THE REALITY OF ARBITRAGE IN CANADIAN CRYPTOCURRENCY MARKETS

Francis E. Taylor, Walden University
francis.taylor@waldenu.edu

Tom Butkiewicz, Walden University
thomas.butkiewicz@mail.waldenu.edu

Kenneth Levitt, Frostburg State University
kjlevitt@frostburg.edu

ABSTRACT

Understanding the unprecedented growth of cryptocurrency has challenged professionals and scholars. This study involved addressing the existence of arbitrage opportunities in the Canadian cryptocurrency market. The purpose of this study was to test the theory of the Law of One Price (LOP) on cryptocurrency in Canada. The LOP demonstrates that the value of a financial asset should be the same across different markets. The research questions for this study examined whether different exchanges cause arbitrage opportunities in the Canadian cryptocurrency market and whether volatility and liquidity were influencers of the arbitrage opportunities between Canadian cryptocurrency exchanges. A quantitative nonexperimental cross-sectional research design was employed with a sample population of almost 3,000 data points collected for four cryptocurrencies across four cryptocurrency exchanges. The data analysis techniques were predictive modeling and a binary logistic regression model. The study results indicated that arbitrage opportunities were found almost 100% of the time, and volatility and liquidity were weak influencers of the arbitrage opportunities. Professionals will become better equipped to protect average and inexperienced investors in cryptocurrency from the study results. The positive social change implications can enable professionals to gain greater insights into supporting and educating investors in high-risk cryptocurrencies who lack risk management knowledge or financial stability, avoid losing a portion or all of their savings.

Keywords: cryptocurrency, arbitrage, law of one price, Canadian markets, volatility, liquidity, quantitative, nonexperimental cross-sectional research, predictive modeling, binary logistic regression model

INTRODUCTION

Cryptocurrency's rise from a conceptual possibility for blockchain technology in 2008 to a key financial asset by the mid to late 2010s has been unprecedented. Though it is a relatively new financial asset, cryptocurrency is one of the most important financial instruments in the world today (Duczmal & Skomorovski, 2021). Cryptocurrency is the technological advancement of

currency into a digital format. While the currency has roots on the internet, the recent success of cryptocurrencies is not based on the currency's seamless ability to be used in online formats.

The advantages of cryptocurrency go beyond its natural online applications. Core characteristics of cryptocurrencies are that transactions are decentralized, unregulated, and anonymous (Inci & Lagasse, 2019). The lack of regulation or accountability mechanisms guiding different markets may drive cryptocurrency growth. These advantages may also be causing cryptocurrencies to break away from the conventional understanding of financial markets.

An example of discontinuity between cryptocurrency, cryptocurrency markets, and conventional financial thinking is arbitrage opportunities in these markets. Recent studies have found arbitrage opportunities between cryptocurrency markets and noted the role the lack of uniform global regulatory frameworks played in allowing arbitrage to exist (Kabašinskas & Šutienė, 2021; Makarov & Schoar, 2020; Pieters & Vivanco, 2017). The topic of this study is arbitrage opportunities for cryptocurrency as a financial asset. This topic is important to study because cryptocurrencies' noted characteristics and outcomes undermine commonly accepted financial principles, which unwittingly expose average and inexperienced investors to undesirable risk-to-reward propositions. Gaining a better understanding of arbitrage in cryptocurrency markets will have a positive social impact by better preparing professionals to protect average and inexperienced investors using cryptocurrencies to maximize their portfolio performance.

The issue of arbitrage was addressed using the Law of One Price (LOP), which states that assets should be fairly priced by market forces. The LOP is a key principle for understanding financial markets (Kabašinskas & Šutienė, 2021; Makarov & Schoar, 2020; Persson, 2008; Pieters & Vivanco, 2017). The organization of the study will cover the background of the topic, problem statement, purpose, research questions, theoretical framework, and method used to support the study, followed by a review of results and a discussion of the study.

BACKGROUND

The concept of money has been around for a long time, and its characteristics and purpose have adapted with the evolution of civilization. Money has been a part of civilization since 3000 B.C.E., but its role at that time was more of a "social lubricant" (Surowiecki, 2012, p. 46). At the time, money was used more to stimulate social interactions, allowing markets and fairs to form. It would not be until more current events that money would take on a more important role in the local and global economies.

The economic role of money has evolved significantly over time, adapting to changing societal and technological needs. While early forms of money existed, it was not until the seventh century that standardized metal coins began to resemble modern currency (Surowiecki, 2012). The rise of multi-territorial trade in the 1600s spurred the use of paper money, though early versions were plagued by instability and fraud. In response, the 1800s saw the creation of regulatory bodies like the Bank of England and the U.S. Federal Reserve, which adopted the gold standard to restore confidence. However, economic crises such as World War I and the Great Depression led to

abandoning the gold standard in favor of fiat currencies—money not backed by a physical commodity but by government policy and economic strength. This transition reflects money's enduring ability to adapt and maintain its function through economic transformation.

Money has demonstrated resilience by evolving with the rise of current-day economic demands. Over the years, technological advances have made the material substance of money less important. In its place, electronic payment methods have been adopted (Bezhovski et al., 2021). While electronic payment methods, such as credit/debit cards, digital wallets, payment gateways, and bank transfers, still use fiat currencies, the adoption of these types of payment methods by both the business community and the public fostered a demand for further innovation of technology, such as digital currencies.

Digital currencies have been available for over 30 years. Several digital currencies were created but were not adopted, such as DigiCash in 1990, e-Gold in 1996, and Liberty Reserve in 2006, and it was not until 2009 that the first successful digital currency, Bitcoin, was introduced (Trautman, 2014). Bitcoin was the world's first decentralized cryptocurrency. Being decentralized, cryptocurrencies are neither backed by a government nor a commodity.

Fiat currencies rely on governments and financial regulators to manage risk. Financial risk management history demonstrates that maintaining the economy through generally accepted financial principles has been a way for countries to mitigate risks involving inflation, trade, jobs, and overall consumer sentiment (Khan et al., 2019). The financial principles have been enabled by centralized banking system regulations and markets (Kabašinskas & Šutienė, 2021). Recent technological advances in currency markets have changed the way nations and investors understand financial risk, along with the theories and principles that govern these dynamics. The outcome gives rise to cryptocurrency's adoption.

A recent addition to the financial markets has been the introduction of cryptocurrencies. Cryptocurrencies, originally created to safely and securely manage digital transactions, have transitioned into a widely accepted form of currency (Inci & Lagasse, 2019). Unlike traditional currencies, cryptocurrencies are most notably characterized as being decentralized, unregulated, and anonymous (Inci & Lagasse, 2019). These characteristics have made cryptocurrency markets a haven for illicit activities, and a bane for financial and governmental risk managers. Bringing into question the need to regulate cryptocurrency and cryptocurrency markets.

There is no regulatory mechanism guiding cryptocurrency markets that has allowed cryptocurrencies to break away from conventional ways of understanding money and the economy, and eliminated concerns over giving governments too much control and using money for class discrimination. While the benefits of cryptocurrency have been universally recognized, adoption has been limited (Bezhovski et al., 2021; Liang et al., 2021). A hinderance to cryptocurrency adoption concerns how this form of money will meet expectations based on traditional uses of money and generally accepted financial principles. These concerns have gained the attention of professionals and scholars alike.

Cryptocurrency has gained the interest of both professional and scholarly communities. There have been several current studies on cryptocurrency about illicit activities (Dawson, 2020; Didenko &

Buckley, 2018; Foley et al., 2019; Trautman, 2014), financial/governmental regulations (Pieters & Vivanco, 2017; Yin et al., 2019), and investment opportunities as a financial asset (Baur, Dimpfl, et al., 2018; Baur, Hong, et al., 2018; Bayram et al., 2020; Bedi & Nashier, 2020; Corbet et al., 2018; Inci & Lagasse, 2019; Zaher et al., 2020). Findings from these studies reinforce the fact that cryptocurrencies are breaking away from generally accepted financial principles. The research results have generated concerns over the unknown risks associated with cryptocurrency.

One type of risk arising from cryptocurrency's disconnection with generally accepted financial principles within cryptocurrency markets is the arbitrage opportunity. Arbitrage opportunities arise when investors can profit from simultaneously buying assets in one market and selling them in other markets (Zaher et al., 2020). Recent studies have indicated arbitrage opportunities between cryptocurrency markets and noted the role that a lack of a uniform, global regulatory framework played in allowing arbitrage to exist (Bruzgė & Šapkauskienė, 2022; Kabašinskas & Šutienė, 2021; Makarov & Schoar, 2020; Pieters & Vivanco, 2017). While these studies have demonstrated the existence of arbitrage, gaps still exist within the literature regarding this topic.

The literature review for this study encompassed an analysis of over 150 academic sources. Several gaps in the existing research were identified. First, there is a notable lack of studies focusing specifically on the Canadian cryptocurrency market. Second, most existing research is heavily concentrated on Bitcoin, with limited attention to other cryptocurrencies. Third, the literature presents mixed findings regarding whether arbitrage opportunities exist for cryptocurrency as a financial asset. Finally, there are similarly inconsistent findings concerning the role of volatility and liquidity as potential influencers of such arbitrage opportunities. These literature gaps directly informed this study's purpose and objectives.

The study's goal was to grow the body of knowledge regarding cryptocurrency by focusing on arbitrage opportunities in the Canadian cryptocurrency market. Due to the relative newness and seemingly boundless expansion of different cryptocurrencies and cryptocurrency markets, recent studies have concluded that further studies are required to fully understand arbitrage in these markets (Bruzgė & Šapkauskienė, 2022; Kabašinskas & Šutienė, 2021; Makarov & Schoar, 2020; Pieters & Vivanco, 2017). These conclusions are the foundation of the topic of this study. This topic is important to study because the noted types of characteristics and outcomes for cryptocurrencies undermine generally accepted financial principles, which unwittingly expose average and inexperienced investors to undesirable risk-to-reward propositions. Gaining a better understanding of arbitrage in cryptocurrency markets could lead to positive social change by better preparing professionals to protect average and inexperienced investors regarding the use of cryptocurrencies to maximize their portfolio performance.

THE PROBLEM

The social problem that prompted this study was that average and inexperienced investors may be accepting unnecessary and increased risks by adding cryptocurrencies to their financial portfolios, due to expectations of improved performance. The characteristics of cryptocurrency and many investors undermine the commonly accepted financial principles required to understand the risk-

to-reward relationship associated with an investment (Almeida & Gonçalves, 2023). Such as investors being assured they are getting the market price for their investment. These characteristics make cryptocurrency a highly volatile and risky investment that needs to be researched to understand better and protect average and inexperienced investors.

The specific research problem addressed through this study was to determine whether arbitrage opportunities exist in the Canadian cryptocurrency market. While cryptocurrency has experienced professional and academic attention due to its unprecedented growth, unlike traditional asset classes, cryptocurrency is most notably characterized as being riddled with high price volatility, burst bubbles, fraud, and collapsed currencies and exchanges (Baur, Dimpfl, et al., 2018; Bruzgė & Šapkauskienė, 2022). These characteristics fuel the high-risk-high-reward speculative nature of cryptocurrency (Baur, Dimpfl, et al., 2018). The research problem was selected based on the underlying social problem created by cryptocurrency's increasing popularity, as evidenced by its significance to the financial community, and notable gaps in current literature. This evidence justifies the importance of this topic to the professional and academic communities.

PURPOSE OF THE STUDY

The purpose of this quantitative study was to test the theory of the LOP on cryptocurrency and cryptocurrency markets in Canada. LOP models that identical goods must be sold for identical prices at different locations. As a key financial principle, recent studies have indicated the need to continue to study arbitrage in the cryptocurrency markets through the LOP theoretical lens (Kabašinskas & Šutienė, 2021; Pieters & Vivanco, 2017). These studies demonstrate the connection between the problem being addressed and the purpose of this study. The study's intent needs to be reviewed to understand its purpose entirely.

The study's intent was to compare daily closing prices of individual cryptocurrencies between different Canadian cryptocurrency exchanges. The LOP involves comparing the market value of cryptocurrencies across different markets to see if there are arbitrage opportunities. If there are arbitrage opportunities, then the LOP has been violated. The dependent variable, daily arbitrage opportunity, was measured as a dichotomous value (yes or no). The independent variable was the daily closing prices of different markets. This comparison demonstrated whether there were arbitrage opportunities for cryptocurrency within the Canadian markets but did not show possible influences of such opportunities.

If arbitrage opportunities are found, the subsequent intent of the study is to demonstrate probable influencers of arbitrage opportunities among Canadian cryptocurrency exchanges. Where arbitrage opportunities were found, relationship measures for volatility and liquidity were tested. The dependent variable was the daily arbitrage opportunity (yes or no). Independent variables of this test would be the measurements for volatility and liquidity. To achieve the purpose of this study, it is essential to address the research questions comprehensively.

Two research questions were formed to address the research problem and align with the study's purpose.

Research Question 1: To what extent do daily closing prices of cryptocurrency by different exchanges cause arbitrage opportunities in the Canadian cryptocurrency market?

$H_0 1$: Daily closing prices by exchange do not cause arbitrage opportunities in the Canadian cryptocurrency market.

$H_a 1$: Daily closing prices by exchange do cause arbitrage opportunities in the Canadian cryptocurrency market.

Research Question 2: To what extent do volatility and liquidity influence arbitrage opportunities between Canadian cryptocurrency exchanges?

$H_0 2$: Volatility and liquidity do not influence arbitrage opportunities between Canadian cryptocurrency exchanges.

$H_a 2$: Volatility and liquidity do influence arbitrage opportunities between Canadian cryptocurrency exchanges.

Theoretical Foundation

The theoretical framework that grounded this study was the LOP. While the intellectual history of LOP dates to mid-1700s France, Miljkovic (1999) and Persson (2008) attribute the current economic contextualization of LOP to Giovannini (1988). Giovannini defined the LOP as a model that demonstrates the value of an asset, such as currency, should be the same value regardless of the market, and should not fluctuate between markets. The LOP is a key financial principle that helps investors understand the inner workings of market prices.

Investors rely on key financial principles to help them understand markets and risk-to-reward relationships. The LOP is a fundamental and unifying economic principle for understanding the workings of financial markets and their valuations (Giovannini, 1988; Kabašinskas & Šutienė, 2021; Kristoufek, 2019; Makarov & Schoar, 2020; Miljkovic, 1999; Persson, 2008; Pieters & Vivanco, 2017; Shynkevich, 2021; Witzel, 2005). LOP ascertains that identical goods must be sold for identical prices regardless of the market. If there are price differences between markets, then the markets' price variances would be quickly corrected through arbitrage.

Arbitrage is the practice of moving supply between markets for profit, which involves buying assets in one market and simultaneously selling them for profit in another market. Transferring the supply from one market to another causes shifts in price for both markets based on supply and demand economics: the decreased supply will cause an increase in the price in the original market. The increased supply will cause a decrease in the price in the destination market. The transactions continue until there are no longer price incentives to transfer supply from one market to another (see Figure 1).
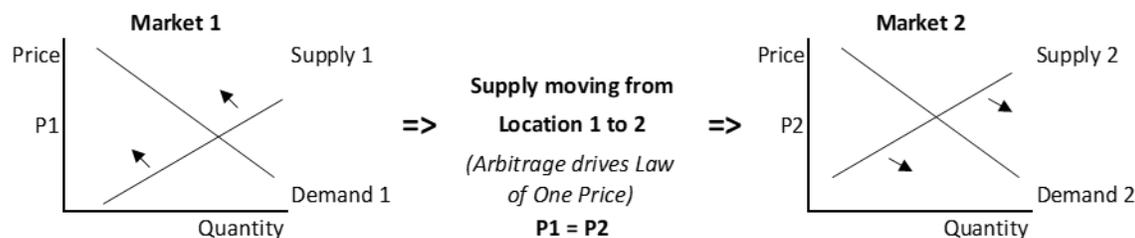
FIGURE 1. HOW ARBITRAGE SUSTAINS THE LOP

Misaligned with its label, LOP is not a law of economic and financial theory, but an explanation that is not always maintained. While the LOP is frequently violated, it is still considered a key building block of current financial and economic theory (Giovannini, 1988; Miljkovic, 1999). The LOP is commonly maintained for highly traded commodities and currencies, such as gold and the U.S. dollar (Miljkovic, 1999; Rogoff, 1996). Furthermore, recent quantitative studies have used the LOP framework to examine if arbitrage opportunities exist between cryptocurrency markets (Kabašinskas & Šutienė, 2021; Makarov & Schoar, 2020; Shynkevich, 2021). The theory demonstrates that no arbitrage opportunities will be found if the LOP is respected between cryptocurrency markets within Canada, which aligns the theoretical framework to the research questions of this study.

SIGNIFICANCE OF THE STUDY

The adoption of cryptocurrency as a financial asset cannot be questioned. While cryptocurrencies are being accepted as a new payment system and financial asset, there remains "skepticism and a lack of understanding of their nature" (Charfeddine et al., 2020, p. 198). One topic of incomplete knowledge surrounding cryptocurrencies is the existence of arbitrage opportunities between cryptocurrency markets (Bruzgė & Šapkauskienė, 2022; Kabašinskas & Šutienė, 2021; Krückeberg & Scholz, 2020; Makarov & Schoar, 2020; Shynkevich, 2021). The significance of this study was the advancement of the knowledge of arbitrage opportunities for cryptocurrency as a financial asset. The following sections review how this study will advance knowledge in academic theory, professional practice, and its contribution to social change.

Significance to Theory

Theoretically, cryptocurrency is a relatively new but critical phenomenon and has garnered much discussion in current literature. Recent studies have focused on cryptocurrency as a financial asset (Corbet et al., 2018), its relationship with other financial assets (Nedved & Kristoufek, 2023), enhancing portfolio performance (Inci & Lagasse, 2019), governmental and financial regulations (Borri & Shakhnov, 2020; Lee & Oh, 2022), cyber criminality (Dawson, 2020; Foley et al., 2019), and arbitrage (Bruzgė & Šapkauskienė, 2022; Kabašinskas & Šutienė, 2021; Makarov & Schoar, 2020). While these studies have been successful, other studies have noted that advancing

knowledge regarding how to analyze arbitrage opportunities between cryptocurrency markets through traditional financial theory would help to increase the integrity of cryptocurrency as a financial asset (Krückeberg & Scholz, 2020) and the efficiency of financial markets (Shynkevich, 2021). Academic theory is expected to be advanced as scholars continue to contribute to the evolving body of knowledge on this relatively new and dynamic financial asset. Bringing into question the completeness of the current body of work on this topic of interest.

The academic literature on arbitrage opportunities for cryptocurrency as a financial asset is lacking. Duan et al. (2021) noted that studies on arbitrage opportunities in the cryptocurrency market are surprisingly "scant" (p. 1). Recent studies have generalized these findings and have noted that research has not kept up with either the technological advancements involving cryptocurrency or the influencers of arbitrage opportunities for cryptocurrency as a financial asset (Duczmal & Skomorovski, 2021). This study is significant because it will address this gap in the literature. The study results will allow scholars to better inform practitioners of the nature and influences of cryptocurrencies.

Significance to Professional Practice

Despite being 16 years old, cryptocurrency is a relatively new financial asset. In comparison to other financial assets, cryptocurrencies and their markets are considered to be in their infancy (Bruzgė & Šapkauskienė, 2022). Bringing into question how cryptocurrency may change as it develops into a mature financial asset. In practice, this developmental characteristic of cryptocurrency should be mitigated by the low level of impact cryptocurrency has on the financial markets.

There is an imbalance between the financial magnitude of cryptocurrency and what is known about the financial asset. Despite its early development status, cryptocurrency as a financial asset has immensely impacted the financial markets. Several recent studies have concluded that cryptocurrency markets are less synchronized in comparison to other financial markets due to a lack of understanding of the influences on the market (Bedi & Nashier, 2020; Bouri et al., 2019; Bruzgė & Šapkauskienė, 2022; Leung & Nguyen, 2019; Makarov & Schoar, 2020; Wątorek et al., 2021). Being less synchronized is evidenced by the belief that arbitrage opportunities exist between cryptocurrency markets, prompting the question: If such opportunities exist, what factors influence arbitrage in cryptocurrency as a financial asset?

A deeper understanding of arbitrage opportunities and their influencing factors in the context of cryptocurrency as a financial asset can assist professional investors in more effectively managing cryptocurrency investments. Recent studies have denoted that a more current and expressive understanding of arbitrage opportunities in cryptocurrency markets will enable investors to gain a better understanding of how to use important financial indicators and instruments, such as interrelationships between markets (Bruzgė & Šapkauskienė, 2022; Wątorek et al., 2021), trading strategies (Kabašinskas & Šutienė, 2021; Leung & Nguyen, 2019; Makarov & Schoar, 2020), price assumptions for adaptation to Futures markets (Shynkevich, 2021), optimal portfolio management (Bianchi et al., 2019; Krückeberg & Scholz, 2020), hedging strategies (Bruzgė & Šapkauskienė,

2022; Salisu et al., 2019), and portfolio diversification (Charfeddine et al., 2020; Inci & Lagasse, 2019; Mensi et al., 2019). This study will advance investment practice in cryptocurrency by providing a deeper understanding of the extent of arbitrage opportunities across Canadian cryptocurrency exchanges. This study's results will, in turn, allow for financial analysts and other professional investors to better serve and direct their customers and the general public.

Significance to Social Change

With the rapid growth of cryptocurrencies, experienced and inexperienced investors are attracted to invest in cryptocurrencies (Delfabbro et al., 2021). There is a significant risk that average and inexperienced investors lack the risk management strategies and financial resilience necessary to absorb potential losses associated with cryptocurrency investments. To mitigate this risk, professional investors and scholars must contribute to a deeper understanding of cryptocurrency as a financial asset, thereby supporting the protection of less experienced market participants.

Given cryptocurrency's high volatility, frequent misrepresentations on social media, and the absence of widely accepted financial principles guiding trading behavior, average and inexperienced investors may be exposed to unnecessary or unintended risks. Recent studies suggest that cryptocurrency investments are predominantly driven by speculative motives, potentially increasing these investors' vulnerability to financial losses. (Baur, Dimpfl, et al., 2018; Baur, Hong, et al., 2018; Corbet et al., 2018). This risk is compounded by the fact that non-professional investors in cryptocurrency erroneously regard their investments as having the same characteristics as more common, traditional assets (Kim et al., 2020). These characteristics demonstrate that there are more influences on a particular investor's behavior than just inexperience. To protect investors, these other influences need to be reviewed.

Overexposure to risk may not be due to inexperience, but rather the mental state of the investor. Recent studies have likened the behaviors of non-professional investors of cryptocurrencies to that of online gamblers (Delfabbro et al., 2021; Mills & Nower, 2019), risk-seekers (Pelster et al., 2019), and irrational investors (Almeida & Gonçalves, 2023; Ballis & Drakos, 2020; Kaiser & Stöckl, 2020; Tjondro et al., 2023). Almeida and Gonçalves (2023) and Delfabbro et al. (2021) noted the need for professionals and scholars to gain a better understanding of strategies to protect average and inexperienced cryptocurrency investors from harm, while still allowing them to benefit from investing in cryptocurrencies. As noted in the prior two sections, a greater understanding of the extent of arbitrage opportunities between Canadian cryptocurrency exchanges would allow the use of generally accepted financial principles when dealing with cryptocurrencies.

Professional investors and scholars are responsible for creating the knowledge necessary to protect average and inexperienced investors. Bruzgė and Šapkauskienė (2022) noted that a more in-depth understanding of arbitrage opportunities would allow investors to understand better the interrelationships between cryptocurrency markets and how this can be employed to create optimal financial portfolios. The increased understanding of cryptocurrency and cryptocurrency exchanges would have a positive social impact by helping to preserve average and inexperienced investors'

savings for retirement and their children's education by reducing unnecessary or unwanted risk. The potential for positive social change exists from the significance of this study.

RESEARCH DESIGN AND METHODS

To address the research questions, this study employed a nonexperimental cross-sectional research design and used quantitative statistical methods, including descriptive statistics and binary logistic regression. Recent studies have shown that arbitrage opportunities for cryptocurrencies can be successfully researched using a quantitative method (Bruzgė & Šapkauskienė, 2022; Duan et al., 2021; Foley et al., 2019; Kabašinskas & Šutienė, 2021; Kristoufek & Bouri, 2023; Leung & Nguyen, 2019; Makarov & Schoar, 2020; Wątorek et al., 2021; Zaher et al., 2020). The specific research design in this study followed the work of Bruzgė and Šapkauskienė (2022). These studies successfully demonstrated arbitrage opportunities between cryptocurrency markets.

To answer the research questions, daily closing prices, bid prices, and ask prices of cryptocurrencies were compared across various Canadian cryptocurrency exchanges. The dependent variable in this study was the presence of arbitrage opportunities, defined as a dichotomous variable (yes/no) and measured at the nominal level. The independent variable was the daily closing price of individual cryptocurrencies across different Canadian cryptocurrency exchanges. These prices are discrete and measured at the ratio level. To test for the existence of daily arbitrage opportunities, daily closing prices of the same cryptocurrency were compared across multiple exchanges. If arbitrage opportunities were identified, a second analysis was conducted to examine the relationship between the dependent variable and volatility and liquidity measures. The dependent variable—daily arbitrage opportunity—was operationalized as a dichotomous (yes/no) variable at the nominal level of measurement. The independent variables included volatility, measured using beta, and liquidity, measured using the bid-ask spread, for each cryptocurrency across different Canadian cryptocurrency exchanges. Both independent variables are discrete and measured at the ratio level.

Population, Sample Population, and Data Collection

Like most of the world, cryptocurrency is not considered legal tender in Canada; however, it is not illegal to use cryptocurrency in Canada. Approximately 9% of the Canadian population owning cryptocurrency has access to the almost $1 trillion U.S. market, consisting of over 200 cryptocurrency exchanges and almost 10,000 different cryptocurrencies (Laycock, 2022). While a study focused on the Canadian cryptocurrency market would add to the existing knowledge, further refinement of the population was required to make the study manageable while still ensuring its validity. This kind of subset of the population is known as a sample.

With approximately 10,000 cryptocurrencies, credible criterion to select the sample population is required. The criterion of the most popular cryptocurrencies in Canada was used. This sample population criterion follows the sample process used by recent studies that looked at arbitrage

opportunities for more than one cryptocurrency (Bruzgė & Šapkauskienė, 2022; Kabašinskas & Šutienė, 2021). The top four popular cryptocurrencies in Canada with at least 1% of the market, which account for 64% of the overall market holdings, are Bitcoin, Ethereum, Dogecoin, and Cardano (de Best, 2022; Laycock, 2022). Internationally, these cryptocurrencies are seen as a leading cryptocurrency (Demmler, 2023). Only data for these cryptocurrencies were collected for the sample.

With over 200 cryptocurrency exchanges from which to collect data, a credible set of criteria to select the sample population was required. The LOC principle notes that local costs must be accounted for and considered in the sample selection. Embedded into the market prices for cryptocurrency are regulatory costs and transactional costs. To ensure that the exchanges selected had the same regulatory and transactional costs, three selection criteria were made: the exchange must support the four noted cryptocurrencies; prices are quoted in Canadian dollars and paid out in Canadian dollars (to remove foreign exchange costs); and the exchange had to be approved by Canada's largest security committee—the Ontario Security Committee.

The noted criteria will help to ensure that, along with consistent regulatory costs, only legitimate and leading exchanges are selected for data collection. These sample population criteria follow the sample process used by recent studies that looked at arbitrage opportunities for more than one cryptocurrency (Bruzgė & Šapkauskienė, 2022; Kabašinskas & Šutienė, 2021). Based on these criteria, there were four exchanges selected: Bitbuy Canada & Bitvo (due to the purchase and amalgamation of Bitvo by Bitbuy during the data collection period, the data collected for these exchanges were referred to as Bitbuy/Bitvo); Coinsquare; Netcoins; Newton. These exchanges accounted for 50% of the Canadian cryptocurrency market revenues (Smith, 2023). Binance, the world's largest cryptocurrency exchange, announced in May 2023 that they would be immediately leaving the Canadian market due to regulatory issues, such as its inability to gain approval from the Ontario Securities Commission (Durrani, 2023). This announcement will have an effect of increasing the market share of the noted exchanges.

The quantitative data collected for this study consisted of the daily closing values for price, bid price, and ask price for each of the four selected cryptocurrencies across the four identified cryptocurrency exchanges. These three data points provide a foundation for analyzing the presence of arbitrage opportunities between exchanges and constructing metrics to assess market volatility and liquidity. This approach enables a comprehensive evaluation of price discrepancies and trading dynamics within the Canadian cryptocurrency market.

Data Analysis Plan

Data for this study were collected over a 3-month (92-day) period beginning on October 15, 2023. Two distinct datasets were developed from this collection: a primary dataset and a secondary dataset. The primary dataset consisted of the daily values for closing price, bid price, and ask price for each of the four selected cryptocurrencies across the identified exchanges. This dataset was designed to support the analysis of Research Questions 1 and 2 (RQ1 and RQ2). The secondary dataset comprises daily closing prices of the S&P/TSX, sourced from the S&P/TSX Composite

Index, and was specifically used to support the evaluation of Research Question 2 (RQ2).

A key challenge in aligning these datasets stems from the operational differences between cryptocurrency markets and traditional financial markets. Cryptocurrency exchanges operate continuously, whereas the TSX follows a fixed trading schedule and is closed on weekends and statutory holidays. To ensure comparability, 27 non-trading days (13 Saturdays, 14 Sundays) and three Canadian statutory holidays (December 25, 2023; December 26, 2023; and January 1, 2024) were excluded from the primary dataset, resulting in 62 days of fully aligned data.

Data collection was automated using Microsoft Excel's Visual Basic and Power Query features, with a scheduled refresh set to capture exchange data at 11:59:59 PM daily. The resulting data was analyzed using descriptive statistics and IBM SPSS software to conduct a binary logistic regression model to address the research questions.

Data Collection

Data for this study were collected over 92-days, from October 15, 2023, to January 14, 2024. For each of the four selected cryptocurrencies, data was recorded for 62 trading days—excluding weekends and Canadian statutory holidays to align with the traditional trading calendar of the S&P/TSX Index. Three data points were collected daily (closing price, bid price, and ask price) from four different cryptocurrency exchanges, resulting in 744 observations per cryptocurrency (62 days * 3 datapoints * 4 exchanges) and a total of 2,976 observations across all cryptocurrencies (744 observations * 4 cryptocurrencies). Following the Central Limit Theorem and the events-per-variable rule of thumb, this sample size is sufficient to ensure statistical power and generalizability of results, particularly given the study's use of a binary logistic regression model.

The complete dataset, titled the Raw Dataset, was used to address RQ1. To address RQ2, a second dataset, titled the Transformed Dataset, was created through the systematic transformation of the Raw Dataset. The transformation of raw data involved two key steps: (1) calculating a measure of volatility using beta (β), benchmarked against the S&P/TSX Index, and (2) calculating a measure of liquidity using the bid-ask spread.

The first transformation focused on capturing the volatility of each cryptocurrency relative to the broader Canadian financial market, represented by the S&P/TSX Index. β is a standard measure of systematic risk, reflecting the degree to which an asset's price fluctuates relative to a market benchmark. In this study, β was calculated as the percentage change in the cryptocurrency's closing price relative to the previous day's closing price. The formula used was:

$$\beta = \frac{(Current\ Day's\ Closing\ Price - Previous\ Day's\ Closing\ Price)}{Previous\ Day's\ Closing\ Price}$$

To interpret volatility, the daily percentage change of each cryptocurrency was compared to the corresponding daily change in the S&P/TSX Index. A β value greater than 1 indicates greater volatility than the benchmark; a value less than 1 indicates lower volatility; and a negative β suggests an inverse relationship. For analytical clarity and consistency with risk assessment

conventions, a dichotomous variable was constructed to represent volatility. A value of 1 indicates high volatility, defined as a daily price fluctuation equal to or greater than ±1.5 times the β of the S&P/TSX Index. In contrast, a value of 0 denotes low or average volatility, defined as a fluctuation less than ±1.5 times the benchmark β.

The second transformation addressed liquidity by analyzing the bid-ask spread, a widely recognized indicator of market efficiency and transaction cost. The bid-ask spread represents the difference between the highest price a buyer is willing to pay (bid) and the lowest price a seller is willing to accept (ask). The spread was calculated as follows:

$$\textbf{Bid-Ask Spread} = (\frac{Ask\ Price - Bid\ Price}{Ask\ Price})\ x\ \textbf{100}$$

To categorize liquidity levels, this study adopted the framework established by Makarov and Schoar (2020), who analyzed average bid-ask spreads in cryptocurrency markets. Their thresholds were applied: spreads of 0–3 basis points (bps is 1/100th of a percentage point) were classified as liquid, 4–16 bps as average, and 17+ bps as illiquid. These categories were converted into an ordinal variable for analysis: liquid (2), average (1), and illiquid (0). While the bid-ask spread is inherently a ratio-level measure, its transformation into an ordinal variable facilitated categorical analysis of market liquidity conditions across exchanges and over time.

RESULTS

The purpose of this quantitative study was to examine the existence of arbitrage opportunities within the Canadian cryptocurrency markets through the theoretical framework of LOP. Specifically, the study sought to determine whether identical cryptocurrencies were being traded at different prices across Canadian exchanges, violating price parity conditions posited by LOP. In instances where such arbitrage opportunities were identified, the study further aimed to assess the relationship between these opportunities and key market characteristics—namely, volatility and liquidity—by employing quantitative metrics to evaluate their potential influence on price discrepancies.

Research Question 1

To address RQ1, a probability-based statistical analysis was conducted to evaluate the frequency of arbitrage opportunities within the dataset. This analysis considered the total number of valid trading days (n = 62), the number of arbitrage instances identified per cryptocurrency, and the frequency of occurrences across specific buy-sell exchange pairings. The approach was grounded in the assumptions underlying basic probability and frequency analyses, including random sampling, normal distribution of the data, independence of observations, and goodness-of-fit, as outlined by Warner (2012). Before conducting the analysis, these assumptions were evaluated using the Raw Dataset. They were determined to be sufficiently met, thereby supporting the validity of the inferential results derived from this analysis.

The methodology used to identify arbitrage opportunities in this study was adapted from the frameworks established by Bruzgė and Šapkauskienė (2022) and Kabašinskas and Šutienė (2021), who conducted successful empirical investigations into cryptocurrency arbitrage. In alignment with these prior studies, the daily closing prices sourced from multiple cryptocurrency exchanges were interpreted as indicative of potential buy and sell points. An arbitrage opportunity was considered to exist only when a trader could simultaneously purchase a cryptocurrency on one exchange and sell it on another at a profit, net of any transactional costs.

To depict this buy-sell relationship within the data collected for this study, we calculated the net value by subtracting the closing price from the buying exchange from the closing price from the selling exchange (Selling Closing Price – Buying Closing Price). Following the structure used by Bruzgė and Šapkauskienė (2022) in their study of arbitrage opportunities, an arbitrage opportunity was recognized if the resulting amount from the transaction equaled or exceeded $0.01 for Bitcoin or Ethereum, $0.00001 for Cardano, or $0.000001 for Dogecoin. These thresholds reflect the typical magnitude of arbitrage margins observed in high-frequency cryptocurrency markets while accounting for each asset's relative nominal price levels.

Upon analyzing the data and applying our predefined criteria for identifying arbitrage opportunities, it becomes evident that such opportunities are a consistent daily occurrence across all exchanges, albeit meager based on the tolerances. Furthermore, the distribution of arbitrage opportunities, when considered as a percentage frequency, appears remarkably uniform across all platforms. This uniformity implies that no single exchange consistently offers lower or higher prices, highlighting a balanced occurrence of arbitrage opportunities evenly distributed among the exchanges. The output of the probability analysis of cryptocurrency can be found in Figure 2.

Summary of Arbitrage Opportunity Data for Bitcoin				
Buy - Sell Exchanges	**Valid Days**	**Arbitrage Frequency**	**Arbitrage Percentage**	**Cumulative Exchanges %**
Bitbuy/Bitvo - Coinsquare	62	25	40.3%	
Coinsquare - Bitbuy/Bitvo	62	37	59.7%	100.0%
Bitbuy/Bitvo - Netcoins	62	26	41.9%	
Netcoins - Bitbuy/Bitvo	62	36	58.1%	100.0%
Bitbuy/Bitvo - Newton	62	23	37.1%	
Newton - Bitbuy/Bitvo	62	39	62.9%	100.0%
Coinsquare - Netcoins	62	31	50.0%	
Netcoins - Coinsquare	62	31	50.0%	100.0%
Coinsquare - Newton	62	29	46.8%	
Newton - Coinsquare	62	33	53.2%	100.0%
Netcoins - Newton	62	27	43.5%	
Newton - Netcoins	62	35	56.5%	100.0%

Summary of Arbitrage Opportunity Data for Ethereum				
Buy - Sell Exchanges	**Valid Days**	**Arbitrage Frequency**	**Arbitrage Percentage**	**Cumulative Exchanges %**
Bitbuy/Bitvo - Coinsquare	62	37	59.7%	
Coinsquare - Bitbuy/Bitvo	62	25	40.3%	100.0%
Bitbuy/Bitvo - Netcoins	62	30	48.4%	
Netcoins - Bitbuy/Bitvo	62	32	51.6%	100.0%
Bitbuy/Bitvo - Newton	62	28	45.2%	
Newton - Bitbuy/Bitvo	62	34	54.8%	100.0%
Coinsquare - Netcoins	62	34	54.8%	
Netcoins - Coinsquare	62	28	45.2%	100.0%
Coinsquare - Newton	62	23	37.1%	
Newton - Coinsquare	62	39	62.9%	100.0%
Netcoins - Newton	62	26	41.9%	
Newton - Netcoins	62	35	56.5%	98.4%

Summary of Arbitrage Opportunity Data for Cardano				
Buy - Sell Exchanges	**Valid Days**	**Arbitrage Frequency**	**Arbitrage Percentage**	**Cumulative Exchanges %**
Bitbuy/Bitvo - Coinsquare	62	34	54.8%	
Coinsquare - Bitbuy/Bitvo	62	27	43.5%	98.4%
Bitbuy/Bitvo - Netcoins	62	40	64.5%	
Netcoins - Bitbuy/Bitvo	62	22	35.5%	100.0%
Bitbuy/Bitvo - Newton	62	36	58.1%	
Newton - Bitbuy/Bitvo	62	26	41.9%	100.0%
Coinsquare - Netcoins	62	39	62.9%	
Netcoins - Coinsquare	62	23	37.1%	100.0%
Coinsquare - Newton	62	32	51.6%	
Newton - Coinsquare	62	30	48.4%	100.0%
Netcoins - Newton	62	29	46.8%	
Newton - Netcoins	62	33	53.2%	100.0%

Summary of Arbitrage Opportunity Data for Dogecoin				
Buy - Sell Exchanges	**Valid Days**	**Arbitrage Frequency**	**Arbitrage Percentage**	**Cumulative Exchanges %**
Bitbuy/Bitvo - Coinsquare	62	34	54.8%	
Coinsquare - Bitbuy/Bitvo	62	19	30.6%	85.5%
Bitbuy/Bitvo - Netcoins	62	39	62.9%	
Netcoins - Bitbuy/Bitvo	62	23	37.1%	100.0%
Bitbuy/Bitvo - Newton	62	36	58.1%	
Newton - Bitbuy/Bitvo	62	26	41.9%	100.0%
Coinsquare - Netcoins	62	40	64.5%	
Netcoins - Coinsquare	62	22	35.5%	100.0%
Coinsquare - Newton	62	35	56.5%	
Newton - Coinsquare	62	27	43.5%	100.0%
Netcoins - Newton	62	22	35.5%	
Newton - Netcoins	62	40	64.5%	100.0%

FIGURE 2. SUMMARY OF ARBITRAGE OPPORTUNITY BY CRYPTOCURRENCY AND BUY-SELL CRYPTOCURRENCY EXCHANGE COMBINATION

Applying this methodology to the collected data revealed that arbitrage opportunities were present across all four cryptocurrencies and all exchange pairings on a near-daily basis. Specifically, out of 1,488 valid events (calculated as 62 trading days × 4 cryptocurrencies × 6 unique buy-sell

exchange combinations), arbitrage opportunities were observed in 1,477 instances, yielding a frequency rate of 99.3%. This high occurrence rate suggests that arbitrage opportunities are not only present and persistently available within the Canadian cryptocurrency market.

Furthermore, the distribution of these arbitrage events appeared evenly dispersed across all exchanges, indicating no systematic pricing advantage or inefficiency consistently associated with any single platform. This distribution suggests a balanced inter-exchange pricing dynamic that still allows for profitable discrepancies at a microstructural level.

Given the overwhelmingly high frequency of arbitrage events, the null hypothesis for RQ1—which posited that no arbitrage opportunities exist across cryptocurrency exchanges in Canada—was rejected. The evidence supports the alternative hypothesis: daily closing price differentials across exchanges give rise to arbitrage opportunities. This finding contributes to the broader literature by confirming the continued presence of pricing inefficiencies in the Canadian cryptocurrency market, despite its increasing maturity and integration.

Research Question 2

Following the confirmation of persistent arbitrage opportunities across Canadian cryptocurrency exchanges, RQ2 was examined to investigate the influence of market volatility and liquidity on the occurrence of these opportunities. A binary logistic regression model was employed to evaluate this relationship. This statistical method was selected for its suitability for modeling dichotomous dependent variables, aligning with the study's aim of determining whether the presence or absence of arbitrage opportunities could be predicted based on volatility and liquidity measures.

As noted by Warner (2012), binary logistic regression is appropriate when the outcome variable is categorical with two levels—in this case, the presence (1) or absence (0) of an arbitrage opportunity. For the model to yield valid inferences, several assumptions must be satisfied: the dependent variable must be dichotomous; the sample size must be sufficiently large to ensure statistical power; there should be no multicollinearity among predictor variables; observations must be independent; a linear relationship must exist between continuous predictors and the logit of the dependent variable; and there must be no issue of complete or quasi-complete separation in the data.

These assumptions were tested using both the Raw Dataset and the Transformed Dataset prior to the regression analysis. Diagnostic tests confirmed that all necessary conditions were met, thereby validating the appropriateness of the logistic regression model and supporting the reliability of its results in explaining the relationship between volatility, liquidity, and the likelihood of arbitrage events in the Canadian cryptocurrency market.

Model diagnostics began assessing the null model (Block 0), which assumed that no arbitrage occurred. This baseline predicted the outcome correctly 50.4% of the time. Upon including volatility and liquidity as predictors (Block 1), the model's predictive accuracy increased marginally to 52.5%. While the Omnibus Test of Model Coefficients yielded a statistically

significant result (χ^2 = 17.561, df = 3, p = .001), indicating that the overall model improved upon the null model, the model's explanatory power remained weak.

Goodness-of-fit statistics further underscored this limitation. The Nagelkerke R^2 value was .008, suggesting that less than 1% of the variance in arbitrage occurrence could be explained by the independent variables. According to Cohen's (1988) benchmarks, this represents an effect size so small as practically negligible. Additionally, the Hosmer and Lemeshow test (χ^2 = 1.014, p = .798) indicated no significant difference between the observed and predicted outcomes, confirming that the model did not systematically deviate from the data but failed to strongly explain the difference. Despite the weak model fit, the odds ratio analysis revealed statistically significant and directionally meaningful relationships. For volatility, the regression coefficient (β = .252, p = .005) and corresponding odds ratio (Exp(β) = 1.287) suggested that each one-unit increase in volatility raised the odds of arbitrage occurrence by approximately 28.7%. Conversely, the liquidity variable (Liquidity(2): β = –.344, p = .043; Exp(β) = 0.709) demonstrated that higher illiquidity reduced the likelihood of arbitrage opportunities by 29.1%. Given this, the null hypothesis for RQ2—which posited that arbitrage opportunities across cryptocurrency exchanges in Canada were not influenced by volatility or liquidity—was rejected. These findings align with theoretical expectations, as greater volatility is typically associated with price dislocations, while more liquid markets are generally more efficient and less prone to arbitrage gaps.

Summary

This study found that arbitrage opportunities exist in the Canadian cryptocurrency markets and that volatility and liquidity were influencers of these opportunities. While the logistic regression model demonstrated statistically significant associations between arbitrage opportunities and volatility and liquidity, the overall model exhibited poor explanatory power and limited practical significance. The odds ratios indicated moderate, directionally consistent relationships, suggesting that while these variables play a role in shaping arbitrage conditions in Canadian cryptocurrency markets, they do not capture the full complexity of the phenomenon.

DISCUSSION

The results of this study provide empirical evidence that arbitrage opportunities persist within the Canadian cryptocurrency market, thereby supporting the hypothesis that cryptocurrency, as a financial asset, is subject to price inefficiencies. Moreover, the analysis demonstrated that while volatility and liquidity were statistically significant predictors of arbitrage opportunities, the strength of these relationships was negligible, suggesting limited explanatory power. These findings align with prior literature identifying persistent arbitrage conditions in various contexts, including market-specific (Borri & Shakhnov, 2020; Lee & Oh, 2022), cross-border (Makarov & Schoar, 2020), and exchange-specific environments (Bruzgė & Šapkauskienė, 2022; Kabašinskas & Šutienė, 2021). The observed influence of volatility and illiquidity is also consistent with earlier research that recognizes these factors as key contributors to arbitrage dynamics in cryptocurrency

markets (Bianchi et al., 2019; Bouri et al., 2019; Brauneis et al., 2022; Hansen et al., 2024; Shahzad et al., 2021).

The study found that while arbitrage opportunities exist in the Canadian market for cryptocurrency as a financial asset, the opportunity is meager. This finding generalized the findings of Li and Liu (2024), who found that arbitrage opportunities for Bitcoin start to vanish at a spread of 1.02% for centralized and trustworthy exchanges and 1.65% for decentralized and untrustworthy exchanges. Shynkevich (2023) confirmed these findings, noting that since 2018, arbitrage opportunities still exist, but the profitability of the opportunities has significantly declined. The findings of this study and the other noted studies bring into question a limitation of the study based on the effect of tolerances on the scope of what is considered an arbitrage opportunity and the generalizability of the findings.

These contributions add to the growing body of literature on the structural inefficiencies inherent in cryptocurrency markets. From a practical standpoint, the findings underscore the importance of developing more comprehensive regulatory frameworks and investor education initiatives. Such measures are particularly critical for average and inexperienced investors, many of whom may lack the requisite financial literacy or risk management capabilities to navigate the complex and volatile nature of cryptocurrency markets. By deepening scholarly understanding of the mechanisms driving arbitrage, this research supports efforts to enhance market integrity and protect vulnerable participants within the evolving cryptocurrency landscape.

Limitations of the Study

Research on arbitrage opportunities in cryptocurrency markets continues to evolve in parallel with the rapidly expanding and technologically complex nature of digital financial systems. This study aimed to investigate the influence of volatility and liquidity on arbitrage opportunities for cryptocurrency as a financial asset in Canada. While the study design followed established financial principles and statistical methods, several limitations emerged during data collection, transformation, and analysis. These limitations, which affect the reliability and generalizability of the findings, are critical for contextualizing the results and identifying directions for future research.

Although the original design of this study anticipated free and readily available data, practical limitations complicated the data collection process. Contrary to expectations, historical data were not consistently accessible on cryptocurrency exchange websites, and direct requests for the data often yielded no results. As a response, a custom data collection tool using Microsoft Excel was developed to automatically extract (or "scrape") the three datapoints from exchange websites at a fixed time (11:59:59 PM daily). A manual backup process was also maintained to ensure data continuity. Although this adapted method produced data aligned with the study's initial requirements, it introduced complexities that limited the overall repeatability of the research, as the raw dataset cannot be historically reconstructed.

The continuous 24/7 nature of cryptocurrency markets further complicates data collection. Unlike traditional financial markets that operate during fixed hours on weekdays, cryptocurrency trading does not observe weekends or holidays and trades continuously. To maintain comparability with traditional finance studies, weekend and holiday data were excluded, following precedents such as Bianchi et al. (2019). However, the exclusion of this data and the arbitrary selection of a fixed daily pull time potentially compromise the completeness and repeatability of the dataset.

Based on the studies completed by Bruzgė and Šapkauskienė (2022), the tolerance for what is considered an arbitrage opportunity was set at $0.01 for Bitcoin. Based on the data collected for this study, the average daily closing price for Bitcoin was approximately $52,630. The $0.01 tolerance for arbitrage opportunity represents only a fraction of the average daily closing price. As a robustness check to the study's results, a sensitivity analysis was completed on the assumption used for an arbitrage opportunity. If an arbitrary 1% of the average daily closing price, $526.30, was set as the tolerance for what is considered an arbitrage opportunity for Bitcoin, then the cumulative percentage for arbitrage opportunities drastically reduces from 100% to a range of 3.2% to 0.0% - depending on the buy-sell exchange combination. This sensitivity analysis demonstrates that while arbitrage opportunities exist within the Canadian cryptocurrency market, the extent of the opportunity is meager.

The raw dataset underwent transformation to better align with accepted financial modeling practices. Continuous variables were converted to dichotomous (volatility) and categorical (liquidity) forms to meet the analytical needs of binary logistic regression. All statistical model assumptions were confirmed for the raw and transformed datasets, except the linearity of the logit, which can only be tested for continuous variables. This exception was verified for the raw data, but not the transformed dataset—introducing another methodological limitation.

The rapidly evolving cryptocurrency environment presented another constraint. Since the study's inception in early 2022, significant events—including the collapse of cryptocurrency exchanges FTX and TerraUSD, Bitcoin's adoption in El Salvador, and the consolidation of Bitbuy and Bitvo in Canada during the data collection period—have reshaped the global and Canadian cryptocurrency markets. These systemic changes likely affected the dataset in ways that limit its generalizability to future studies.

Additionally, the study's findings indicated weak relationships between arbitrage opportunities and volatility and liquidity. The weak relationships suggest that other unmeasured factors may be more influential. Prior research has identified technology (e.g., blockchain innovations), economic conditions, investor sentiment, and social media influence as potential price-setting factors for cryptocurrencies, which were not included in this study. Their omission represents an important limitation and suggests directions for future inquiry.

A further limitation stems from the study's intent to address a gap in the literature by including cryptocurrencies beyond Bitcoin. Although Bitcoin substantially dominates global and Canadian cryptocurrency markets, its datapoints were weighted equally with Ethereum, Cardano, and Dogecoin. This approach underrepresents Bitcoin's market influence and may reduce the external validity of the findings.

Finally, the study inadvertently excluded decentralized exchanges (DEXs) by selecting only exchanges approved by Canadian regulatory authorities, which are all centralized (CEXs). As prior studies have shown, there are differences in arbitrage behavior between DEXs and CEXs (Hansen et al., 2024; Hansson, 2022; Li & Liu, 2024; Morin & Moore, 2023), this oversight limits the applicability of the findings to the broader cryptocurrency ecosystem and highlights another potential avenue for future research.

Implications

The rise of cryptocurrency as a financial asset has increased interest among professional and average investors. However, the decentralized and unregulated nature of cryptocurrency markets—combined with high volatility, limited investor education, and emerging trading strategies—has raised significant concerns about investor risk, market integrity, and long-term social impact. This study investigates the existence of arbitrage opportunities for cryptocurrency in the Canadian market and explores how factors such as volatility and liquidity contribute to these opportunities. In doing so, the study also examines broader implications through the lenses of academic theory, professional practice, and social change, offering insights into the need for protective mechanisms to guide and safeguard average and inexperienced investors.

This study is grounded in the LOP, an economic theory suggesting that an asset should have the same price across markets when accounting for transactional and localized costs. LOP violations indicate arbitrage opportunities, which occur when a financial asset is priced differently in different markets, allowing investors to profit from the price discrepancy. The relevance of LOP in cryptocurrency markets has been confirmed not only by this study, but in recent studies (Kabašinskas & Šutienė, 2021; Makarov & Schoar, 2020), confirming to scholars that the LOP is a sound theoretical framework to examine market efficiency and trading behaviors in decentralized environments.

The findings from this study uphold the theoretical expectation that volatility and illiquidity can influence arbitrage opportunities. However, the influence of these factors was found to be weak, suggesting that arbitrage conditions are not solely driven by these traditional variables. The findings supports the broader economic understanding that arbitrage is often the result of a confluence of factors—including technological, behavioral, and institutional dynamics. As such, while the findings reinforce the utility of LOP as a guiding theory, they also highlight the need for expanded models that incorporate non-traditional influencers in cryptocurrency markets.

From a practical standpoint, the study reveals the considerable risk exposure faced by non-professional investors who may lack a nuanced understanding of how cryptocurrency markets operate. Many average and inexperienced investors mistakenly equate cryptocurrency with traditional financial assets, misjudging its volatility, liquidity, and price-setting mechanisms (Kim et al., 2020). This misperception, coupled with speculative investment motives, places investors at greater risk of making poor financial decisions, especially in environments where reliable financial benchmarks and protective regulations are absent.

Beyond inexperience, some investor behaviors align with patterns observed in online gambling and risk-seeking behaviors (Delfabbro et al., 2021; Mills & Nower, 2019). Such tendencies suggest that certain cryptocurrency investors may be driven by addiction or irrationality rather than informed strategy. Studies by Almeida and Gonçalves (2023) and Pelster et al. (2019) stress the importance of understanding these behavioral dynamics, recommending that financial professionals develop preventative strategies and educational tools to support more responsible investment practices.

Additionally, the research identifies unethical practices within cryptocurrency exchanges that have direct implications for investor trust. One such practice—skimming—occurs when exchanges capture arbitrage profits that should belong to investors (McLaughlin et al., 2023). These internal mechanisms of profit capture not only mislead investors but also undermine the legitimacy of the entire exchange ecosystem. The findings of this study help to reinforce that professional oversight bodies have a critical role in advocating for greater transparency, improving digital forensics capabilities, and enforcing ethical practices within cryptocurrency platforms.

The social implications of cryptocurrency extend beyond financial markets, touching on broader issues of public education, addiction, and crime prevention. The combination of unregulated markets, speculative hype, and misinformation on social media has created an environment where average citizens are particularly vulnerable. This risk is intensified by the lack of clear, accessible education about the distinctions between cryptocurrencies and traditional financial products.

Furthermore, cryptocurrency's reputation for enabling illicit activities—such as money laundering and terrorist financing—adds another layer of social risk. Although earlier concerns focused on its use for illicit payments, newer studies reveal that some exchanges themselves may facilitate criminal activities through internal manipulation or lack of regulatory oversight (Dudani et al., 2023). For example, skimming constitutes theft and undermines systemic trust and security. The findings of this study could help professionals and scholars to recognize and address these practices, which are essential to advancing public policy that prioritizes investor protection and financial inclusion.

From a social justice perspective, protecting inexperienced investors from external manipulation and their behavioral risks requires a multi-pronged approach. Educational campaigns, clear regulations, and stronger cross-agency collaboration are necessary to mitigate systemic risk and prevent financial harm. Moreover, promoting literacy around cryptocurrency's risks and differentiating it from traditional assets, such as the existence of arbitrage opportunities, can foster more informed decision-making and equitable financial participation.

CONCLUSIONS

The purpose of this study was to test the theory of LOP on cryptocurrency and cryptocurrency exchanges in Canada. To fulfill this purpose, a quantitative statistical research and analysis design was created. The completion of this study advanced the knowledge of cryptocurrency in several ways. First, the study addressed gaps in the literature based on collective trends: a lack of

understanding of cryptocurrency beyond Bitcoin and the Canadian cryptocurrency market. Second, the study addressed gaps in the literature based on collective inconclusive findings: do arbitrage opportunities for cryptocurrency as a financial asset still exist; are volatility and liquidity influencers of arbitrage opportunities for cryptocurrency as a financial asset? Finally, the study answers the academics' and practitioners' calls for continued cryptocurrency research due to its rapidly changing characteristics and environment.

The findings of this study were that arbitrage opportunities do exist for cryptocurrency as a financial asset in the Canadian market, and that volatility and illiquidity had a meager influence on these opportunities. Based on this study and its findings, the current literature was considered, new knowledge was created, limitations were highlighted to foster future research, and implications for scholars, professionals, and positive social impacts were demonstrated. Based on these components, this study contributed to advancing of knowledge of cryptocurrency as a financial asset and cryptocurrency in general.

REFERENCES

Almeida, J., & Gonçalves, T. C. (2023). A systematic literature review of investor behavior in the cryptocurrency markets. *Journal of Behavioral and Experimental Finance*, *37*, 100785. https://doi.org/10.1016/j.jbef.2022.100785

Ballis, A., & Drakos, K. (2020). Testing for herding in the cryptocurrency market. *Finance Research Letters*, *33*, 101210. https://doi.org/10.1016/j.frl.2019.06.008

Baur, D. G., Dimpfl, T., & Kuck, K. (2018). Bitcoin, gold and the US dollar – A replication and extension. *Finance Research Letters*, *25*, 103–110. https://doi.org/10.1016/j.frl.2017.10.012

Baur, D. G., Hong, K., & Lee, A. D. (2018). Bitcoin: Medium of exchange or speculative assets? *Journal of International Financial Markets, Institutions and Money*, *54*, 177–189. https://doi.org/10.1016/j.intfin.2017.12.004

Bayram, M., Akat, M., Bulkan, S., & Kahraman, C. (2020). Algorithmic pairs trading with expert inputs, a fuzzy statistical arbitrage framework. *Journal of Intelligent & Fuzzy Systems*, *38*(1), 697–707. https://doi.org/10.3233/JIFS-179442

Bedi, P., & Nashier, T. (2020). On the investment credentials of Bitcoin: A cross-currency perspective. *Research in International Business and Finance*, *51*, 101087. https://doi.org/10.1016/j.ribaf.2019.101087

Bezhovski, Z., Davcev, L., & Mitreva, M. (2021). Current adoption state of cryptocurrencies as an electronic payment method. *Management Research & Practice*, *13*(1), 44–50. https://ideas.repec.org/a/rom/mrpase/v13y2021i1p44-50.html

Bianchi, D. (2020). Cryptocurrencies as an asset class? An empirical assessment. *The Journal of Alternative Investments*, *23*(2), 162–179. https://doi.org/10.3905/jai.2020.1.105

Bianchi, D., Dickerson, A., & Babiak, M. (2019). Trading volume and liquidity provision in cryptocurrency markets (SSRN Scholarly Paper 3239670). *Social Science Research Network*, 1–42. https://doi.org/10.2139/ssrn.3239670

Borri, N., & Shakhnov, K. (2020). Regulation spillovers across cryptocurrency markets. *Finance Research Letters*, *36*, 101333. https://doi.org/10.1016/j.frl.2019.101333

Bouri, E., Gil-Alana, L. A., Gupta, R., & Roubaud, D. (2019). Modelling long memory volatility in the Bitcoin market: Evidence of persistence and structural breaks. *International Journal of Finance & Economics*, *24*(1), 412–426. https://doi.org/10.1002/ijfe.1670

Brauneis, A., Mestel, R., Riordan, R., & Theissen, E. (2022). Bitcoin unchained: Determinants of cryptocurrency exchange liquidity. *Journal of Empirical Finance*, *69*, 106–122. https://doi.org/10.1016/j.jempfin.2022.08.004

Bruzgė, R., & Šapkauskienė, A. (2022). Network analysis on Bitcoin arbitrage opportunities. *The North American Journal of Economics and Finance*, *59*, 101562. https://doi.org/10.1016/j.najef.2021.101562

Charfeddine, L., Benlagha, N., & Maouchi, Y. (2020). Investigating the dynamic relationship between cryptocurrencies and conventional assets: Implications for financial investors. *Economic Modelling*, *85*, 198–217. https://doi.org/10.1016/j.econmod.2019.05.016

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum.

Corbet, S., Meegan, A., Larkin, C., Lucey, B., & Yarovaya, L. (2018). Exploring the dynamic relationships between cryptocurrencies and other financial assets. *Economics Letters*, *165*, 28–34. https://doi.org/10.1016/j.econlet.2018.01.004

Dawson, M. (2020). Cybercrime: Internet driven illicit activities and behavior. *Revista Academiei Forţelor Terestre*, *25*(4), 356–362. https://doi.org/10.2478/raft-2020-0043

de Best, R. (2022). *Cryptocurrency: Statistics & facts* (51620). Statista. https://www.statista.com/topics/4495/cryptocurrencies/

Delfabbro, P., King, D. L., & Williams, J. (2021). The psychology of cryptocurrency trading: Risk and protective factors. *Journal of Behavioral Addictions*, *10*(2), 201–207. https://doi.org/10.1556/2006.2021.00037

Demmler, M. (2023). Leading cryptocurrencies between 2019 and 2021: Analysis of market prices and portfolio design. *Análisis Económico*, *38*(99), 145–165. https://doi.org/10.24275/uam/azc/dcsh/ae/2023v38n99/Demmler

Didenko, A. N., & Buckley, R. P. (2018). The evolution of currency: Cash to cryptos to sovereign digital currencies (SSRN Scholarly Paper 3256066), *Social Science Research Network, 42*(4), 1–57. https://doi.org/10.2139/ssrn.3256066

Duan, K., Li, Z., Urquhart, A., & Ye, J. (2021). Dynamic efficiency and arbitrage potential in Bitcoin: A long-memory approach. *International Review of Financial Analysis, 75*, 101725. https://doi.org/10.1016/j.irfa.2021.101725

Duczmal, W., & Skomorovski, A. (2021). *Cryptocurrencies – a new financial market: The rules, security and risk*. The Academy of Management and Administration.

Dudani, S., Baggili, I., Raymond, D., & Marchany, R. (2023). The current state of cryptocurrency forensics. *Forensic Science International: Digital Investigation*, *46*, 301576. https://doi.org/10.1016/j.fsidi.2023.301576

Durrani, T. (2023, May 12). Crypto platform Binance to exit Canada amid regulatory crackdown. *The Globe and Mail*. https://www.theglobeandmail.com/business/article-crypto-platform-binance-to-exit-canada-amid-regulatory-crackdown/

Foley, S., Karlsen, J. R., & Putniņš, T. J. (2019). Sex, drugs, and bitcoin: How much illegal activity is financed through cryptocurrencies? *Review of Financial Studies*, *32*(5), 1798–1853. https://doi.org/10.1093/rfs/hhz015

Giovannini, A. (1988). Exchange rates and traded goods prices. *Journal of International Economics*, *24*(1), 45–68. https://doi.org/10.1016/0022-1996(88)90021-9

Hansen, P. R., Kim, C., & Kimbrough, W. (2024). Periodicity in cryptocurrency volatility and liquidity. *Journal of Financial Econometrics*, *22*(1), 224–251. https://doi.org/10.1093/jjfinec/nbac034

Hansson, M. (2022). Arbitrage in crypto markets: An analysis of primary Ethereum blockchain data (*SSRN Scholarly Paper No. 4278272*). https://doi.org/10.2139/ssrn.4278272

Inci, A. C., & Lagasse, R. (2019). Cryptocurrencies: Applications and investment opportunities. *Journal of Capital Markets Studies*, *3*(2), 98–112. https://doi.org/10.1108/JCMS-05-2019-0032

Kabašinskas, A., & Šutienė, K. (2021). Key roles of crypto-exchanges in generating arbitrage opportunities. *Entropy*, *23*(4), 455. https://doi.org/10.3390/e23040455

Kaiser, L., & Stöckl, S. (2020). Cryptocurrencies: Herding and the transfer currency. *Finance Research Letters*, *33*, 101214. https://doi.org/10.1016/j.frl.2019.06.012

Khan, M. K., Teng, J.-Z., & Khan, M. I. (2019). Cointegration between macroeconomic factors and the exchange rate USD/CNY. *Financial Innovation*, *5*(1), 1–15. https://doi.org/10.1186/s40854-018-0117-x

Kim, H. J., Hong, J. S., Hwang, H. C., Kim, S. M., & Han, D. H. (2020). Comparison of psychological status and investment style between bitcoin investors and share investors. *Frontiers in Psychology*, *11*. https://www.frontiersin.org/articles/10.3389/fpsyg.2020.502295

Kristoufek, L. (2019). Is the Bitcoin price dynamics economically reasonable? Evidence from fundamental laws. *Physica A: Statistical Mechanics and Its Applications*, *536*, 120873. https://doi.org/10.1016/j.physa.2019.04.109

Kristoufek, L., & Bouri, E. (2023). Exploring sources of statistical arbitrage opportunities among Bitcoin exchanges. *Finance Research Letters*, *51*, 103332. https://doi.org/10.1016/j.frl.2022.103332

Krückeberg, S., & Scholz, P. (2020). Decentralized efficiency? Arbitrage in bitcoin markets. *Financial Analysts Journal*, *76*(3), 135–152. https://doi.org/10.1080/0015198X.2020.1733902

Laycock, R. (2022). *Finder Cryptocurrency Adoption Index*. Finder CA. https://www.finder.com/ca/finder-cryptocurrency-adoption-index

Lee, J., & Oh, T. (2022). The Kimchi premium and bitcoin-cashing outlets. *Finance Research Letters*, *50*, 103200. https://doi.org/10.1016/j.frl.2022.103200

Leung, T., & Nguyen, H. (2019). Constructing cointegrated cryptocurrency portfolios for statistical arbitrage. *Studies in Economics and Finance*, *36*(3), 581–599. https://doi.org/10.1108/SEF-08-2018-0264

Li, J., & Liu, R. (2024). *Pricing and arbitrage across 80 cryptocurrency exchanges (SSRN Scholarly Paper No. 4816710)*. https://doi.org/10.2139/ssrn.4816710

Liang, T.-P., Kohli, R., Huang, H.-C., & Li, Z.-L. (2021). What drives the adoption of the blockchain technology? A fit-viability perspective. *Journal of Management Information Systems, 38*(2), 314–337. https://doi.org/10.1080/07421222.2021.1912915

Makarov, I., & Schoar, A. (2020). Trading and arbitrage in cryptocurrency markets. *Journal of Financial Economics, 135*(2), 293–319. https://doi.org/10.1016/j.jfineco.2019.07.001

McLaughlin, R., Kruegel, C., & Vigna, G. (2023). A large scale study of the Ethereum arbitrage ecosystem. *Proceedings of the USENIX Security Symposium*, 3295–3312. https://www.usenix.org/conference/usenixsecurity23/presentation/mclaughlin

Mensi, W., Sensoy, A., Aslan, A., & Kang, S. H. (2019). High-frequency asymmetric volatility connectedness between Bitcoin and major precious metals markets. *The North American Journal of Economics and Finance, 50*, 101031. https://doi.org/10.1016/j.najef.2019.101031

Miljkovic, D. (1999). The law of one price in international trade: A critical review. *Applied Economic Perspectives and Policy, 21*(1), 126–139. https://doi.org/10.2307/1349976

Mills, D. J., & Nower, L. (2019). Preliminary findings on cryptocurrency trading among regular gamblers: A new risk for problem gambling? *Addictive Behaviors, 92*, 136–140. https://doi.org/10.1016/j.addbeh.2019.01.005

Morin, A., & Moore, T. (2023). How cryptocurrency exchange interruptions create arbitrage opportunities. *2023 IEEE European Symposium on Security and Privacy Workshops (EuroS&PW)*, 207–215. https://doi.org/10.1109/EuroSPW59978.2023.00028

Nedved, M., & Kristoufek, L. (2023). Safe havens for Bitcoin. *Finance Research Letters, 51*, 103436. https://doi.org/10.1016/j.frl.2022.103436

Pelster, M., Breitmayer, B., & Hasso, T. (2019). Are cryptocurrency traders pioneers or just risk-seekers? Evidence from brokerage accounts. *Economics Letters, 182*, 98–100. https://doi.org/10.1016/j.econlet.2019.06.013

Persson, K. (2008). *Law of one price*. In R. Whaples (Ed.), *EH.Net Encyclopedia*. https://eh.net/encyclopedia/the-law-of-one-price/

Pieters, G., & Vivanco, S. (2017). Financial regulations and price inconsistencies across Bitcoin markets. *Information Economics and Policy, 39*, 1–14. https://doi.org/10.1016/j.infoecopol.2017.02.002

Rogoff, K. (1996). The purchasing power parity puzzle. *Journal of Economic Literature, 34*(2), 647–668. https://ideas.repec.org/a/aea/jeclit/v34y1996i2p647-668.html

Salisu, A. A., Isah, K., & Akanni, L. O. (2019). Improving the predictability of stock returns with Bitcoin prices. *The North American Journal of Economics and Finance, 48*, 857–867. https://doi.org/10.1016/j.najef.2018.08.010

Shahzad, S. J. H., Bouri, E., Kang, S. H., & Saeed, T. (2021). Regime specific spillover across cryptocurrencies and the role of COVID-19. *Financial Innovation*, *7*(1), 5. https://doi.org/10.1186/s40854-020-00210-4

Shynkevich, A. (2021). Bitcoin arbitrage. *Finance Research Letters, 40*, 101698. https://doi.org/10.1016/j.frl.2020.101698

Shynkevich, A. (2023). Law of one price and return on arbitrage trading: Bitcoin vs. Ethereum. *Journal of Economics and Finance, 47*(3), 763–792. https://doi.org/10.1007/s12197-023-09631-0

Smith, J. (2023, November 15). WonderFi subsidiary Bitbuy acquires Bitvo, owns nearly half of all exchanges in Canada. *Cryptonews*. https://cryptonews.com/news/wonderfi-subsidiary-bitbuy-acquires-bitvo-owns-nearly-half-of-all-exchanges-in-canada.htm

Surowiecki, J. (2012). A brief history of money. *IEEE Spectrum, 49*(6), 44–79. https://doi.org/10.1109/MSPEC.2012.6203967

Tjondro, E., Hatane, S. E., Widuri, R., & Tarigan, J. (2023). Rational versus irrational behavior of Indonesian cryptocurrency owners in making investment decision. *Risks, 11*(1), Article 1. https://doi.org/10.3390/risks11010017

Trautman, L. J. (2014). Virtual currencies; Bitcoin & what now after Liberty Reserve, Silk Road, and Mt. Gox? *(SSRN Scholarly Paper No. 2393537)*. https://doi.org/10.2139/ssrn.2393537

Warner, R. M. (2012). *Applied statistics: From bivariate through multivariate techniques* (2nd ed.). Sage Publications.

Wątorek, M., Drożdż, S., Kwapień, J., Minati, L., Oświęcimka, P., & Stanuszek, M. (2021). Multiscale characteristics of the emerging global cryptocurrency market. *Physics Reports, 901*, 1–82. https://doi.org/10.1016/j.physrep.2020.10.005

Witzel, M. (2005). Understanding arbitrage: An intuitive approach to financial analysis. *Corporate Finance Review, 10*(3), 45–46. https://www.proquest.com/scholarly-journals/understanding-arbitrage-intuitive-approach/docview/198776208/se-2

Yin, H. H. S., Langenheldt, K., Harlev, M., Mukkamala, R. R., & Vatrapu, R. (2019). Regulating cryptocurrencies: A supervised machine learning approach to de-anonymizing the Bitcoin blockchain. *Journal of Management Information Systems, 36*(1), 37–73. https://doi.org/10.1080/07421222.2018.1550550

Zaher, A. A., Ghosh, D., & Ghosh, D. K. (2020). Trading strategies in currency markets. *International Journal of Business, 25*(1), 73–82. https://ijb.cyut.edu.tw/var/file/10/1010/img/866/V25N1-4.pdf