014; Hull & McGroarty, 2014; Manahov & Hudson, 2014; Urquhart & Hudson, 2013; Verheyden, Van den Bossche, & De Moor, 2015; Zhou & Lee, 2013). A long-term study of 100 years of U.S. stock market data finds that efficiency has dramatically increased after the 1980s (markets have adapted) and specific market conditions (recession, expansion, market crashes which indicate irrational behavior) are

significant factors in predicting returns (Kim, Shamsuddin, & Lim, 2011). Alvarez-Ramirez et al. (2012) found the period of highest efficiency for the U.S. stock market was between 1973 and 2003, but changed over time. Charles et al. (2012) observed periods of predictability in the Forex market for developing countries and periods of market efficiency, or randomness, appear to be present in markets of developed nations. The financial market in Japan has shown signs of moving from periods of efficiency to periods of inefficiency and back (Noda, 2016). These findings support the AMH hypothesis by showing how markets change over time and how competition among traders diminish the profitability of various strategies and provide opportunities for new trading strategies.

Summary of market theories. The problem addressed in this quantitative study was to examine historical currency data to assess whether or not using alternative trading strategies on an intraday basis can increase the net gains from currency trading. Given the previous findings (Darne & Kim, 2012; Ghazani & Araghi, 2014; Hull & McGroarty, 2014; Manahov & Hudson, 2014; Urquhart & Hudson, 2013; Verheyden et al., 2015; Zhou & Lee, 2013), it appears that financial markets experience periods of predictability. If markets do experience some level of predictability, these findings provide a strong theoretical foundation for the research in the area of increasing net gain currency trading. The researcher examined the weak-form of the EMH to determine if there is any correlation between historical price information and net gains in the foreign currency market. The strength of the correlation between past prices and net gains would help support other researchers who have found evidence against the EMH. Additionally, the use of historical prices to increase net gain beyond the market returns for currencies would provide support against the weak-form of the EMH. According to the weak-form of the EMH, the net

gain from using historical price information should be zero. The results of this study might show evidence that is contra to the weak-form EMH.

Currency trading techniques. The foreign exchange market attracts a vast number of traders and investors who speculate in the exchange rates to maximize their net gain (Addam, Chen, Hoang, Rokne, & Alhajj, 2016). Each currency trader makes decisions based on several qualitative and quantitative factors. The diversity of factors considered and the weight given to each factor differ from one trader to the next (Abuhamad, Mohd, & Salim, 2013; Beilis, Dash, & Wise, 2014). These differences further support the AMH, indicating that traders are adapting the level of weighting for each factor based on previous learnings (Lo, 2004). Many of the factors that influence a trading decision will fall into two broad categories (a) fundamental analysis factors and (b) technical analysis factors (Chen et al., 2014; Coakley et al., 2016; Ozturk et al., 2016). These categories are not mutually exclusive, and most traders use a combination of several factors from both fundamental and technical analysis (Chang, Jong, & Wang, 2017; Kuang et al., 2014; Levich & Poti, 2015; Manahov et al., 2014). The use of fundamental factors or technical analysis factors is meant to help traders enhance their predictive power of the Forex market (Georgiadis & Mehl, 2016; Hayes et al., 2016; Jacobs & Hillert, 2016). The following is a review of some of the more common factors that currency traders consider when trading the Forex market.

Fundamental analysis factors. Fundamental analysis is considered the conventional approach to assessing the potential for future gains and loss of various investments (Eiamkanitchat et al., 2017). Fundamental analysis is based on historical financial and economic data as well as projections of future demand. Fundamental factors tend to be macroeconomic factors that analyzes the overall state of a country's economy (Dobrynskaya, 2015;

Eiamkanitchat et al., 2017). The fundamental factors that tend to impact foreign currencies are projected GDP growth, inflation, interest rates, and the growth of money balance (Abuhamad et al., 2013; Sarno & Schmeling, 2014). These fundamental factors typically impact entire countries and regions, not just individual sectors or firms. Currency managers adhering to a strictly fundamental analysis approach to foreign currency trading would focus solely on macroeconomic factors that affect each country and then take positions that would align with these variables (Copeland & Lu, 2016; de Zwart et al., 2009; Dobrynskaya, 2015). Currency managers using fundamental analysis typically take a long-term view, from three to five years. The three to five-year time horizon is necessary because macroeconomic variables typically do not change to a great extent and often change slowly over multiple years.

Previous researchers examined the correlation between macroeconomic factors and short-term currency trading. Bekiros (2014) studied the connection between exchange rates and predictability of future rates using fundamental variables of money supply and interest rates. Bekiros determined that the linkage between fundamentals and predictability is modest and not uniform across time periods. Earlier studies (Belaire-Franch, & Opong, 2005; Flood & Rose, 1995; Meese & Rogoff, 1982; Rogoff & Starvrakeva, 2008) agreed with the findings of Bekiros and added that currency rates seem to follow a random walk pattern when correlated with macroeconomic factors, although not consistently. Bacchetta and Van Wincoop (2013) found that the macroeconomic fundamentals change so slowly over time that these variables do not provide value for predicting currency movements in the near-term. The authors did find that it is the expectation of a change in these variables that causes movement in the underlying currency (Bacchetta & Van Wincoop, 2013). However, the announcement of fundamental factors does seem to impact currency trading in the short-term.

New information and news announcements about changes in interest rates, inflation, and net foreign asset positions are associated with substantial and quick currency movements (Dal Bianco et al., 2012; Dobrynskaya, 2015). Andersen, Bollerslev, Diebold, and Vega (2003), Andersen et al. (2007), and Faust, Rogers, Wang, and Wright (2007) found that fundamentals do not appear to help forecast currency price movements in the short run, but news about fundamentals does create quick and significant short-term movements in currency exchange rates. Ultimately, the issue with using fundamental economic data, outside of news related events, is the economic data are not available at the same frequency rate as price data (Copeland & Lu, 2016; de Zwart et al., 2009; El Ouadghiri & Uctum, 2016). The findings of these researchers imply that short-term currency trading based on economic fundamentals may not produce a positive net gain consistently over time. There does appear to be one trading strategy, known as the carry trade, that is based upon the fundamental factor of interest rates that have been shown to produce profitable results over the short-term (Coudert & Mignon, 2013; Fung, Tse, & Zhao, 2013; Hutchison & Sushko, 2013).

The carry trade. One relevant theory in international finance is the interest rate parity theory (Cenedese, Sarno, & Tsiakas, 2014; Kim, 2016). Based on the interest rate parity theory, traders created the carry trade strategy to generate positive net gains from currency transactions (Burside et al., 2007; Coudert & Mignon, 2013). The interest rate parity theory indicates that there should be an equilibrium relationship between the movement of exchange rate pairs and their respective interest rates (Baillie & Chang, 2011; Fung et al., 2013; Mollick & Assefa, 2013). Kim (2016) stated "the currency with a higher nominal interest rate is expected to depreciate against the other currency by roughly the same amount as the interest rate differential in the absence of transaction costs" (p. 1077). According to Kim (2016), interest rate parity

works in theory but in practice appears to work in the exact opposite manner. Empirical evidence has shown the interest rate parity works in the opposite direction where higher yielding currencies appreciate over time instead of depreciating (Anzuini & Fornari, 2012; Burside et al., 2007; Coudert & Mignon, 2013). Currency traders can take speculative trades by purchasing high yield currencies while simultaneously borrowing in low yield currencies when interest rate differences are not offset by corresponding interest rate movements (Bakshi & Panayotov, 2013; Hutchison & Sushko, 2013). This strategy is known as the currency carry trade (Das, Kadapakkam, & Tse, 2013; Lustig, Roussanov, & Verdelhan, 2014). Researchers have reported statistically significant positive net gains from carry trades in the Japanese Yen (Colavecchio, 2008), the Japanese Yen and the Swiss Franc (Mollick & Assefa, 2013), and many of the G10 currencies (Jurek, 2014). Finally, Burnside, Eichenbaum, and Rebelo (2008) find that carry trades can increase the Sharpe Ratio of a hedge fund by more than 50%. As with any speculative market activity, the potential for loses is present (Das et al., 2013; Pan, Tang, & Xu, 2016). The potential for loss in a carry trade strategy arises when high levels of exchange rate volatility happen unexpectedly (Menkhoff, Sarno, Schmeling, & Schrimpf, 2012). Unexpected volatility can occur from events stemming from surprise election results, unexpected monetary policy changes, or in developing nations government coups and takeovers (Coudert & Mignon, 2013; Fung et al., 2013; Hutchison & Sushko, 2013. These events can create significant losses from exposed positions in carry trades.

In summary, fundamental analysis in the Forex market involves the study of historical financial and economic data as a means to project future economic factors (Copeland & Lu, 2016; de Zwart et al., 2009; Dobrynskaya, 2015). The fundamental factors that are most often studied include those macro-level indicators that affect an entire economy such as projected GDP

growth, monetary supply, inflation, interest rates, surplus and deficits, and the growth of money balance (Abuhamad et al., 2013; Sarno & Schmeling, 2014). Researchers studying these factors as a means to forecast future currency prices have yet to successfully find high correlations between macro-level economic data and short-term currency price movements. Except for the carry trade, the findings of these researchers implies that short-term currency trading based on economic fundamentals may not produce a positive net gain consistently over time (Burnside et al., 2008; Colavecchio, 2008; Jurek, 2014; Mollick & Assefa, 2013).

Given the results that have been presented, many researchers have turned their attention to quantitative and technical analysis. The use of technical analysis can be a divisive topic and often confounds economist, and traditional financial theorist as technical analysis directly contradicts the weak-form EMH (Narayan et al., 2015; Neely et al., 2009). Technical analysis is a key part of this study and as such a thorough discussion is necessary. The following is a review of the academic literature regarding technical analysis and the use of technical analysis in financial markets.

Technical analysis and trading strategies. Technical analysis is the study of financial market activity through the application of price charts and empirical rules set mainly by active market participants to predict future price movements (Milionis & Papanagiotou, 2013; Neely et al., 1997). Technical analysis focuses primarily on historical price data and other historical market data to predict asset prices in the future (Chang et al., 2017; Coakley et al., 2016). Due to the importance of accurately forecasting short-term currency movements, extensive academic research has been devoted to determining the effectiveness of the various predictive tools (Bitvai & Cohn, 2015; Chang et al., 2014). Additionally, technical analysis has become an essential aspect for financial market practitioners. Most major brokerage firms, international financial

firms, hedge funds, and even individual market professionals use technical analysis as a means to understand the movements of financial assets and assist in forecasting potential direction of future price movements (Brock et al., 1992; Zarrabi et al., 2017). Much attention has been given to the study of technical trading for two primary reasons. The first is due to the importance of financial markets and currency markets to practitioners, academics, and global economies (Chang et al., 2014; Lo, 2002). Secondly, if traders can earn excessive risk-adjusted profits in the financial markets, this would provide significant evidence against the efficient market hypothesis (Lo, 2002; Narayan et al., 2015; Neely et al., 2009). Evidence for or against a market theory, whether the EMH or the AMH, moves the understanding of all market participants forward and furthers practicioners understanding of market functions.

The first scholarly study of technical analysis was titled "Can Stock Market Forecasters Forecast?" written in 1933 by Alfred Crowles who studied whether 45 stock professionals were able to predict future price movement. However, the use of technical analysis for trading is believed to date back to the rice trade in Japan as early as the 1700 (Lin, Yang, & Song, 2011; Neely, Rapach, Tun, & Zhou, 2014; Northcott, 2009). Many believe that these rice traders were first to develop a technical strategy known as Japanese Candlesticks (Chen, Bao, & Zhou, 2016; Romeo, Joseph, & Elizabeth, 2015).

In the United States, Charles Dow, a market practitioner and founder of the Dow Jones Financial News Services in the late 1800s, used the closing prices of stocks as a means of predicting future price movement (Brock et al., 1992; Lin et al., 2011; Nazario, Lima-eSilva, Amorim-Sobreiro, & Kimura, 2017). The writings of Charles Dow form the foundational concepts of technical analysis today (Oliveira, Nobre, & Zárate, 2013; Vanstone & Finnie, 2009; Zhu & Zhou, 2009). Technical analysis covers a broad category of tools and rules that traders

use to help interpret and predict future price movement. The intensive and exclusive use of technical analysis has created a whole new trading style that is known as quantitative analysis.

Quantitative analysis. Quantitative analysis, commonly viewed as a subset of technical analysis, uses mathematical and statistical tools to help investors discover hidden patterns in financial data (Davis, 2017; Gerlein, McGinnity, Belatreche, & Coleman , 2016; Kirilenko, Kyle, Samadi, & Tuzun, 2017). This branch of technical analysis focuses on the use of machine learning, neural networks, and support vector machine techniques to discover patterns in large amounts of financial data (Arnoldi, 2016; Kampouridis & Otero, 2017; Manahov et al., 2014; Singh & Srivastava, 2017). Quants, as they are referred to in the industry, use these quantitative techniques to create new technical tools to identify the most suitable moments throughout the trading day to open and close positions (Huang, Hsu, Chen, Chang, & Li, 2015; Manahov, Hudson, & Hoque, 2015; Wang, Smith, & Hyndman, 2008). These newly created quantitative tools typically rely on small statistical advantages in the market, but the net gains are increased by executing potentially thousands of trades throughout a trading session (Gerlein et al., 2016; Wang et al., 2008). This study focused on the use of a common technical analysis tool. However, the researcher did not develop new quantitative indicators using advanced machine learning. Therefore, quantitative analysis, as defined here, was not a focus of this study. The researcher, instead, focused on traditional and pre-existing technical analysis tools as they might be applied to the Forex market.

The foreign currency markets often employ a great deal of technical analysis (Chang et al., 2017; Zarrabi et al., 2017). It is estimated that up to 40% of FX traders around the globe use some technical analysis to assist in their trading (Kolkova, 2017; Manahov et al., 2014). The use of technical analysis often confounds economist, and traditional financial theorist as technical

analysis directly contradicts the weak-form EMH. Menkhoff and Taylor (2007) propose the reason for the widespread use of technical analysis is that fundamental economic factors such as interest rates and GDP are effective at explaining the long-term exchange rate movements; however, these variables are far less useful at explaining the exchange rate movement within the short-term and intraday basis. Blume, Easley, and O'Hare (1994) stated "because technical analysis helps traders interpret current information, watching the sequence of market statistics allows traders to correctly update their beliefs" (p. 177).

Challenges of technical analysis. There is considerable academic research that does not support the use of technical analysis as an effective tool to produce positive net gains in trading. Park and Irwin (2010) and Marshall, Cahan, and Cahan (2008a, 2008b) examined the use of technical analysis in the commodity futures market and found no statistical support for the profitability of technical analysis. Other researchers (Anderson & Faff, 2005; Bajgrowicz & Scaillet, 2012; Sullivan, Timmermann, & White, 1999) found that technical analysis was not effective in generating profits in the S&P 500 index or the Dow Jones Industrial Average over various time periods. Goldbaum (2003) found that technical trading rules can be profitable, but the fluctuation in popularity of various technical trading rules leads to losses in the long term.

Several researchers discovered that technical trading rules supported the generation of profits (Coe & Laosethakul, 2010; Hudson, Dempsey, & Keasey, 1996; Zhu et al., 2015). However, when those profits were compared to the profits that would have been generated using the traditional buy and hold strategy, the researchers determined that technical analysis could not generate excess profits above the buy and hold strategy (Coe & Laosethakul, 2010; Hudson et al., 1996; Zhu, Jiang, Li, & Zhou, 2015). Additional researchers have found that various technical trading tools to support profitable trading in excess of the buy and hold strategy. Yet,

when these researchers accounted for the transaction costs associated with the technical trading signals, the technical analysis did not outperform the buy and hold strategy (Ellis & Parbery, 2005; Frömmel & Lampaert, 2016; Zakamulin, 2014).

The findings of these researchers provide two critical aspects to consider when examining the results of any study using technical analysis (a) excess profits above the buy and hold strategy, (b) transaction costs. Technical analysis might produce positive net gains, but those net gains must exceed the net gains realized from the buy and hold strategy (Coe & Laosethakul, 2010; Hudson et al., 1996; Zhu et al., 2015). Additionally, the study must incorporate transaction costs as technical analysis will generate more trading costs than a buy and hold strategy (Ellis & Parbery, 2005; Frömmel & Lampaert, 2016; Zakamulin, 2014). Therefore, profits from technical analysis must be higher than the buy and hold strategy after accounting for transactions costs.

In support of technical analysis. Scholars often discount the use of technical analysis because it contradicts an entirely rational approach to the financial markets as outlined by the EMH (Zoicas-Ienciu, 2016). However, over the past several decades there is significant academic research that supports the use of technical analysis in various financial markets. In emerging markets, technical analysis has been shown to produce excess profits beyond the traditional buy and hold strategy (Fifield, Power, & Knipe, 2008; Liu, Ji, & Jin, 2016; Ni, Liao, & Huang, 2015; Shynkevich, 2017; Sobreiro et al., 2016). Technical trading rules support traders in predicting price movements in emerging markets better than those in developed nations (Zhu et al., 2015), which might lend support for the EMH by indicating that developing nations do not have efficient markets and developed nations do have efficient markets (Liu et al., 2016; Zhu et al., 2015). Researchers also found that technical traders in the market help to

reduce volatility by quickly identifying pricing errors and capitalizing on these errors (Detollenaere & Mazza, 2014; Chiarella & Ladley, 2016).

Extensive research has focused on a primary technical trading strategy known as the moving average technical trading strategy (Bonenkamp, Homburg, & Kempf, 2011; Han, Hu, & Yan, 2016; Liu et al., 2017). Researchers applied the moving average cross-over strategies to various equity markets and found these strategies were able to generate profits that exceeded the buy and hold strategy and accounted for the additional transactions cost associated with technical trading (Ahmad et al., 2017; Glabadanidis, 2014, 2015, 2017). Researchers have found similar results in the commodities market (Clare, Seaton, Smith, & Thomas , 2014; Han et al., 2016; Liu et al., 2017; Szakmary, Shen, & Sharma, 2010) using moving average and momentum studies. Bonenkamp et al. (2011) deviated from traditional research studies by combining the use of fundamental analysis (free cash flow) in equity markets and technical analysis to form a trading strategy that exceeds the transaction costs and outperforms the buy and hold strategy. These studies lend support for implementing technical analysis in trading as a means to increase net gains.

Earlier findings from researchers presented evidence that technical analysis applied to foreign currency markets could outperform a buy and hold strategy (Cornell & Dietrich, 1978; Sweeney, 1986). These early results were further supported by researchers analyzing various currency pairs and timeframes (Chang & Osler, 1999; Gencay, Ballocchi, & Dacorogna, Olsen, & Pictet, 2002; LeBaron, 1999; Levich & Thomas, 1993; Neely et al., 1997; Schulmeister, 2006, 2009). Recent technical analysis studies in the foreign currency market have shown that profits have diminished over time (Neely et al., 2007; Olson, 2004; Pukthuanthong et al., 2007). The current research into technical analysis and the Forex market tends to combine various types of

technical analysis-like order flow (Ghyselse, Hill, & Motegi, 2013; Gradojevic & Lento, 2015) and momentum trading (He & Li, 2015; Manahov, Hudson, & Gebka, 2014; Narayan et al., 2015; Orlov, 2016). Gradojevic and Gencay (2013) find that "fuzzy" technical trading rules can outperform simple moving averages in the EUR/USD currency, particularly on high volatility trading days, and produce significant profits. The findings of these researchers support the use of technical analysis in the Forex market.

In summary, the importance of accurately forecasting short-term currency movements has been recognized by both practitioners and academics. Evidence of this importance can be found in the considerable resources devoted to determining the effectiveness of the various predictive tools. Technical analysis is one of these predictive tools and usually involves examining financial market activity through the application of price charts and empirical rules. Although some researchers have found evidence against the profitability of technical analysis in the Forex market, a majority of scholars conclude that using technical analysis in the foreign exchange market can produce statistically significant net gains for currency traders. The findings of these scholars suggest that technical trading is a way for currency portfolio managers to exploit short-term misprices in the market (Poti et al., 2014). Additionally, technical analysis became an essential aspect for financial market practitioners (Neely et al., 2007; Zhu et al., 2015). Most international financial firms and hedge funds engaged in the Forex market use technical analysis as a means to understand the movement of currency prices.

For this research, the researcher studied the use of technical analysis in the EUR/USD currency market on an intraday basis. The intraday timeframe of the Forex market had not been extensively studied by researchers. Given the considerable turnover volume in the Forex market and the need for currency traders to increase the net gains from trading activity, it is important to

further understand the application of technical analysis to intraday currency movements. The results of this study might show evidence that using technical analysis on an intraday basis for currency traders could increase the net gains from trading activity.

Types of technical trading analysis. Various technical trading tools are commonly used by currency traders as a means to increase net gains for their respective companies (Neely et al., 2009; Schulmeister, 2006; Zarrabi et al., 2017). Technical analysis and technical trading rules can be broken down into various categories, and each category has its own unique characteristics (Zarrabi et al., 2017). Moving average, both simple moving averages and exponential moving averages, are trading rules attempt to identify a trend and identify when the trend might come to an end by examing how prices interact with the moving average line (Deng & Sakurai, 2013; Menkhoff & Taylor, 2007; Ozturk et al., 2016; Raj, 2013; Sobreiro et al., 2016). Moving average crossover rules examine the interaction of two or more moving average lines. The moving average technical indicator requires two moving average calculations, one fast and one slow (Coakley et al., 2016; Hsu et al., 2016; McMillan & Speight, 2012; Milionis & Papanagiotou, 2013). An example of a moving average crossover might consist of a 50-period simple moving average and a 200-period simple moving average. When the 50-period simple moving average crosses below the 200 periods moving average, this might indicate a selling opportunity. As with most technical indicators, there is a great deal of subjectivity, and specific inputs (moving average timeframes) can vary from trader to trader.

Support and resistance technical analysis rules use prior price lows as support and prior price highs as resistance (Hsu et al., 2016; Neely et al., 2014; Zarrabi et al., 2017). These areas of support and resistance seem to be pricing levels that currency prices have a difficulty penetrating. Similarly, channel trading creates support and resistance based upon prior price

movements, but the lower and upper bound tend to vary over time creating a channel (Neely et al., 1997; Nazario et al., 2017; Poti et al., 2014). Traders, for example, might sell a currency as prices reach the upper bounds of the channel and buy when prices reach the lower bounds.

Filter rules used in technical analysis produce trade signals in the direction of the prevailing trend when the currency price as moved a specified percentage above or below the opening price (Hsu et al., 2016; Popovic & Durovic, 2014; Zarrabi et al., 2017). Oscillator trading rules attempt to indicate situations when the currency is over-bought (prices are too high) and oversold (prices are too low; Ni et al., 2015; Pukthuanthong et al., 2007). Oscillator analysis does not seek to follow the trend, but instead looks for contrarian trades and mean reversion (Metghalchi et al., 2014; Savin et al., 2007; Schulmeister, 2006). One of the technical analysis tools that are mean reverting is the Bollinger Bands. This study focused on the use of Bollinger Bands on an intraday timeframe.

Variables in the study. The Bollinger Bands technical trading indicator was designed by John Bollinger and is based upon mean reversion and relative price (Coakley et al., 2016; Temnov, 2017; Yan, Zhang, Lv, & Li, 2017). Bollinger Bands are a technical analysis tool that is built upon the mean reverting properties of financial assets (Bollinger, 2002). Bollinger Bands are designed to identify potential reversal patterns in currency pairs (Bajgrowicz & Scaillet, 2012; Hayes et al., 2016). The Bollinger Bands consist of three lines drawn on the price chart for various currency and can be used across several financial instruments. The top line, or band, of the Bollinger Bands, is typically set to a specified number of standard deviations above the moving average line (da Costa, Nazário, Bergo, Sobreiro, & Kimura, 2015; Girma & Paulson, 1998; Kolková & Lenertová, 2016). The moving average line is the middle of the three lines (Bollinger, 2002). The moving average is usually an exponential moving average, but can also

be set to a simple moving average. The lower line, or bottom band, of the Bollinger Bands, is typically set to a specific number of standard deviations below the middle moving average line (Bollinger, 2002; Ozturk et al., 2016; Velez & Capra, 2000). The upper and lower lines form a band around the price movement of the currencies. These bands shift proportionately to maintain a relatively high band and a relatively low band instead of an absolute high and low band (Azizan & M'ng, 2010; Temnov, 2017; Xu & Yang, 2013; Yan et al., 2017). When currency prices reach a high band level, this would indicate prices are currently overbought or too high and present an opportunity to sell the currency or take a short position. Additionally, when currency prices reach the lower band, this would indicate that currency prices are oversold or too low compared to relative prices and present a buying opportunity (Chen et al., 2014). The bands act as a signal for the beginning and end of price trends and price reversals.

Bollinger Bands have been studied in various financial markets and were found to be profitable in the commodities futures energy market (Lubnau & Todorova, 2015; Girma & Paulson, 1998, 1999). Bollinger Bands have also been applied to the equity futures market and shown to produce statistically significant profits (Kathy, 2015; Yan et al., 2017). Researchers applying Bollinger Bands to equity markets were able to capture unexpected price movement. However, researchers ultimately concluded that moving averages tended to be more profitable (Joseph & Terence, 2003; Williams, 2006) than Bollinger Bands. Coakley et al. (2016) studied Bollinger Bands using daily currency prices for 22 currencies traded against the U.S. dollar and found that the strategy produced an average annual return of 20.6%, which exceeded the traditional buy and hold returns. Additional studies have looked at Bollinger Bands and the Forex market on daily timeframes or longer (Bitvai & Cohn, 2015; Chen et al., 2014; Kolková &

Lenertová, 2016) and found that Bollinger Bands help to increase net gains from trading activity in comparison to the buy and hold strategy.

Despite the extensive research into the use of technical analysis in the Forex market, Bollinger Bands research on intraday or tick-level price movements is extremely limited (Savin et al., 2007; Zarrabi et al., 2017). These time frames are essential to currency traders as they are continually studying and analyzing market conditions throughout the day, not just the end of day prices. Therefore, the examination of Bollinger Bands on an intraday currency price might have positive implications for the currency traders and currency managers.

Buy and hold strategy. The buy and hold strategy is an investment strategy where an asset is purchased with the belief that the value of the asset will increase over time creating a net gain (Cohen & Cabiri, 2015). From the literature reviewed above, the buy and hold strategy is often used as a base line to compare any alternative trading strategy. Technical analysis might produce positive net gains, but those net gains must exceed the net gains realized from the buy and hold strategy (Coe & Laosethakul, 2010; Hudson et al., 1996; Zhu et al., 2015). Additionally, the study must incorporate transaction costs as technical analysis will generate more trading costs than a buy and hold strategy (Ellis & Parbery, 2005; Frömmel & Lampaert, 2016; Zakamulin, 2014). Therefore, profits from technical analysis must be higher than the buy and hold strategy after accounting for transaction costs.

Sell and hold strategy. A sell and hold strategy is an investment strategy where an asset is sold to the market at a high price with the belief that the value of the asset will decrease over time and can be bought back at a lower price creating a net gain (Mohamad, 2016). Shorting, also referred to as selling, the market would be the contra-position to the buy and hold strategy (Kelley & Tetlock, 2013; Lee, 2016). Shorting within the foreign currency market can also

represent a hedging position for traders at international banks and global hedge funds (Hasbrouck, 2002; Cohen, Diether, & Mallory, 2007; Tornell & Yuan, 2012). Currency market shorting is an important aspect in the price discovery process (Lee, 2016; Jorge & Augusto, 2016; Mohamad, 2016) and therefore has been included as a variable of interest in many empirical studies (Alexander, 2000; Chen, Gau, & Liao, 2016; Gilje & Taillard, 2017; Nwachukwa & Shitta, 2015). Therefore, profits from technical analysis must be higher than the short and hold strategy after accounting for transaction costs.

Summary of the literature review. The focus of this study is to explore the relationship between net gains and alternative trading techniques. Currency managers, working at hedge funds or international financial institutions, can utilize these techniques and potentially increase the net gains from their currency trading activity. In this literature review I discussed the significant components and structure of the current foreign exchange market to ensure an operational understanding of currency markets. Next, the following section of this research study reviewed the two major market theories. Support and challenges for the EMH and the AMH can be found in scholarly literature. The combination of the efficient market hypothesis, specifically the weak-form, and the adaptive market hypothesis, specifically technical analysis, provides the theoretical support for this study. Next, information in the literature review compared and contrasted fundamental analysis and technical analysis. Various scholarly findings supported the use of technical analysis in the Forex market as a means of predicting short-term price movements and providing traders with a tool for increasing net gains. The literature indicated that research of technical analysis must account for the returns that could have been earned from a buy and hold strategy and account for transaction costs. Previous academic researchers provided information that technical trading strategies, specifically

Bollinger Bands, applied to the Forex market might increase the positive net gains from trading on an intraday basis.

Transition and Summary of Section 1

Understanding the movement of currency prices is a critical component for traders and currency managers (Costantini, Cuaresma, & Hlouskova, 2016; Chen et al., 2014; El Ouadghiri & Uctum, 2016; Mcmillan & Speight, 2012). Accurately forecasting exchange rates continues to be an elusive endeavor despite the vast amount of academic and non-academic resources devoted to the task (Dal Bianco et al., 2012). Currency managers working for global financial institutions and international hedge funds should use every method at their disposal to increase the net gains from foreign currency transactions as a means to maximize shareholder value (Morck, 2014).

Section 2: The Project

The weak form of the EMH states that historical prices are ineffective at increasing the net gains from trading activity for currency traders because all historical price information is known by all currency traders (Fama, 1970). Based upon the EMH technical analysis, which depends on historical prices, should provide zero benefits to currency traders in an efficient market. Due to the unique nature of the currency market, which is a decentralized over-the-counter market, information regarding prices may not disseminate uniformly or efficiently (Dowell-Jones, 2012; Metghalchi et al., 2014; Nurunnabi, 2012) creating opportunities for currency traders to increase net gains using technical analysis.

The focus of this quantitative study is to explore the potential relationship between net gains from currency trading and alternative trading techniques using technical analysis that could be utilized by currency managers at hedge funds and international financial institutions. The previous literature review provided an analysis of existing research in the area of currency trading and alternative trading strategies. Almost all scholarly research has focused on daily prices or longer timeframes with very few researchers focusing on intraday timeframes. The intraday nature of data will be a distinction of this study as compared to previous research.

This section of the research study includes a discussion of the activities necessary to perform the research, collect the data, and analyze the data. Included within this section is a review of the purpose of this research project, data collection methods, selection of the data, research methodology and research design, data analysis, and a review of validity and reliability of the data. These activities were necessary to properly conduct the research based on the problem statement and purpose statement.

Purpose Statement

The purpose of this quantitative study is to examine the net gains from alternative trading techniques that can be utilized by currency managers working for international banks and hedge funds when trading the EUR/USD currency on an intraday basis. The results may provide additional insights for currency managers with regards to the use of alternative trading strategies on an intraday basis within the currency markets. The findings of the research may have a direct application to the business problem of increasing the net gain from foreign currency transactions undertaking by currency management teams and currency traders within global financial institutions and hedge funds. Also, this examination will add to the current literature on technical analysis and help fill in the gap with regards to intraday time frames.

Role of the Researcher

The researcher in this study served several important roles for this project. In order to ensure validity and reliability of this study, it is imperative to discuss the actions the researcher performed during data collection and testing (Rudestam & Newton, 2015). The researcher determined which research method and research design would be most appropriate to answer the research question for this study. The researcher gathered all necessary data required to perform the correlation study of currency exchange rates and Bollinger Band trading on an intraday basis. This correlational research study included data that were generated and collected without any regard of the purpose for this research study. Data collected in this manner allowed no opportunity for the researcher to bias the data. The researcher served as the primary analyst of the data, which included performing the statistical tests and reviewing the results of the data. Finally, the researcher provided an interpretation of the results from the statistical tests to determine if the information addressed the research question and corresponding hypothesis.

Participants

No human participants or organizational representatives were used in this research study. Archival data gathered from a third party were the primary source for all data used for statistical tests. Therefore, no measures to gain access to individual participants and ensure the ethical protection of participants was necessary.

Research Method and Design

There are three main research methods (quantitative, qualitative, and mixed method) employed by researchers. Within the quantitative method, there are multiple research designs: experimental, quasi-experimental, descriptive, and correlation. Selecting the appropriate research design is important to ensure that the research question is addressed. Choosing a proper research design will depend upon the problem to be addressed, the research questions, and the nature of the data available (Creswell, 2014; Parylo, 2012). For this study, a quantitative correlational study was selected as the appropriate method for addressing the research questions and purpose of the study.

Discussion of method. Researchers using quantitative methods seek to exam various hypotheses by testing the relationship between numerical variables (Creswell, 2014). Quantitative researchers tend to gather objective, historical, numerical sample data and then analyze these sample sets using statistical tools. Researchers then gain insights based on the results of the statistical analysis (Stake, 2010; Yin, 2011). The quantitative research method supports the nature of the data collected for this study. More importantly, since the purpose of this research was to determine if there is any correlation between net gain within foreign exchange transactions and various trading techniques (Creswell, 2014), the quantitative research method was used for this study.

Qualitative research was not an appropriate research method for the problem identified because analyzing personal experiences would not be appropriate to address the research question. At the core of qualitative research is a method that has a "reliance on human perceptions and understanding" (Stake, 2010, p. 11). Scholars using qualitative research often attempt to explain a particular social behavior or way of thinking (Yin, 2011). Multiple sources of data can be collected in the qualitative research approach to explore the specific context that may help explain a particular observed behavior (Creswell, 2014). The researcher using a qualitative study approach seeks to contribute insights from existing concepts or attempts to develop new concepts (Yin, 2011). Based on the purpose of this study, qualitative research methods would not be applicable.

The mixed method approach incorporates both qualitative and quantitative research methods. Researchers employing a mixed method approach attempt to provide a more thorough and complete understanding of the research problem by those employing this method (Stake, 2010). By combining both methods, the researcher hopes to gain greater clarity than either the qualitative or the quantitative approach can provide on its own (Creswell, 2014). The mixed method approach was not an appropriate research method for the problem identified in this study. The qualitative portion of the mixed method would not be appropriate to address the research questions.

Discussion of design. A quantitative correlational research design was selected for this study to examine the relationship between net gain from currency trading and alternative trading strategies using Bollinger Bands. Correlation research design typically uses sample data gathered from a population to determine if there is any relationship between the variables being tested (Cash et al., 2016). Additionally, within correlation studies, there is no attempt by the

researcher to control any variables used in the study (Meyers et al., 2016). Random sample data for this study were gathered for the EUR/USD foreign currency pair starting in January 2009 and ending December 2016. No attempt to control any of the variables in the sample set was made. The dependent variable, the net gain from trading, was documented by several other researchers (Menkhoff & Taylor, 2007; Metghalchi et al., 2014; Bitvai & Cohn, 2015). Three different trading techniques were the independent variables (Bollinger Bands [X1], buy and hold-long strategy [X2], and sell and hold-short strategy [X3]). These techniques will be applied to the data to determine if a specific trading technique has a higher positive correlation with net gains and to determine if there is a statistical difference between the different group means. Trading techniques used to increase net gains can be utilized by currency managers working for international banks and hedge funds. Given the nature of the data and problem statement, conducting a correlation study was justified as the research method for this study.

The research for this study was designed to answer the following research question: Do currency trading managers at international banks and hedge funds experience a difference in net gain from currency transactions when employing a traditional trading approach as compared to an alternative trading strategy when trading the EUR/USD spot market on an intraday period? For this study, net gains from trading was the dependent variable. Net gains as a dependent variable are documented by other researchers (Menkhoff & Taylor, 2007; Metghalchi et al., 2014; Bitvai & Cohn, 2015). Based on the research question, the first independent variable was the alternative trading strategy using Bollinger Bands (X1). Based on the research question, the second independent variable was the traditional trading technique using a buy and hold strategy (X2). Based on the research question, the third independent variable was the traditional trading technique using a sell and hold strategy (X3). These variables relate directly to the specific

problem addressed in this study, which is some managers of currency traders are unclear if using alternative trading strategies on an intraday basis can increase the net gains from currency trading.

Summary of Research Method and Design

In summary, the research for this study was designed to answer the following research question: Do currency trading managers at international banks and hedge funds experience a difference in net gain from currency transactions when employing a traditional trading approach as compared to an alternative trading strategy when trading the EUR/USD spot market on an intraday period? A quantitative correlational study was selected for this study to examine the relationship between net gain from currency trading and alternative trading strategies using Bollinger Bands to address the research question. Net gains from trading will be the dependent variable. The traditional trading strategy of buy and hold, a strategy of shorting the EUR/USD, and the alternative trading strategy will be the independent variables. Net gains as a dependent variable are documented by other researchers. These variables relate directly to the specific problem to be addressed in this study, which is some managers of currency traders are unclear if using alternative trading strategies on an intraday basis can increase the net gains from currency trading.

Population and Sampling

Foreign currencies are traded globally over-the-counter and are not governed by any centralized exchange (Ackerman, 2016; El Ouadghiri & Uctum, 2016). The population of currency exchange rates includes thousands of currency pairs such as EUR/USD, AUD/USD, USD/JPY, and USD/CHF (Harvey, 2013). For this study, a sample was drawn from the population of EUR/USD exchange rates. According to the Bank of International Settlement, the

USD and the EUR account for the largest portion of exchange turnover volume in the spot market (April 2016). The EUR/USD was chosen because of the significant volume that these two currencies represent in the overall Forex market. Several recent studies have also examined the EUR/USD currency pair because of the significance of trading volume (Bush & Stephens, 2016; Costantini et al., 2016; Hamzaoui & Regaieg, 2016; Kolkova, 2017; Wong & Heaney, 2017). The sample was gathered for an eight-year period beginning January 2009 through December 2016. This period was selected based on the availability of the data. Forex market is traded 24 hours a day, five days a week. Weekends were excluded from sampling because the FX market is closed. This time period produced an estimated 500,000 price changes per day with a projected total number of prices observed reaching 70,000,000 over the sample period.

Using Microsoft Excel, a stratified random sample of 20 days were selected from each of the eight years providing a sample of 160 observations (n=160). The sample size of 160 was selected based upon the confidence level of 90% and a confidence interval of 10%. A 90% confidence level and lower has been employed by other researchers testing various trading techniques in the financial markets. Hsu et al. (2016) set the 90% confidence interval as their threshold when testing technical trading tools in the foreign exchange market. Kim, An, and Kim (2015) examined exchange rates and capital flow using a confidence level of 84%. Kraple and O'Brien (2105) and Krapl (2017) studied the Forex cash flow and equity exposure of U.S. multinational corporations using the 90% confidence level. Marshall, Musayev, Pinto, and Tang (2012) studied the foreign exchange volatility and the impact of news announcements using both the .10 level and .05 level. Gloede and Menkhoff (2014) examined the financial professional's ability to accurately forecast their own financial performance using the 90% confidence interval. Finally, Crowder (2014), examined exchange rate equilibrium using purchasing power parity for

roughly 12 different currencies and various time horizons using the 90% confidence interval. Based on these previous research parameters and the similarity to this study, the 90% confidence level and 10% confidence interval level were selected for this study.

Data Collection

The focus of the data is on the Forex spot market or cash market. The FX spot market is the currency market for immediate delivery with all trades settling within two days of the transaction (Powers, 2016; Rzepczynski, 2008). The spot market does not include trades of financial instruments but instead is an exchange of one currency for another at the current exchange rate or spot rate (Gerber, 2016; Kamau et al., 2015). In contrast, the futures market includes the same current pairs, but the exchange will take place on some date in the future (Pintar et al., 2016). The spot market was chosen because this is the market that most global bank traders and hedge fund traders participate (Wang et al., 2017). The distinction between the spot market and futures is important because the spot market is decentralized and no single source of data encapsulates all currency activity. The decentralization issue is overcome by using a third party data aggregator as described in the next section.

Instruments. This quantitative research did not employ any specific instrument such as questionnaires, interviews, or surveys. The data needed to conduct the statistical tests were obtained from a third-party provider. The data were downloaded directly from the data provider's website in comma delimited format. This information was loaded directly into Microsoft Excel. A Microsoft Excel template was created for this project to handle the creation of Bollinger Bands, simple moving average, trade entry, trade exit, and calculate cumulative net gains from each trading strategy. These results were then imported into SPSS to perform the statistical analysis.

Data collection techniques. The Forex market is a globally decentralized over-the-counter market (Ackerman, 2016; El Ouadghiri & Uctum, 2016). This means there were no single source for all currency data transactions. Data for this study were obtained from a third party data provider, TickData, LLC. TickData, LLC overcomes the issues of decentralization and over-the-counter execution by aggregating currency quotes from several contributing institutions. Each contributor provides primary, secondary, and tertiary data (TickData, LLC., 2016). This process provides data that are isolated, redundant, and geographically diverse. Through a proprietary data system, TickData, LLC compares all three levels of currency exchange prices and synthesizes all information into a single data item free from errors and omissions (TickData, 2017).

The information provided by Tickdata, LLC includes quote date, quote time down to the millisecond, bid price, ask price, contributor code (source of exchange data), region code (region of the exchange data), and city code (city of the exchange data). Tick-level data includes the date, a time stamp, bid price, and ask price. The regional data are provided from North America (NAM), Europe, the Middle East and Africa (EMEA), Asia-Pacific (ASI), and other global locations (GLO).

Data organization techniques. Data for this study were organized using Microsoft Excel. Currency tick data were collected for each random day selected for this study. Several days in the study required more than one Excel file because there were more lines of data than one Excel sheet could hold. Each day's data were then processed for the opening bid price, opening ask price, closing ask price, and closing bid price. Additionally, each day was processed to obtain the net gain from each trading strategy.

Summary of Data Collection

In summary, the decentralization issue was overcome by using a third party data aggregator, Tickdata, LLC. The data were downloaded directly from the data provider's website in comma delimited format. This information was loaded directly into Microsoft Excel. A Microsoft Excel template was created for this project to handle the creation of Bollinger Bands, simple moving average, trade entry, trade exit, and calculate cumulative net gains from each trading strategy.

Data Analysis

Data obtained from Tickdata, LLC were directly exported into Microsoft Excel. Microsoft Excel was used to establish the Bollinger Bands, trade entry, trade exit, calculate net gains, and summation of trading activity. All Microsoft Excel files were stored in a cloud-based storage system for easy access and retrieval. The cloud storage provider, DropBox, offers password-protected access. However, because the data did not contain any sensitive information, no additional security steps were taken to safeguard the data. The Microsoft Excel data were then imported into IBM SPSS to perform statistical analysis of the data.

Variables used in the study. In order to address the research question for this study, the first independent variable was the alternative trading strategy using Bollinger Bands (X1). Based on the research question, the second independent variable was the traditional trading technique using a buy and hold strategy (X2). Based on the research question, the third independent variable was the traditional trading technique using a sell and hold strategy (X3). These variables relate directly to the specific problem to be addressed in this study, which is some managers of currency traders are unclear if using alternative trading strategies on an intraday basis can increase the net gains from currency trading. The following paragraphs provide: (a) a

detailed explanation of all the variables used in this study, (b) a discussion of how those variables will be collected, and (c) a review of how those variables will be tested.

Bollinger Band Parameters. Bollinger Bands are a technical analysis tool that is built upon the mean-reverting properties of financial assets (Bollinger, 2002). Bollinger Bands are designed to identify potential reversal patterns in currency pairs (Bajgrowicz & Scaillet, 2012; Hayes et al., 2016). The Bollinger Bands consist of three lines drawn on the price chart for various currency and can be used across several financial instruments. The top line, or band, of the Bollinger Bands, is typically set to a specified number of standard deviations above the moving average line (da Costa et al., 2015; Girma & Paulson, 1998; Kolková & Lenertová, 2016). The moving average line is the middle of the three lines (Bollinger, 2002). The moving average can be a simple moving average or an exponential moving average. For this study, the moving average is a simple moving average similar to other studies (Hayes et al., 2016, Kolková & Lenertová, 2016).

For this study, the moving average was a simple moving average calculated using the previous 20 price ticks of the mid-price. The mid-price was calculated as follows:

$$\text{Mid-price} = \frac{b+a}{2}$$

Where *b* is the current bid price, and *a* is the current ask price. The simple moving average will be calculated using the mid-price from the previous 20 price ticks. The simple moving average was calculated as follows:

$$\text{Simple Moving Average} = \frac{\sum_{i=1}^{n} P_{(d-i)+1}}{n} \quad n \leq d$$

Where *P* is the mid-price, *n* is the number of periods, *d* is moving average periods. The lower line, or bottom band, of the Bollinger Bands, is typically set to a specific number of

moving standard deviations below the middle moving average line. Similarly, the upper line, or upper band, of the Bollinger Bands, is typically set to a specific number of moving standard deviations above the middle moving average line (Bollinger, 2002; Ozturk et al., 2016; Velez & Capra, 2000). The simple moving average and the moving standard deviation will both be calculated on the same number of periods. For this study, the upper and lower bands were set at 3 standard deviations from the simple moving average over the previous 20 periods. The standard deviation for each exchange rate for the previous 20 periods was calculated as follows:

$$\text{Moving Standard Deviation} = \sqrt{\frac{\sum(x-\overline{x})^2}{N}}$$

Where x is mid-price, $\overline{x}$ is the mean of the mid-price over the last 20 periods, and N is the number of periods. The moving standard deviation formula does not use the sample standard deviation formula because there is no attempt, at this point in the calculation, to infer sample data onto population data (Lubnau & Todorova, 2015; Ozturk et al., 2016). Therefore, there is no need for degrees of freedom adjustment that is contained in the sample standard deviation calculation.

Bollinger Band Entry and Exit. Trade signals for entering and exiting positions are described below. Entry signals for long and short positions for Bollinger Bands are generated when EUR/USD prices reach extreme values (Lubnau & Todorova, 2015; Ozturk et al., 2016). For this study, extreme values are defined as 3 standard deviations above the simple moving average and -3 standard deviations below the simple moving average. Entry signals for long currency trades occur whenever prices have reached an extreme value (-3 standard deviations below the simple moving average), and then prices begin reverting toward the simple moving average. A long position will be entered whenever prices cross back above the -3.0 standard

deviation line. Long positions will be executed at the current ask price. Long position profit targets will be set at 50% of 1% of the current exchange rate for that trade. Long position stop loss targets will be set at 50% of 1% of the current exchange rate for that trade.

Long positions will be closed at the bid price. This effectively captures the bid/ask spread which would account for the transaction costs of the Bollinger Band strategy. The difference of the bid/ask spread will effectively lower each net gain and increase each net loss as would be experienced by real-time traders. Additionally, once a long trade has been entered into, this position must be closed before any new trades can be executed (there will only be one trade active at any one time regardless of the signals). Net gains from this strategy, inclusive of transaction cost, will be combined with the net gains from the short Bollinger Band trades to arrive at one figure for net gains from the Bollinger band strategy for that particular trading day.

Short positions will be entered into at the current bid price. Entry signals for short currency trades occur whenever the exchange rate has reached an extreme value (a standard deviation of 3), and then the exchange rate begins reverting toward the simple moving average. A short position will be entered whenever the exchange rate crosses below the 3 standard deviations after prices have traded above the 3 standard deviation value. Short positions will be executed at the ask price. Short position profit targets will be set at 50% of 1% of the current exchange rate for that trade. Short position stop loss targets will be set at 50% of 1% of the current exchange rate for that trade price.

Short positions will be closed at the ask price. This effectively captures the bid/ask spread which would account for the transaction costs of the Bollinger Band strategy. The difference of the bid/ask spread will effectively lower each net gain and increase each net loss as would be experienced by real-time traders. Additionally, once a long trade has been entered into,

this position must be closed before any new trades can be executed (there will only be one trade active at any one time regardless of the signals). Net gains from this strategy, inclusive of transaction cost, will be combined with the net gains from the short Bollinger Band trades to arrive at one figure for net gains from the Bollinger Band strategy for that specific trading day.

Buy and hold: Parameters and entry/exit. In order to address the research question for this study and the second hypothesis, a traditional buy and hold strategy will be examined. Trades for the traditional buy and hold technique will be entered into at the beginning of the trading day. Every trading day, a long currency trade will be opened at the beginning of the trading day at the opening ask price for that day and closed at the end of the trading day at the closing bid price for that day. These trades will represent a traditional trading strategy taking a long position in the EUR/USD. Long transactions will be executed at the ask price and closed at the bid price. The net gains from this strategy, inclusive of transaction costs equal to the bid/ask spread, will be calculated for the sample period (Kuang et al., 2014; Lubnau & Todorova, 2015).

Sell and hold: Parameters and entry/exit. Simulating a short currency trade was accomplished by opening a short currency position every day and closing that short position at the close of every trading day. Short transactions were executed at the bid price and closed at the ask price. Net gains from this strategy, inclusive of transactions costs equal to the bid/ask spread, will be calculated for the sample period (Kuang et al., 2014; Lubnau & Todorova, 2015). These net gains or losses for each trading day were then used to compare the variance between the Bollinger Band strategy, buy and hold strategy, and the short and hold strategy.

Transaction size, transaction costs, and interest. The specific problem to be addressed in this study was that some managers of currency traders are unclear if using alternative trading strategies on an intraday basis can increase the net gains from currency trading. It is necessary to

replicate trading activities that are similar to real-world situations. The contract size for each trade will be the standard lot size of 100,000 units of the base currency which is USD (Mende & Menkhoff, 2006; Ozturk et al., 2016). Transaction costs will be calculated at the time of each trade. Transaction costs will be equal to the difference between the bid/ask spread at the time of the transaction (Levich & Thomas, 1993; Opie & Dark, 2015). This costs will be deducted from the gain or added to any loss incurred by both the traditional trading strategy of buy and hold or the alternative trading strategy using Bollinger Bands. For example, a long position in the EUR/USD is entered into when the bid is 1.25603, and the ask is 1.25601. The transaction cost would be equal to the difference between the bid and the ask price (0.00002) multiplied by $100,000 for a total cost of $2.00 (Neely et al., 2009; Ozturk et al., 2016). Upon exiting the position, the same method to calculate the transaction costs will be used. Each trade will have two transactions costs, one to open the trade and one to close the trade.

Given that all trading began and ended within the same trading day, the researcher assumed that traders would not gain any interest for holding currencies overnight. Additionally, no interest is earned for holding cash positions (Dunis & Evans, 2006; Lubnau & Todorova, 2015; Metghalchi et al., 2014; Narayan et al., 2015).

Hypotheses 1. The stated hypotheses directly relate to the research question and attempt to address the specific problem of this research study. The first null hypothesis and corresponding alternative hypothesis examines the relationship between the alternative trading strategy using Bollinger Bands and the traditional buy and hold strategy. It states:

$H1_0$: There is no statistically significant difference between net gains generated and the use of an alternative trading strategy (X1) on an intraday basis for the EUR/USD spot currency market as compared to the traditional buy and hold strategy (X2).

$H1_a$: There is a statistically significant difference between net gains generated and the use of an alternative trading strategy (X1) on an intraday basis for the EUR/USD spot currency market as compared to the traditional buy and hold strategy (X2).

Hypotheses 2. The second null hypothesis and corresponding alternative hypothesis examines the relationship between the alternative trading strategy using Bollinger Bands and the traditional sell and hold strategy. It states:

$H2_0$: There is no statistically significant difference between net gains generated and the use of an alternative trading strategy (X1) on an intraday basis for the EUR/USD spot currency market as compared to the sell and hold strategy (X3).

$H2_a$: There is a statistically significant difference between net gains generated and the use of an alternative trading strategy (X1) on an intraday basis for the EUR/USD spot currency market as compared to the sell and hold strategy (X3).

Statistical analysis. The one-way analysis of variance (ANOVA) was used to test for significant differences between the independent variables (treatments). The dependent variable in this study is the net gains from trading activity. The treatments or independent variables are the Bollinger band strategy (X1), buy and hold strategy (X2), and short and hold strategy (X3). As described above Microsoft Excel was used to generate a random sample of 20 days per year between January 2009 and December 2016. Net gains (dependent variable) for each independent variable was determined using the same tick level currency data. Therefore, the only difference between the independent variables are the trading strategies.

In order to generate a net gain figure from the Bollinger Band strategy (X1), the raw tick level data are imported into Microsoft Excel, and the trading parameters described above (Bollinger Band Entry and Exit) were applied to the data. This procedure produced a set of

trades using the Bollinger Band strategy. The gains and losses for all trades from that specific trading day were aggregated together to arrive at a single net gain or net loss from the Bollinger Band strategy for each randomly selected day. The net gains from this strategy were used to test Hypothesis 1 and Hypothesis 2.

In order to generate a net gain figure (dependent variable) for each random day for the buy and hold strategy (X2), a long currency trade was opened at the beginning of the trading day at the opening ask price for that day and closed at the end of the trading day at the closing bid price for that day. These trades represented a traditional buy and hold trading strategy taking a long position in the EUR/USD. Long transactions were executed at the bid price and closed at the ask price. The net gains from this strategy, inclusive of transaction costs equal to the bid/ask spread, were calculated for the sample period and entered into Microsoft Excel for that day. The net gains from this strategy were used to test Hypothesis 1.

In order to generate a net gain figure (dependent variable) for each random day for the sell and hold strategy (X3), a short currency trade was accomplished by opening a short currency position every day and closing that short position at the close of every trading day. Short transactions were executed at the ask price and closed at the bid price. The net gains from this strategy, inclusive of transaction costs equal to the bid/ask spread, were calculated for the sample period and entered into Microsoft Excel for that day. The net gains from this strategy were used to test Hypothesis 2.

These net gains or losses for each trading day was then used to compare the average net gains of the Bollinger Band strategy, the buy and hold strategy, and the short and hold strategy using ANOVA. The level of significance for this study was alpha = .10. The 0.10 level of alpha

provides a 90% confidence level that the null hypothesis will be rejected when it is false. Support for these levels were previously cited.

To conclude, NumXL, an add-on to Microsoft Excel, was used to test for normality of the data. If the data are found to be normally distributed, then Microsoft Excel was used to perform the ANOVA tests. Microsoft Excel was used to perform any additional post-hoc testing if necessary.

Summary of data analysis. To address the research question for this study and the related hypotheses, an alternative trading technique using Bollinger Bands was examined. Data obtained from Tickdata, LLC were directly exported into Microsoft Excel. Microsoft Excel was used to establish the Bollinger Bands, trade entry, trade exit, calculate net gains, and summation of trading activity. Trades for the traditional buy and hold technique were entered into at the beginning of the trading day. Every trading day, a long currency trade was opened at the beginning of the trading day at the opening ask price for that day and closed at the end of the trading day at the closing bid price for that day. Short transactions were executed at the ask price and closed at the bid price. Net gains from this strategy, inclusive of transactions costs equal to the bid/ask spread, were calculated for the sample period. These net gains or losses for each trading day were then used to compare the variance between the Bollinger Band strategy, buy and hold strategy, and the short and hold strategy.

Reliability and Validity

Reliability and validity are essential in all scholarly research (Creswell, 2014). Reliability addresses the replicability of the study under similar circumstances and attempts to understand any measurement error that might exist (Muijs, 2011). The concept of validity seeks to ensure that the research tools being used are measuring what they are supposed to and directly

relate back to the hypothesis (Creswell, 2014). Reliability and validity need to be present in research studies so the findings and conclusions can be examined by other researchers.

Reliability. Reliability in research examines the issue of replication of the study under similar circumstances (Fink, 2014). The application of reliability varied depending on the research method (qualitative, quantitative, or mixed method). In qualitative studies, reliability can address issues of training interviewers, describing a systematic approach to recording data, and theme development (Yin, 2006). Reliability in qualitative studies focuses on consistency in coding raw data in such a way that other researchers could arrive at similar conclusions (Rudestam & Newton, 2015). In quantitative research methods, reliability addresses the ability of other researchers to confirm the results of the study and examines the accuracy of the data collection process (Creswell, 2014). Given this study used a quantitative research approach, the focus of reliability was on replication of the results and understanding the accuracy of the data.

The researcher used archival data for this research project, and no other testing instrument was used. Archival data were provided by TickData, LLC, a third party data provider for currency market data. Historical market data provided by TickData have been used in several other market research studies which have appeared recently in scholarly peer-reviewed journals (Bastidon, 2017; Drechsler, 2013; Ishida, McAleer, & Oya, 2011; Jubinski & Lipton, 2012; Lasser & Spizman, 2016; Prokopczuk, Symeonidis, & Wese-Simen, 2016; Wright, 2012). Usage of the archival currency data provided by TickData by other researchers supports the reliability of this study. However, there is an inherent data issue with all historical spot currency market data. The foreign currency exchange market is a decentralized over-the-counter market (Ackerman, 2016; El Ouadghiri & Uctum, 2016). Therefore, one single source for all currency data transactions does not exist. TickData, LLC attempts to overcome the issues of

decentralization and over-the-counter execution by aggregating currency quotes from several contributing institutions. Each contributor provides primary, secondary, and tertiary data. This process provides data that are isolated, redundant, and geographically diverse. Through a proprietary data system, TickData, LLC compares all three levels of currency exchange prices and synthesizes all information into a single data item free from errors and omissions (TickData, 2017). Based upon this process and the use of TickData information by other researchers, it is reasonable to assume the currency data used in this study accurately represents the historical currency prices of the EUR/USD spot exchange market. It is also reasonable to assume that researchers using other data sources would reach similar conclusions.

Validity. Validity in the context of quantitative research "refers to the degree to which a measure assesses what it purports to measure" (Fink, 2014, p. 106). The validity of research studies can be broken down into the internal validity and the external validity. The researcher discusses both internal and external validity issues below.

Internal validity. Internal validity refers to the ability of the study to claim a causal relationship between independent variables and the dependent variable (Creswell, 2014; Rudestam & Newton, 2015). In this quantitative correlation study, the researcher was not attempting to claim a causal relationship between the independent variables (trading strategies) and the dependent variable (net gains). Instead, the researcher sought to understand the correlation of the relationship, the direction of the relationship, the strength of the relationship, and the statistical significance of the relationship between the independent variables and dependent variable. Additionally, the researcher used historical archival currency data provided by an independent third party to reduce the threat to internal validity. There were no other data collection methods used in this research study.

External validity. External validity of quantitative research methods addresses the issue of generalizability of the sample data to make inferences about the population as a whole (Creswell, 2014). Threats to external validity in research studies occur when generalizability of the results do not transfer to other samples, times, or situations (Taylor, 2014). To avoid the threat of external validity due to sample selection, the researcher focused on an entire year of data from the EUR/USD exchange rates. No attempt was made to bias the data set toward a favorable or non-favorable outcome for any of the independent variables selected. The researcher could not overcome the threat to external validity regarding time. Since this study is not a replication of previous research, the only way to overcome this threat is to replicate this study over different time periods (Creswell, 2014). This threat will be addressed in the recommendations for future research. The threat to external validity posed by the situation, or setting, was minimized by using historical archival data from the same source for all tests and using similar data processing.

Summary of reliability and validity. Reliability and validity need to be present in research studies so that the findings and conclusions can be examined by other researchers. Reliability addresses the replicability of the study under similar circumstances and attempts to understand any measurement error that might exist. The concept of validity seeks to ensure that the research tools being used are measuring what they are supposed to and directly relate back to the hypothesis. Reliability and validity are essential for all scholarly research.

Transition and Summary of Section 2

The focus of this quantitative study was to explore the potential relationship between net gains from currency trading and alternative trading techniques using technical analysis that could be utilized by currency managers at hedge funds and international financial institutions. Almost

all scholarly research has focused on daily prices or longer timeframes with very few focusing on intraday. The intraday nature of data will be a distinction of this study as compared to previous research. This section reviewed the purpose of the study, the stated research question, and the hypothesis formed to answer the research question. Additionally, this section discussed the research methodology and quantitative design, data collection, data analysis, reliability, and validity. Consideration was given to each step of this research study to maximize the validity and reliability of the findings presented in this research study.

The next section of this research project will discuss in detail the results of the data analysis, correlations, strength of the relationship, ANOVA results, and confidence in the data. Due to the applied nature of the research problem, the next section will also include recommendations for application in currency trading taking place at international banks and hedge funds. Finally, recommendations for further study will be made to support the validity and reliability of the findings of this study.

Section 3: Application to Professional Practice and Implications for Change

International financial institutions and hedge funds speculate in currency markets as a means to increase profits for their existing currency positions (Aktan et al., 2013; Shen & Hartarska, 2013). The role of currency traders, whether they are working for multinational financial institutions or hedge funds, is to engage in currency activities that increase the net gain per currency transaction for their respective firms (Fiedor & Holda, 2016; Kamau et al., 2015). Currency traders use technical analysis, fundamental analysis, or a combination of both as a means to increase net gains from trading activity (Kuang et al., 2014; de Zwart et al., 2009). Technical analysis tools such as the Bollinger Bands can be used by currency traders and may support increased net gains realized from their foreign exchange trading activity (Coakley et al., 2016; Chen et al., 2014; Lubnau & Todorova, 2015). The purpose of this quantitative study is to examine the net gains from alternative trading techniques that can be utilized by currency managers working for international banks and hedge funds when trading the EUR/USD currency on an intraday basis.

The findings from this research are presented in this section. These findings may potentially contribute to the existing body of knowledge concerning the use of technical analysis when trading the EUR/USD currency pair on an intraday basis. This section includes: (a) overview of the study, (b) presentation of the findings, (c) applications to professional practice, (d) recommendation for further action, (e) recommendation for further study, (f) reflections, and (g) summary and conclusion of the study.

Overview of the Study

The challenge for many international firms is that essential currency markets are also a source of volatility and risk for all participants (Wong, 2016). Global financial institutions

provide a mechanism for multinational corporations to hedge against exchange rate risk via currency futures contracts and spot exchange rates (Chien et al., 2013). Within these global financial institutions, the currency trading team, led by currency managers, speculate in currency markets as a means to increase profits of their existing currency positions (Aktan et al., 2013; Shen & Hartarska, 2013). This research project was undertaken to add to the current body of knowledge concerning currency trading and technical analysis.

The research for this study was designed to answer the following research question: Do currency trading managers at international banks and hedge funds experience a difference in net gain from currency transactions when employing a traditional trading approach as compared to an alternative trading strategy when trading the EUR/USD spot market on an intraday period? The findings from this research suggest that using an alternative trading strategy, such as the Bollinger Bands, on an intraday basis does not necessarily increase net gain from trading activity. The net gain from trading activity using the Bollinger Bands on an intraday basis produced an average negative return. This is similar to the results of the buy and hold strategy which also produced an average negative return over the same sample period. However, the sell and hold strategy produced a positive average return over the sample period. A detailed discussion of the findings from this study is provided in the following section.

Presentation of the Findings

The data available for this research study included historical tick data for the EUR/USD from 2009 to 2016. The data were purchased from TickData, LLC. A stratified random sample of 20 days per year (excluding weekends) was selected producing a sample size of 160 days (n=160). There were no gaps or missing data for the random days selected. Appendix A lists all

160 days that were randomly generated using Microsoft Excel's random function. These days are provided for those who wish to examine the specific trading days included in the study.

Descriptive Statistics

Table 1 below provides the descriptive statistics for the Bollinger Band trading strategy, the buy and hold strategy, and the sell and hold strategy for all eight years.

Table 1

Descriptive Statistics for All Eight Years

Bollinger Band Strategy		*Buy and Hold Strategy*		*Sell and Hold Strategy*	
Mean Net Gain	$ (1,128.61)	*Mean Net Gain*	$ (65.81)	*Mean Net Gain*	$ 16.88
Standard Error	248.27	Standard Error	60.32	Standard Error	60.24
Median	$ (70.00)	Median	$ 10.00	Median	$ (60.00)
Standard Deviation	$ 3,140.38	Standard Deviat	$ 763.00	Standard Devi	$ 761.97
Sample Variance	9,862,014.24	Sample Varianc	582,166.63	Sample Variar	580,601.49
Kurtosis	3.21	Kurtosis	3.31	Kurtosis	3.28
Skewness	-1.74	Skewness	-0.81	Skewness	0.78
Range	$ 19,480.00	Range	$ 5,500.00	Range	$ 5,480.00
Minimum	$ (13,740.00)	Minimum	$ (3,320.00)	Minimum	$ (2,250.00)
Maximum	$ 5,740.00	Maximum	$ 2,180.00	Maximum	$ 3,230.00
Sum	$ (180,578.00)	Sum	$(10,530.00)	Sum	$ 2,700.00
Count	160	Count	160	Count	160

Table 1 displays the mean net gain from each trading strategy. Over the entire sample period (n=160), the mean net gain from using the Bollinger Band strategy produced a negative gain of $1,128.61 for each trading day with a total negative gain of $180,578. The mean net gain from using the buy and hold strategy was a negative $65.81 per trading day with a total negative gain of $10,530. The sell and hold strategy produced a mean net gain of $16.88 per trading day with a total positive net gain of $2,700.

Table 2 displays the descriptive statistics on a year-by-year basis for each trading strategy. From Table 2, the Bollinger Band strategy produced positive mean net gains in 2009, 2010, and 2014. For the Bollinger Band strategy, the highest positive net gain was in 2009 for a

total gain of $17,330, while 2015 showed the largest negative net loss of $132,426. The buy and hold strategy produced positive mean net gains in 2012 and 2016. For the buy and hold strategy, the highest positive net gain was in 2012 in the amount of $2,000 while the largest net loss was in 2009 in the amount of $9,540. The sell and hold strategy produced positive mean net gains in 2009, 2010, and 2013. For the sell and hold strategy, the highest positive net gain was in 2009 in the amount of $8,250 while the largest net loss was in 2012 in the amount of $3,100.

Table 2

Year-by-Year Descriptive Statistics for each Trading Strategy

Bollinger Bands										
	Mean Net Gain	*SE*	*Median*	*Std. Dev.*	*Sample Var.*	*Kurtosis*	*Skewness*	*Range*	*Sum*	*Sample size (n)*
2009	$ 866.50	420.74	470	1881.60	3,540,434.47	1.08	1.09	$ 7,280.00	$ 17,330.00	20
2010	$ 106.50	151.99	95	679.72	462,013.42	-0.77	0.34	$ 2,450.00	$ 2,130.00	20
2011	$ (111.50)	172.46	35	771.27	594,855.53	-0.08	0.39	$ 2,910.00	$ (2,230.00)	20
2012	$ (25.00)	102.11	-35	456.65	208,531.58	1.01	-0.21	$ 2,060.00	$ (500.00)	20
2013	$ (135.50)	142.57	-25	637.61	406,541.84	1.48	-1.05	$ 2,710.00	$ (2,710.00)	20
2014	$ 32.40	53.95	25	241.29	58,219.94	-0.09	0.30	$ 880.00	$ 648.00	20
2015	$ (6,621.30)	798.42	-6660	3570.65	12,749,537.06	0.39	0.22	$14,380.00	$(132,426.00)	20
2016	$ (3,141.00)	945.12	-2490	4226.72	17,865,146.32	-0.55	-0.02	$15,050.00	$ (62,820.00)	20
Buy and Hold										
	Mean Net Gain	*SE*	*Median*	*Std. Dev.*	*Sample Var.*	*Kurtosis*	*Skewness*	*Range*	*Sum*	*Sample size (n)*
2009	$ (477.00)	297.09	-300.00	1328.63	1,765,264.21	0.62	-0.27	$ 5,370.00	$ (9,540.00)	20
2010	$ (91.50)	195.52	-125.00	874.39	764,550.26	1.04	0.83	$ 3,640.00	$ (1,830.00)	20
2011	$ (38.00)	161.47	160.00	722.10	521,427.37	1.08	-1.00	$ 2,910.00	$ (760.00)	20
2012	$ 100.00	127.88	85.00	571.91	327,084.21	-0.21	-0.27	$ 2,030.00	$ 2,000.00	20
2013	$ (55.50)	108.18	-30.00	483.80	234,057.63	1.05	-0.96	$ 1,810.00	$ (1,110.00)	20
2014	$ (20.50)	73.29	-20.00	327.74	107,415.53	0.91	0.75	$ 1,300.00	$ (410.00)	20
2015	$ (13.00)	169.71	30.00	758.96	576,022.11	3.70	-1.33	$ 3,480.00	$ (260.00)	20
2016	$ 69.00	131.00	105.00	585.86	343,230.53	-0.48	-0.37	$ 1,970.00	$ 1,380.00	20
Sell and Hold										
	Mean Net Gain	*SE*	*Median*	*Std. Dev.*	*Sample Var.*	*Kurtosis*	*Skewness*	*Range*	*Sum*	*Sample size (n)*
2009	$ 412.50	297.39	225.00	1329.98	1,768,840.79	0.59	0.26	$ 5,350.00	$ 8,250.00	20
2010	$ 27.00	195.73	65.00	875.35	766,232.63	1.06	-0.83	$ 3,630.00	$ 540.00	20
2011	$ (19.50)	160.36	-200.00	717.15	514,310.26	1.01	0.97	$ 2,880.00	$ (390.00)	20
2012	$ (155.00)	128.80	-150.00	576.03	331,805.26	-0.16	0.31	$ 2,080.00	$ (3,100.00)	20
2013	$ 12.00	109.32	-50.00	488.88	239,006.32	1.18	1.01	$ 1,860.00	$ 240.00	20
2014	$ (15.00)	73.41	-5.00	328.32	107,794.74	0.74	-0.75	$ 1,270.00	$ (300.00)	20
2015	$ (23.00)	170.00	-80.00	760.28	578,032.63	3.70	1.34	$ 3,480.00	$ (460.00)	20
2016	$ (104.00)	129.84	-130.00	580.68	337,193.68	-0.40	0.32	$ 2,010.00	$ (2,080.00)	20

The positive mean net gains generated by the Bollinger Band strategy are consistent with those of Coe and Laosethakul (2010), Hudson et al. (1996), and Zhu et al. (2015), who discovered that alternative trading strategies using technical analysis can generate profitable

trades. However, the negative mean net gains generated by the Bollinger Band Strategy are consistent with those of Anderson and Faff (2005), Bajgrowicz and Scaillet (2012), and Sullivan et al. (1999), who found that technical tools like Bollinger Bands are not effective in generating profits from trading. The positive net gains and the negative net gains support the accretions of the AMH (Adaptive Market Hypothesis).

As previously discussed on the literature review, the main premise of the AMH is that market efficiency is not a steady state, and therefore alternative trading rules can be employed to achieve positive net gains (Lo, 2004). Based on the descriptive statistics presented in Table 2, the mean net gains using the Bollinger Band strategy produces both positive and negative gains. This is consistent with the non-constant efficient market premise found in the AMH. Another premise of the AMH is that market participants will adapt in order to gain profits and therefore profitable trading strategies will diminish over time (Noda, 2016). Referring to the descriptive statistics in Table 2, it is unclear whether the data support this premise of the AMH. If diminishing net gains were occurring, a Bollinger Band strategy that produced positive net gains at the beginning of the sample period would be expected to have diminishing positive net gains over the sample period. However, Table 2 shows the Bollinger Band strategy was profitable in the earlier years of the sample period (2009 and 2010), then produced negative net gains (2011, 2012, and 2013), then produced positive net gains in 2014, and finally the Bollinger Bands produced extremely negative net gains for 2015 and 2016. This does not correlate with the diminishing returns phenomena as described by the adaptive market hypothesis.

Additional observations from Table 2 indicate that the Bollinger Band strategy produced the largest net gains and largest net losses of any of the three trading strategies. The Bollinger Band strategy has the largest range and standard deviation in five out of the eight years. The

largest range and standard deviation for the Bollinger Band strategy occured in 2015 and 2016 which correspond to the largest mean net losses for this strategy.

Normality

Prior to testing the hypotheses, the data were tested for normal distribution to ensure that parametric testing would be valid. The following normality tests were performed for each of the sample data using Microsoft Excel and an add-on data analysis tool provided by NumXL: the Jarque-Bera, the Sharipo-Wilk, and the Doornik Chi-Squared. All three tests require a null hypothesis stating that the population is normally distributed and the alternative hypothesis stating that the population is not normally distributed. Using an alpha of 0.05, all three tests provided a p-value for comparison. The lowest p-value, 0.1144, was obtained by the Doornik Chi-Square test for the 2012 sample. Appendix 2 provides the results by year for each test using an alpha of 0.05. The highest p-value, 0.8470, was obtained by the Shapiro-Wilk test for the 2010 sample. At the alpha of 0.05, all sample data for each year passed the test of normality. These findings align with those of other researchers analyzing similar returns in currency trading (Bush & Stephens, 2016; Caporale, Gil-Alana, & Plastun, 2018; Hsu et al., 2016; Kumar, 2016). Based on the null hypothesis for all three tests is that the population is normally distributed, there is not enough statistical evidence to reject the null hypothesis. Given that the sample data are normal, the ANOVA test can be performed. A discussion of the hypotheses test is provided in the next section.

Hypothesis 1

The research for this study was designed to answer the following research question: Do currency trading managers at international banks and hedge funds experience a difference in net gain from currency transactions when employing a traditional trading approach as compared to

an alternative trading strategy when trading the EUR/USD spot market on an intraday period? This research question leads to the formation of the hypotheses for this study. Hypothesis 1 states:

$H1_0$: There is no statistically significant difference between net gains generated and the use of an alternative trading strategy on an intraday basis for the EUR/USD spot currency market as compared to the traditional buy and hold strategy.

$H1_a$: There is a statistically significant difference between net gains generated and the use of an alternative trading strategy on an intraday basis for the EUR/USD spot currency market as compared to the traditional buy and hold strategy.

To address hypothesis 1, an ANOVA test was performed to determine if the difference between the mean net gains for each of the trading strategies was statistically significant. Table 3 below shows the results of the ANOVA test. The p-value for the F-statistic is 0.00000000361. This p-value is considerably smaller than the alpha of 0.10, indicating that there is a statistically significant difference between all three trading strategies.

Table 3

ANOVA

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Bollinger Band Strategy	160	(180,578.00)	(1,128.61)	9,862,014.24
Buy and Hold Strategy	160	(10,530.00)	(65.81)	582,166.63
Sell and Hold Strategy	160	2,700.00	16.88	580,601.49

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	130,587,876	2	65,293,938	17.77	0.000000036	3.01463
Within Groups	1,752,940,396	477	3,674,927			
Total	1,883,528,272	479				

Based on the results of the ANOVA test and corresponding p-value for the F distribution, there is a statistically significant difference between the three different trading strategies.

However, in order to reject the null hypothesis and accept the alternative hypothesis, as stated in hypothesis 1, a post-hoc t-test must be performed to determine where the difference exists. The t-test is used to determine if the statistically significant difference identified by the ANOVA test is between the Bollinger Band strategy and the buy and hold strategy. The results of the t-test can indicate a significant difference between the Bollinger Band strategy and the buy and hold strategy. Table 4 below presents the results of the post-hoc t-test.

Table 4

t-Test Comparison of Bollinger Band Strategy and Buy and Hold Strategy

	Bollinger Bands	*Buy and Hold*
Mean	(1,128.61)	(65.81)
Variance	9,862,014.24	582,166.63
Observations	160.00	160.00
Pooled Variance	5,222,090.44	
df	318.00	
t Stat	(4.16)	
P-value one-tail	0.0000205	
t Critical one-tail	1.65	
P-value two-tail	0.0000410	
t Critical two-tail	1.97	

Table 4 displays a p-value of 0.0000410 for a two-tailed test of differences. This indicates that there is a statistically significant difference between the Bollinger Bands and the buy and hold strategy. Therefore, the null hypothesis for hypothesis 1 is rejected and the alternative hypothesis is accepted. However, both the Bollinger Band strategy and the buy and hold strategy produced a mean negative net gain for the sample period.

The p-value provided by the t-test results indicates that there is a statistical difference between the Bollinger Bands and the buy and hold strategy. To determine the magnitude of the difference a Cohen d-test for effect size was performed. The Cohen d-test provides an indication as to the magnitude of the difference between to the two trading methods (Faul, Erdfelder, Lang,

& Buchner, 2007; Ferguson, 2009). The effect size d-statistic was calculated for the Bollinger Bands and the sell and hold strategy as 0.46. Inputting the d-statistic into G*Power 3.1 software the power or magnitude of the difference between these two methods was .9939. The power of .9939 indicates the probability of rejecting the null hypothesis assuming that the alternative hypothesis is true (Khalilzadeh & Tasci, 2017). According to Cohen (1988), any value over 0.80 for a t-test would indicate a large effect size. This additional information helps to add to the generalizability of the sample to the overall population.

The Bollinger Band strategy demonstrated a mean negative net gain for the eight-year sample period, indicating that the alternative trading strategy does not effectively increase the net gain for currency traders on an intraday basis. Additionally, rejecting the null hypothesis indicates the mean negative gains from the Bollinger Band strategy are significantly different than the mean negative gains from the buy and hold strategy. These findings confer with the weak-form of the EMH in that using historical prices does not allow currency traders to earn excess profits over time. Additionally, these findings are consistent with the findings of other researchers (Hsu et al., 2016; Westerlund & Narayan, 2013; Kofarbai & Zubairu, 2016) who have examined other financial markets and various time-frames. The findings presented in this study are unique in that I have examined the spot EUR/USD currency market at a tick-level.

The Bollinger Band strategy, as an alternative trading method, produced an overall mean negative net gain that was significantly different than the mean negative net gains of the buy and hold strategy. These findings are consistent with the weak-form of the EMH signifying that historical pricing data is not effective in helping currency traders increase net gains from trading activity. These results would indicate that the Bollinger Band strategy would produce larger negative returns and should not be considered by currency trading managers for implementation.

Hypothesis 2

The research question produced a second hypothesis to be tested. Similar to hypothesis one, hypothesis 2 examines the relationship between the Bollinger Band strategy and the sell and hold strategy. Hypothesis two is stated as follows:

$H2_0$: There is no statistically significant difference between net gains generated and the use of an alternative trading strategy on an intraday basis for the EUR/USD spot currency market as compared to the sell and hold strategy.

$H2_a$: There is a statistically significant difference between net gains generated and the use of an alternative trading strategy on an intraday basis for the EUR/USD spot currency market as compared to the sell and hold strategy.

To address hypothesis 2, an ANOVA test was performed to determine if the difference between the mean net gains for each of the trading strategies was statistically significant. Table 3 shows the results of the ANOVA test. The p-value for the F-statistic is 0.00000000361. This p-value is considerably smaller than the alpha of 0.10 indicating that there is a statistically significant difference between all three trading strategies.

As previously mentioned, the results presented in the ANOVA test indicate that there is a statistically significant difference between the three different trading strategies. However, in order to reject the null hypothesis and accept the alternative hypothesis, as stated in hypothesis 2, a post-hoc t-test must be performed. The t-test is used to determine if the statistically significant difference identified by the ANOVA test is between the Bollinger Band strategy and the sell and hold strategy. The results from the t-test, presented below, indicates that there is a significant difference between the Bollinger Band strategy and the buy and hold strategy. Table 5 presents the results of the post-hoc t-test.

Table 5

t-Test Comparison of Bollinger Band Strategy and Sell and Hold Strategy

	Bollinger Bands	*Sell and Hold*
Mean	(1,128.61)	16.88
Variance	9,862,014.24	580,601.49
Observations	160.00	160.00
Pooled Variance	5,221,307.87	
df	318.00	
t Stat	(4.48)	
P-value one-tail	0.0000051	
t Critical one-tail	1.65	
P-value two-tail	0.0000103	
t Critical two-tail	1.97	

Table 5 displays a p-value of 0.0000103 for a two-tailed test of differences. This indicates that there is a statistically significant difference between the Bollinger Bands and the sell and hold strategy. Therefore, the null hypothesis for hypothesis 2 is rejected and the alternative hypothesis is accepted. However, the Bollinger Bands produced a mean negative net gain from trading. Based upon this finding, currency traders and currency managers should be extremely cautious when using Bollinger Bands as a method to increase net gains from trading. However, the sell and hold strategy produced a mean positive net gain from trading and therefore should be considered by currency traders as a method to increase net gains from trading.

The p-value from the t-test indicates that there is a statistical difference between the Bollinger Bands and the sell and hold strategy. To determine the magnitude of the difference a Cohen d-test for effect size was performed. The Cohen d-test provides an indication as to the magnitude of the difference between to the two trading methods (Faul et al., 2007; Ferguson, 2009). The effect size d-statistic was calculated for the Bollinger Bands and the sell and hold strategy as 0.5031. Inputting the d-statistic into G*Power 3.1 software the power or magnitude of the difference between these two methods was .9937. The power of .9973 indicates the

probability of rejecting the null hypothesis assuming that the alternative hypothesis is true (Khalilzadeh & Tasci, 2017). According to Cohen (1988), any value over 0.80 for a t-test would indicate a large effect size. This additional information helps to add to the generalizability of the sample to the overall population.

The Bollinger Band strategy, representing alternative trading strategies, produced a mean negative net gain for the eight-year sample period indicating that the alternative trading strategy does not effectively increase the net gain for currency traders. Additionally, rejecting the null hypothesis indicates the mean negative gains from the Bollinger Band strategy are significantly different than the mean positive gains from the sell and hold strategy. These findings confer with the weak-form of the EMH in that using historical prices does not allow currency traders to earn excess profits over time. The sell and hold strategy is successful when the Euro weakens against the U.S. dollar. Although this strategy is the inverse of the buy and hold strategy, the findings would still be consistent with the findings of other researchers (Hsu et al., 2016; Westerlund & Narayan, 2013; Kofarbai & Zubairu, 2016) who have examined other financial markets and various time-frames using a buy and hold strategy.

The Bollinger Band strategy, as an example of an alternative trading method, produced an overall negative return that was significantly different than the positive returns of the sell and hold strategy. These findings are consistent with the weak-form of the EMH signifying that historical pricing data is not effective in helping currency traders increase net gains from trading activity. These results would indicate that the Bollinger Band strategy would produce larger negative returns and should not be considered by currency trading managers for implementation.

In conclusion, the null hypothesis was rejected for hypothesis 1 and hypothesis 2, and the alternative hypothesis was accepted for both hypotheses. However, the results of the Bollinger

Band strategy produced a mean net negative gain from trading activity. This would indicate that using the alternative trading strategy of Bollinger Bands on an intraday currency trading activity produces a negative mean net gain that is significantly different than the negative mean net gains of the buy and hold strategy. Furthermore, using the alternative trading strategy of Bollinger Bands on an intraday currency trading activity produces a negative return that is significantly different than the positive mean net gains of the sell and hold strategy.

Relationship of the hypotheses to research questions. The research for this study was designed to address the research question: Do currency trading managers at international banks and hedge funds experience a difference in net gain from currency transactions when employing a traditional trading approach as compared to an alternative trading strategy when trading the EUR/USD spot market on an intraday period? Hypothesis one examined the difference between the alternative trading strategy using Bollinger Bands and the traditional buy and hold strategy. Based upon the sample used in this study, it was determined that there is a statistically significant difference between the two trading strategies. However, the alternative strategy using Bollinger Bands produced a mean negative net gain. This would indicate that currency traders and managers of currency traders should not expect the alternative strategy using Bollinger Bands for intraday currency trading to increase net gains.

Hypothesis two examined the difference between the alternative trading strategy using Bollinger Bands and the sell and hold strategy. Based upon the sample used in this study, it was determined that there is a statistically significant difference between the two trading strategies. However, the alternative strategy using Bollinger Bands produced a mean negative net gain. This would indicate that currency traders and managers of currency traders should not expect the alternative strategy using Bollinger Bands for intraday currency trading to increase net gains.

Moreover, the sell and hold strategy did produce a mean positive net gain over the sample period and should be considered by currency traders and currency managers as a method for increasing net gains from trading activities.

Additional findings. Although not a part of the original research question, after performing the initial ANOVA test and appropriate t-tests, this researcher wanted to see if there were statistical differences between the three strategies on a year-by-year basis. An ANOVA test was performed for each year and the results can be found in Appendix C. The p-value for of the ANOVA test for 2009 was 0.0245 indicating that there is a statistically significant difference between the average net gains from the three different trading techniques. Conducting a post-hoc t-Test to determine where the difference exists, the p-value of 0.013 was obtained for the difference with the Bollinger Band and buy and hold strategy. A p-value of 0.38 was obtained for the difference between the mean net gain generated from the Bollinger Band strategy and the sell and hold strategy. Therefore, the difference with the Bollinger Band and the buy and hold strategy is the only difference that is statistically significant.

The p-value from the ANOVA test for the years 2010, 2011, 2012, 2013, and 2014 did not produce any statistically significant difference between the average net gains produced from the three strategies. The lowest p-value obtained from 2010 through 2014 was 0.3314. The ANOVA results for all years can be found in Appendix C. The ANOVA produced a p-value of 0.0000 for 2015 and a p-value of 0.0001 for 2016 indicating that there is a statistically significant difference between the mean net gains produced by each trading strategy.

For 2015, a post-hoc t-Test was performed for the Bollinger Band and buy and hold strategy. The t-Test produced a p-value of 0.0000000000853 which is less than the alpha of .10 indicating a statistically significant difference between the two strategies. However, the outcome

of the Bollinger Band strategy resulted in a negative net gain which does not support the use of this strategy as a method to increase net gains from intraday trading of the EUR/USD. Additionally, a post-hoc t-Test was performed for the Bollinger Band and sell and hold strategy. The t-Test produced a p-value of 0.0000000000886, which is less than the alpha of .10 indicating a statistically significant difference between the two strategies. However, the outcome of the Bollinger Band strategy resulted in a negative net gain which does not support the use of this strategy as a method to increase net gains from intraday trading of the EUR/USD. Finally, a t-Test was performed using the buy and hold strategy and the sell and hold strategy. The p-value for this test was 0.9670, which is greater than the level of alpha of .10 indicating there is no significant difference between the buy and hold strategy and the sell and hold strategy. This indicates the statistical difference lies between the Bollinger Band strategy and buy and hold strategy and the Bollinger Band Strategy and the sell and hold strategy. This also indicates there is no statistically significant difference between the buy and hold strategy and the sell and hold strategy. The full results of the t-Test for 2015 can be found in Appendix D.

For 2016, a post-hoc t-Test was performed for the Bollinger Band and buy and hold strategy. The t-Test produced a p-value of .0017 which is less than the alpha of .10 indicating a statistically significant difference between the two strategies. However, the outcome of the Bollinger Band strategy resulted in a negative net gain which does not support the use of this strategy as a method to increase net gains from intraday trading of the EUR/USD. Additionally, a post-hoc t-Test was performed for the Bollinger Band and sell and hold strategy. The t-Test produced a p-value of .0029, which is less than the alpha of .10 indicating a statistically significant difference between the two strategies. Although there was a statistically significant difference, the outcome of the Bollinger Band strategy resulted in a negative net gain which does

not support the use of this strategy as a method to increase net gains from intraday trading of the EUR/USD. Finally, a t-Test was performed using the buy and hold strategy and the sell and hold strategy. The p-value for this test was 0.3544, which is greater than the level of alpha of .10 indicating there is no significant difference between the buy and hold strategy and the sell and hold strategy. The full results of the t-Test for 2016 can be found in Appendix D.

Summary of Findings

Currently, there is gap in the literature relating to intraday trading, tick-level data, and technical analysis (Ozturk et al., 2016). Much of the current literature focuses on the end of day price changes of currency pairs and does not focus on intraday price changes (Hayes et al., 2016; Narayan et al., 2015; Poti et al., 2014). Additionally, most studies that have tested Bollinger Bands and other alternative trading methods focused on individual stocks, ETFs, or indices without much focus on specific foreign currency trading (Brock et al., 1992; Lento et al., 2007; Duvinage et al., 2013; Metghalchi et al., 2014). This study attempted to add to the scholarly body of knowledge by focusing on intraday price changes and the application of Bollinger Bands to currency trading.

The overall mean produced by the Bollinger Band strategy, an alternative trading method, for the sample period was negative. The descriptive statistics on a year-by-year basis showed the Bollinger Band strategy did produce positive mean net gains in 2009, 2010, and 2014, however the negative net losses in 2015 and 2016 far exceeded any gains in previous years. A test for normality was also conducted. The following normality tests were performed for each of the sample data using Microsoft Excel and an add-on data analysis tool provided by NumXL: the Jarque-Bera, the Sharipo-Wilk, and the Doornik Chi-Squared. At the alpha of 0.05, all sample data for each year passed the test of normality.

The Bollinger Band trading strategy showed significantly different mean negative net gains as compared to the buy and hold strategy and the mean positive net gain from the sell and hold strategy. Therefore, both null hypotheses were rejected at an alpha level of 0.05 and the alternative hypotheses were accepted. The post-hoc power test using G*Power 3.1 provided a power level of .9839 for the buy and hold strategy as compared to Bollinger Band strategy and a power level of .9937 for the sell and hold strategy as compared to the Bollinger Band strategy. The outcome of the Bollinger Band strategy resulted in a negative net gain which does not support the use of this strategy as a method to increase net gains from intraday trading of the EUR/USD. Moreover, the sell and hold strategy did produce a mean positive net gain over the sample period and should be considered by currency traders and currency managers as a method for increasing net gains from trading activities.

Applications to Professional Practice

Increased global commerce has given rise to the importance of foreign currency exchange markets (Harvey, 2013). Multinational firms engage in business activities that are outside of their home country and often adapt products, services, and pricing to each local market to be successful (Devereux et al., 2017). The local currency is the easiest way for local consumers to make purchases from international firms (Satterlee, 2014). These global companies then rely on the services of international banks to exchange the foreign currency for the currency of the home country. It is this trend in a global economic expansion that drives currency transactions at global financial institutions (Cetorelli & Goldberg, 2012; Meschi et al., 2016).

Currency trading is an essential function of all international businesses, a key service for international banks, and a vital source of profitability for international hedge funds (Wong, 2016). The findings and results produced from this research may be applied by those working in

the currency markets. Specifically, the results from this study are applicable for currency traders working for international financial institutions and currency managers overseeing currency trading operations.

Currency Manager and Currency Trader

International financial institutions act as brokers for their global clients in the currency market which causes these global financial institutions, as well as hedge funds, to speculate in currency markets as a means to increase profits of their existing currency positions (Aktan et al., 2013; Shen & Hartarska, 2013). Many currency trading teams and currency managers are seeking for a competitive advantage in the spot currency market that will increase net gains for their financial firm (Bahmani-Oskooee & Aftab, 2017; Kamau et al., 2015). As cited previously in the literature review, currency managers and currency traders working for these financial firms are constantly looking for tools to help increase net gain from currency activity. The findings of this study indicate that currency traders using Bollinger Bands at a tick-level while trading the EUR/USD from 2009 to 2016 probably would not have increased the net gains from trading activity. Based upon the findings of this study, it can be reasoned that using Bollinger Bands at a tick level within intraday currency trading would not increase net gains from currency trading.

Biblical Implications

The biblical principle of stewardship should be evident in all areas of life, including international currency transactions. The biblical view of stewardship is traditionally defined as using and managing the resources God provides for the glory of God and the betterment of his creation (Botha, 2014). Stewardship can further be understood as entrusting someone with resources and acting on behalf of another's interest (McCuddy & Pirie, 2007). All people are responsible for the resources they control, and wasted resources quickly yield no fruit (McCuddy

& Pirie, 2007). Currency traders working for hedge funds and international banks have a responsibility to make decisions that are in the best interest of the business owners and clients of the firm (Morck, 2014) or risk producing no fruit for their owners. By utilizing the best tools available, currency traders can potentially maximize value for clients and owners (Osiyevskyy & Biloshapka, 2017), which is foundational to stewardship (Luke 16:2, MEV). Understanding the effectiveness of a trading tool like Bollinger Bands can increase the return and minimize the risk for currency traders. This leads to increased stewardship by currency managers and currency traders (Luke 19:12-19, NASB). The findings of this study indicate that using Bollinger Bands for trading tick-level data does not increase the net gain from trading activity. Currency managers and traders aware of these findings are able to practice stewardship by ensuring the greatest net gains for clients and owners by not using Bollinger Bands on tick-level data.

Finally, the role of the global financial institutions should fit into God's design (Van Doser, 2010). "And there are varieties of ministries, and the same Lord. There are varieties of effects, but the same God who works all things in all persons. But to each one is given the manifestation of the Spirit for the common good" (1 Corinthians 12:5-7, NASB). Global financial traders and business professionals can fulfill God's purpose by providing resources for God's creation to flourish with the understanding that these goods and services are beneficial to God's people (Van Doser, 2010). Positive net gains are vital to any for-profit organization, but within God's design, making money provides a means to serve God's creation rather than being the ultimate pursuit of the organization (Van Duzer, 2010). All people are responsible for the resources they control, and wasted resources quickly yield no fruit (McCuddy & Pirie, 2007). There, implementing effective biblically based stewardship within the foreign exchange markets

for international banks and hedge funds includes the exploration of alternative investment methods.

Recommendations for Action

The results of this research could potentially be of value to managing currency traders and for currency traders themselves. Additionally, the findings could potentially be of value to all those who engage in currency trading activity on a speculative basis.

The results of this study suggest that the use of alternative trading strategies, specifically Bollinger Bands as tested and applied to tick-level time frames did not result in an increase net gains as compared to traditional buy and hold trading strategies or the sell and hold trading strategy. Although three of the years included in the sampling showed a positive net gain from the Bollinger Band strategy, five of the sample years showed negative net gains. Furthermore, two years out of the five years that showed a negative net gain produced exceedingly large losses as compared to the more conservative trading strategies. This suggests that the use of Bollinger Bands may or may not be useful for currency traders and currency trading managers as they did not provide a positive net gain during the sample period in this study.

Currency traders desiring to use Bollinger Bands in their trading should do so cautiously, based upon the findings from this study. The findings of this study did not indicate the use of Bollinger Bands at the tick-level using 3 standard deviations from a 20 period moving average as signals for entering and exiting currency trades. Although the results presented in this study show the net gains from the Bollinger Band strategy for 2009 were statistically different than those of the buy and hold strategy, there was no statistical difference between the sell and hold strategy and this was the only year out of the eight-year sample which showed a difference. The information put forth in this research study should be examined by those working as currency

traders in international banks and hedge funds. However, the findings should also provide a catalyst for additional research.

Recommendations for Further Study

This research contributed to the current gap in the literature concerning the use of Bollinger Bands on an intraday basis, specifically at the tick-level. Additional research in this area is warranted. The following are recommendations for further research.

First, the sample size for future studies could be increased. A larger sample size would result in a higher confidence level and a lower confidence interval. The study could be repeated with similar parameters but increase the sample size to 360 days. Although the power test showed a significant effect, a larger sample size will add additional confidence. Furthermore, future studies might include every trading day instead of sampling specific days to better understand the Bollinger band strategy on the entire population of trading days.

Second, there are other timeframes that should be considered as an area for further study. Currency traders might focus their attention on timeframes of 1-minute, 5-minute, 10-minute, 15-minute or even 30-minute trading. These various timeframes would then produce different moving averages from which to calculate the standard deviation prices. These different standard deviation prices would be used for trade entry signals and trade exit signals. Using longer timeframes would result in fewer trades and fewer transaction costs as compared to the Bollinger Band strategy employed in this study.

Third, a further study might examine which Bollinger Band parameters provide the best results for tick-level data. This study used a 20-period moving average and 3 standard deviations as the settings to create the Bollinger Bands. Various standard deviations ranging from one to five might produce different results over the sample period. Additionally, one could argue that a

20-period moving average on tick-level data is not a long enough time period to establish a trend. Extending the number of periods in the moving average to 100 or even 200 ticks might produce different results than those found in this study.

Fourth, additional studies could focus on different currency pairs and different time periods. This study focuses exclusively on the EUR/USD, given the significance of these two currency pairs in the global foreign exchange market as previously cited. However, applying the Bollinger Bands to other currency pairs over the same time period might produce different results. Additional factors of liquidity and volume might play a factor in the results.

Lastly, combining the Bollinger Band strategy with another alternative trading strategy on a tick-level timeframe could also be an area for further study. This study focused on Bollinger Bands for both entering trades and exiting trades. However, there is a potential to combine the Bollinger Band strategy with a relative strength indicator or a moving average convergence divergence strategy for entering and exiting a trade might produce different results and reduce transaction costs using alternative trading strategies.

Reflections

As an active day trader in the U.S. equity markets and a user of technical analysis, I began this study with a desire to better understand if an increase in net gains could be realized using alternative trading strategies in the currency market. The results from this quantitative study indicated that currency traders using Bollinger Bands on a tick-level should do so cautiously. Additionally, the results provided opportunities for further studies using Bollinger Bands with various parameters, different currency pairs, and with larger sample sizes.

If the results of the Bollinger Band strategy matched or outperformed the net gains from the buy and hold strategy and the sell and hold strategy, the researcher would have considered

the study to have a positive outcome for those using technical analysis. However, the findings presented here do not support the use of Bollinger Bands.

For this study the researcher relied on historical data obtained from a third party. Using historical data helped to eliminate research bias and add to the validity and reliability of the results (Rudestam & Newton, 2015). If the Bollinger Bands had produced a statistically significant difference in positive net gains than the other two traditional strategies or if the mean gains were equal, then the currency trader could consider using this strategy as part of his or her daily analysis of the currency market.

Although the findings indicate that Bollinger Bands should be used cautiously for tick-level trading of the EUR/USD, the opinion of the researcher is this research provided important insights for currency traders and currency trading managers working for international financial institutions and global hedge funds. This study helped to provide awareness for the potential negative net gains for those considering the use of Bollinger Bands on an intraday basis, specifically using them for tick-level trading. The researcher thinks there are currency traders that will continue to use Bollinger Bands in their daily currency trading, but will most likely adjust the parameters of the Bollinger Bands to adapt in real time to the changing market conditions.

Summary and Study Conclusions

For this study the researcher examined the net gain and losses of currency transactions using alternative trading techniques that are available for currency traders and currency managers working at international banks and hedge funds. The specific business problem addressed by this study was to provide currency trading manager's additional data to help determine the most effective tool to increase net gains from trading activity. The results of this study indicate that

using Bollinger Bands while trading the EUR/USD spot market at the tick-level probably does not increase the net gains from trading activity.

The Bollinger Band strategy, an alternative trading method, produced an overall mean negative net gain for the sample period. The descriptive statistics on a year-by-year basis showed the Bollinger Band strategy did produce positive mean net gains in 2009, 2010, and 2014; however, the negative net losses in 2015 and 2016 far exceeded any gains in previous years. A test for normality was also conducted. The following normality tests were performed for each of the sample data using Microsoft Excel and an add-on data analysis tool provided by NumXL: the Jarque-Bera, the Sharipo-Wilk, and the Doornik Chi-Squared. At the alpha of 0.05, all sample data for each year passed the test of normality.

The Bollinger Band trading strategy showed significantly different mean negative net gains as compared to the buy and hold strategy and the mean positive net gain from the sell and hold strategy. Therefore, both null hypotheses were rejected at an alpha level of 0.10 and the alternative hypotheses were accepted. This would indicate that currency traders and managers of currency traders should not expect the alternative strategy using Bollinger Bands for intraday currency trading to increase net gains. Moreover, the sell and hold strategy did produce a mean positive net gain over the sample period and should be considered by currency traders and currency managers as a method for increasing net gains from trading activities.

These findings have a direct application to the business problem of increasing the net gain from foreign currency transactions undertaking by currency management teams and currency traders within global financial institutions and hedge funds. Additionally, the results of this study have added to the current literature on technical analysis and have helped to fill in the gap with regards to tick-level time frames.

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Appendix A: Listing of all Days

2009	*2010*	*2011*
Monday, January 5, 2009	Tuesday, January 5, 2010	Wednesday, January 5, 2011
Friday, January 9, 2009	Tuesday, January 12, 2010	Tuesday, February 8, 2011
Friday, January 30, 2009	Wednesday, February 3, 2010	Wednesday, March 2, 2011
Monday, March 16, 2009	Friday, February 5, 2010	Friday, March 4, 2011
Thursday, April 2, 2009	Friday, March 5, 2010	Friday, March 25, 2011
Tuesday, April 14, 2009	Wednesday, April 7, 2010	Monday, April 11, 2011
Monday, April 20, 2009	Tuesday, June 8, 2010	Wednesday, April 13, 2011
Thursday, May 14, 2009	Monday, June 14, 2010	Thursday, May 12, 2011
Monday, May 25, 2009	Tuesday, July 27, 2010	Friday, June 10, 2011
Friday, June 12, 2009	Tuesday, August 17, 2010	Monday, June 20, 2011
Tuesday, June 30, 2009	Monday, August 30, 2010	Friday, July 15, 2011
Friday, July 31, 2009	Thursday, September 2, 2010	Monday, July 18, 2011
Wednesday, September 9, 2009	Thursday, September 23, 2010	Monday, July 25, 2011
Monday, September 14, 2009	Tuesday, September 28, 2010	Thursday, August 11, 2011
Friday, September 18, 2009	Monday, October 18, 2010	Friday, September 23, 2011
Monday, September 28, 2009	Wednesday, October 20, 2010	Wednesday, September 28, 2011
Monday, October 26, 2009	Thursday, October 21, 2010	Tuesday, October 18, 2011
Thursday, November 5, 2009	Thursday, November 11, 2010	Thursday, October 20, 2011
Tuesday, November 10, 2009	Tuesday, November 30, 2010	Friday, October 21, 2011
Thursday, December 31, 2009	Thursday, December 16, 2010	Thursday, December 22, 2011

2012	*2013*
Monday, January 16, 2012	Monday, March 4, 2013
Monday, February 6, 2012	Monday, April 22, 2013
Monday, February 13, 2012	Wednesday, May 1, 2013
Monday, February 20, 2012	Friday, May 3, 2013
Tuesday, February 21, 2012	Thursday, May 9, 2013
Friday, February 24, 2012	Friday, May 10, 2013
Friday, March 23, 2012	Monday, May 13, 2013
Friday, April 6, 2012	Monday, May 20, 2013
Thursday, June 28, 2012	Monday, July 8, 2013
Friday, July 6, 2012	Thursday, July 18, 2013
Wednesday, July 25, 2012	Wednesday, July 31, 2013
Monday, August 6, 2012	Thursday, August 1, 2013
Monday, August 13, 2012	Thursday, August 22, 2013
Tuesday, September 11, 2012	Friday, August 30, 2013
Tuesday, September 25, 2012	Thursday, September 19, 2013
Friday, October 5, 2012	Wednesday, September 25, 2013
Monday, October 8, 2012	Thursday, September 26, 2013
Wednesday, October 10, 2012	Monday, October 21, 2013
Tuesday, October 16, 2012	Thursday, November 14, 2013
Friday, December 28, 2012	Monday, November 18, 2013

2014
Wednesday, January 1, 2014
Monday, January 20, 2014
Wednesday, February 12, 2014
Friday, March 7, 2014
Tuesday, March 18, 2014
Monday, March 31, 2014
Thursday, April 17, 2014
Tuesday, April 29, 2014
Tuesday, May 6, 2014
Monday, May 12, 2014
Tuesday, May 20, 2014
Thursday, May 22, 2014
Monday, June 2, 2014
Wednesday, June 4, 2014
Monday, June 23, 2014
Thursday, July 17, 2014
Friday, September 12, 2014
Thursday, September 25, 2014
Tuesday, December 9, 2014
Thursday, December 11, 2014

2015
Wednesday, January 7, 2015
Wednesday, February 18, 2015
Tuesday, March 17, 2015
Tuesday, March 24, 2015
Tuesday, April 14, 2015
Thursday, May 7, 2015
Friday, May 8, 2015
Friday, May 15, 2015
Friday, July 17, 2015
Tuesday, July 21, 2015
Friday, July 24, 2015
Friday, July 31, 2015
Friday, August 7, 2015
Tuesday, September 1, 2015
Monday, September 7, 2015
Thursday, October 22, 2015
Monday, November 2, 2015
Thursday, November 12, 2015
Monday, November 23, 2015
Monday, December 28, 2015

2016
Wednesday, January 6, 2016
Friday, February 12, 2016
Tuesday, March 1, 2016
Tuesday, March 29, 2016
Friday, May 27, 2016
Monday, May 30, 2016
Wednesday, June 22, 2016
Wednesday, July 13, 2016
Tuesday, July 26, 2016
Friday, July 29, 2016
Tuesday, August 2, 2016
Thursday, August 18, 2016
Wednesday, August 31, 2016
Monday, October 24, 2016
Thursday, October 27, 2016
Thursday, November 3, 2016
Monday, November 14, 2016
Monday, November 21, 2016
Friday, December 2, 2016
Wednesday, December 14, 2016

Appendix B: Normality Test by Year Using Alpha of 0.05

	Normality Test	*Score*	*C.V.*	*P-Value*	*Pass?*
2009	*Jarque-Bera*	1.41946	5.99146	0.49178	TRUE
	Shapiro-Wilk	0.96694	#N/A	0.68948	TRUE
	Doornik Chi-Square	2.42747	5.99146	0.29709	TRUE
	Normality Test	*Score*	*C.V.*	*P-Value*	*Pass?*
2010	*Jarque-Bera*	0.63966	5.99146	0.72627	TRUE
	Shapiro-Wilk	0.97458	#N/A	0.84710	TRUE
	Doornik Chi-Square	0.72405	5.99146	0.69627	TRUE
	Normality Test	*Score*	*C.V.*	*P-Value*	*Pass?*
2011	*Jarque-Bera*	1.86062	5.99146	0.39443	TRUE
	Shapiro-Wilk	0.94083	#N/A	0.24854	TRUE
	Doornik Chi-Square	3.23364	5.99146	0.19853	TRUE
	Normality Test	*Score*	*C.V.*	*P-Value*	*Pass?*
2012	*Jarque-Bera*	1.80743	5.99146	0.40506	TRUE
	Shapiro-Wilk	0.92360	#N/A	0.11626	TRUE
	Doornik Chi-Square	4.33542	5.99146	0.11444	TRUE
	Normality Test	*Score*	*C.V.*	*P-Value*	*Pass?*
2013	*Jarque-Bera*	1.31182	5.99146	0.51897	TRUE
	Shapiro-Wilk	0.96419	#N/A	0.63051	TRUE
	Doornik Chi-Square	2.02797	5.99146	0.36277	TRUE
	Normality Test	*Score*	*C.V.*	*P-Value*	*Pass?*
2014	*Jarque-Bera*	0.36306	5.99146	0.83399	TRUE
	Shapiro-Wilk	0.96302	#N/A	0.60568	TRUE
	Doornik Chi-Square	0.54164	5.99146	0.76275	TRUE
	Normality Test	*Score*	*C.V.*	*P-Value*	*Pass?*
2015	*Jarque-Bera*	1.77657	5.99146	0.41136	TRUE
	Shapiro-Wilk	0.93983	#N/A	0.23806	TRUE
	Doornik Chi-Square	2.76296	5.99146	0.25121	TRUE
	Normality Test	*Score*	*C.V.*	*P-Value*	*Pass?*
2016	*Jarque-Bera*	1.40362	5.99146	0.49569	TRUE
	Shapiro-Wilk	0.96343	#N/A	0.61431	TRUE
	Doornik Chi-Square	2.52524	5.99146	0.28291	TRUE

Appendix C: ANOVA by Year

2009 Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Bollinger Bands (Net Gain or Lo	20	17330	866.5	3540434.474
Long (Net gain or Loss)	20	-9540	-477	1765264.211
Short (Net Gain or Loss)	20	8250	412.5	1768840.789

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	18682123.3	2	9341061.667	3.961132043	0.02450271	3.158843
Within Groups	134416250	57	2358179.825			
Total	153098373	59				

2010 Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Bollinger Bands (Net Gain or Lo	20	2130	106.5	462013.4211
Long (Net gain or Loss)	20	-1830	-91.5	764550.2632
Short (Net Gain or Loss)	20	540	27	766232.6316

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	397110	2	198555	0.298909123	0.742782126	3.15884
Within Groups	37863130	57	664265.439			
Total	38260240	59				

2011 Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Bollinger Bands (Net Gain or Lo	20	-2230	-111.5	594855.5263
Long (Net gain or Loss)	20	-760	-38	521427.3684
Short (Net Gain or Loss)	20	-390	-19.5	514310.2632

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	94723.33333	2	47361.66667	0.087137002	0.91667337	3.15884
Within Groups	30981270	57	543531.0526			
Total	31075993.33	59				

2012 Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Bollinger Bands (Net Gain or Lo	20	-500	-25	208531.5789
Long (Net gain or Loss)	20	2000	100	327084.2105
Short (Net Gain or Loss)	20	-3100	-155	331805.2632

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	650333.333	2	325166.6667	1.124598022	0.33188164	3.15884
Within Groups	16481000	57	289140.3509			
Total	17131333.3	59				

2013 Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*		
Bollinger Bands (Net Gain or Lo	20	-2710	-135.5	406541.8421		
Long (Net gain or Loss)	20	-1110	-55.5	234057.6316		
Short (Net Gain or Loss)	20	240	12	239006.3158		

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	218083.3333	2	109041.6667	0.371899553	0.69108395	3.15884272
Within Groups	16712510	57	293201.9298			
Total	16930593.33	59				

2014 Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*		
Bollinger Bands (Net Gain or Lo	20	648	32.4	58219.93684		
Long (Net gain or Loss)	20	-410	-20.5	107415.5263		
Short (Net Gain or Loss)	20	-300	-15	107794.7368		

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	33836.13333	2	16918.0667	0.185620316	0.831088946	3.15884
Within Groups	5195173.8	57	91143.4			
Total	5229009.933	59				

2015 Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*		
Bollinger Bands (Net Gain or Lo	20	-132426	-6621.3	12749537.06		
Long (Net gain or Loss)	20	-260	-13	576022.1053		
Short (Net Gain or Loss)	20	-460	-23	578032.6316		

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	581381945	2	290690972.6	62.72285107	3.98222E-15	3.158843
Within Groups	264168244	57	4634530.6			
Total	845550189	59				

2016 Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*		
Bollinger Bands (Net Gain or Lo	20	-62820	-3141	17865146.32		
Long (Net gain or Loss)	20	1380	69	343230.5263		
Short (Net Gain or Loss)	20	-2080	-104	337193.6842		

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	130382653.3	2	65191326.67	10.54558983	0.00012685	3.15884
Within Groups	352365840	57	6181856.842			
Total	482748493.3	59				

Appendix D: t-Test when ANOVA was Significant

t-Test: 2015		
	Bollinger Bands	*Buy and Hold*
Mean	-6621.3	-13
Variance	12749537.06	576022.1053
Observations	20	20
Pooled Variance	6662779.584	
Hypothesized Diff.	0	
df	38	
t Stat	-8.095842068	
P(T<=t) one-tail	4.26568E-10	
t Critical one-tail	1.68595446	
P(T<=t) two-tail	8.53135E-10	
t Critical two-tail	2.024394164	

t-Test: 2015		
	Bollinger Bands	*Sell and Hold*
Mean	-6621.3	-23
Variance	12749537.06	578032.6316
Observations	20	20
Pooled Variance	6663784.847	
Hypothesized Diff.	0	
df	38	
t Stat	-8.082981301	
P(T<=t) one-tail	4.43426E-10	
t Critical one-tail	1.68595446	
P(T<=t) two-tail	8.86852E-10	
t Critical two-tail	2.024394164	

t-Test: 2015		
	Buy and Hold	*Sell and Hold*
Mean	-13	-23
Variance	576022.1053	578032.6316
Observations	20	20
Pooled Variance	577027.3684	
Hypothesized Diff.	0	
df	38	
t Stat	0.041629557	
P(T<=t) one-tail	0.48350599	
t Critical one-tail	1.68595446	
P(T<=t) two-tail	0.967011979	
t Critical two-tail	2.024394164	

t-Test: 2016		
	Bollinger Bands	*Buy and Hold*
Mean	-3141	69
Variance	17865146.32	343230.5263
Observations	20	20
Pooled Variance	9104188.421	
Hypothesized Diff.	0	
df	38	
t Stat	-3.364220197	
P(T<=t) one-tail	0.000882082	
t Critical one-tail	1.68595446	
P(T<=t) two-tail	0.001764164	
t Critical two-tail	2.024394164	

t-Test: 2016		
	Bollinger Bands	*Sell and Hold*
Mean	-3141	-104
Variance	17865146.32	337193.6842
Observations	20	20
Pooled Variance	9101170	
Hypothesized Diff.	0	
df	38	
t Stat	-3.183436406	
P(T<=t) one-tail	0.00145073	
t Critical one-tail	1.68595446	
P(T<=t) two-tail	0.002901461	
t Critical two-tail	2.024394164	

t-Test: 2016		
	Buy and Hold	*Sell and Hold*
Mean	69	-104
Variance	343230.5263	337193.6842
Observations	20	20
Pooled Variance	340212.1053	
Hypothesized Diff.	0	
df	38	
t Stat	0.937931716	
P(T<=t) one-tail	0.177101501	
t Critical one-tail	1.68595446	
P(T<=t) two-tail	0.354203001	
t Critical two-tail	2.024394164	