



**IMPACT OF RANGE BAR AND ERGODIC PROCESS ON EARLY PRICE
TREND DETECTION USING EVIDENCES FROM USD/CNY CURRENCY**

By

PANG TOR NEE

**Thesis Submitted to the School of Graduate Studies, Universiti Putra
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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science.

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By

PANG TOR NEE

April 2021

Chair : Soh Wei Ni, PhD
Faculty : School of Business and Economics

This research uses ergodic theory to study early price trends for USD/CNY currency in China. The motivation of this study is to detect early price trends within two standard deviations away from average prices. Researchers can find the current method in forecasting the price trend after two standard deviations from the average prices named “trend following” methodology, which has caused two gaps experienced by prior researchers. Without this research, the first gap is failure price trend formation within two standard deviations away from average prices that cause researchers cannot collect sufficient valuable samples to justify their hedge position. The second gap is lagging higher prices after two standard deviations from the average prices during trend following that causes researchers to select price to overvalue sample. This research introduces a solution for preventing failure price trend formation within two standard deviations and lagging higher price after two standard deviations prevention. Hence, this research is motivated to introduce range bar as a mediator variable and ergodic theory to support ergodic process as a moderator variable to create a new model. First, the range bar serves as a mediator to replace minutes of each bar time interval to make a recent sample of a non-periodic bar during the range-bound trading period. The objective is to select a successful price trend formation sample within two standard deviations away from moving average prices to hypothesize effectiveness by achieving at least 68% of frequency mean. Second, the ergodic process serves as a moderator to analyze a new sample of a non-periodic bar during the range-bound trading period within two standard deviations away from average prices. The objective is to choose a price to undervalue sample to hypothesize effectiveness by achieving at least a 0.8 correlation coefficient. This research tends to enhance the accuracy of price trend analysis during early detection within two standard deviations. It is possible to save up to 1.3% (statistic estimation) or USD54 billion of USD4.15 trillion annual foreign exchange between 2015 to 2019 by applying range bar and ergodic process variables. The future direction would replicate Malaysia to improve market liquidity.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Master Sains.

**KESAN BAR JULAT DAN PROSES ERGODIK TERHADAP PENGESANAN
TREND HARGA AWAL MENGGUNAKAN BUKTI DARI MATA WANG
USD/CNY.**

Oleh

PANG TOR NEE

April 2021

Pengerusi : Soh Wei Ni, PhD
Fakulti : Sekolah Perniagaan dan Ekonomi

Penyelidikan ini menggunakan teori ergodik untuk mengkaji trend harga awal untuk mata wang USD / CNY di China. Motivasi kajian ini adalah untuk mengesan trend harga awal dalam dua sisihan piawai dari harga purata. Para penyelidik dapat mencari kaedah semasa dalam meramalkan trend harga setelah dua sisihan piawai dari harga rata-rata yang disebut metodologi "trend mengikut", yang telah menyebabkan dua jurang yang dialami oleh penyelidik sebelumnya. Tanpa penyelidikan ini, jurang pertama adalah pembentukan trend harga kegagalan dalam dua sisihan piawai dari harga purata yang menyebabkan penyelidik tidak dapat mengumpulkan sampel berharga yang cukup untuk membenarkan kedudukan lindung nilai mereka. Jurang kedua adalah ketinggian harga yang lebih tinggi setelah dua sisihan piawai dari harga rata-rata semasa trend menyusul yang menyebabkan penyelidik memilih harga untuk menilai lebih tinggi sampel. Penyelidikan ini memperkenalkan penyelesaian untuk mencegah pembentukan trend harga kegagalan dalam dua sisihan piawai dan ketinggalan harga yang lebih tinggi setelah pencegahan dua sisihan piawai. Oleh itu, penyelidikan ini didorong untuk memperkenalkan bar sebagai pemboleh ubah mediator dan teori ergodik untuk menyokong proses ergodik sebagai pemboleh ubah moderator untuk membuat model baru. Pertama, julat bar berfungsi sebagai orang tengah untuk menggantikan minit setiap selang waktu bar untuk membuat sampel bar bukan berkala baru-baru ini semasa tempoh perdagangan julat. Objektifnya adalah untuk memilih sampel pembentukan trend harga yang berjaya dalam dua sisihan piawai dari harga purata bergerak ke keberkesanan hipotesis dengan mencapai sekurang-kurangnya 68% min frekuensi. Kedua, proses ergodik berfungsi sebagai moderator untuk menganalisis sampel baru bar tidak berkala selama jangka masa perdagangan terikat dalam dua sisihan piawai dari harga rata-rata. Objektifnya adalah memilih harga untuk menilai nilai sampel untuk membuat hipotesis keberkesanan dengan mencapai sekurang-kurangnya koefisien korelasi 0.8. Penyelidikan ini cenderung meningkatkan ketepatan analisis trend

harga semasa pengesanan awal dalam dua sisihan piawai. Adalah mungkin untuk menjimatkan sehingga 1.3% (anggaran anggaran) atau USD54 bilion USD4.15 trilion pertukaran asing tahunan antara tahun 2015 hingga 2019 dengan menerapkan pemboleh ubah bar bar dan proses ergodik. Arah masa depan akan mereplikasi Malaysia untuk meningkatkan kecairan pasaran.



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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

Soh Wei Ni, PhD

Senior Lecturer
School of Business and Economics
Universiti Putra Malaysia
(Chairman)

Fakarudin bin Kamarudin, PhD

Associate Professor
School of Business and Economics
Universiti Putra Malaysia
(Member)

ZALILAH MOHD SHARIFF, PhD

Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 8 September 2022

Declaration by Graduate Student

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Signature: _____

Name of Member of Supervisory Committee: Fakarudin bin Kamarudin, PhD

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LIST OF ABBREVIATIONS

ADX	Average Directional Index
c	current range price bar
d	prior range price bar
EMA	Exponential moving average
i	Periodic interval
k	Weighted multiplier
N	Number of each range bar
n	Incremental ticks
ni	Sequence of time interval of price bar
nt	Sequence of each bar incremental ticks
OHLC	Open high low closed
PPP	Purchasing power parity
r	Range bar
SMA	Simple moving average
t	Time interval
TEMA	Triple exponential moving average
UPM	Universiti Putra Malaysia
USD/CNY	US Dollars exchange with Chinese Renminbi currency

CHAPTER 1

INTRODUCTION

This research analyzes USD/CNY pair currency because it is the second worst-performing currency in Asia with a validity intraday data from 2015 to 2019. Current methodology to detect price trend after two standard deviations from the average prices, namely 'trend following,' has challenged prior researchers to justify hedge positions. Without this research, firstly, failure price trend formation during the range-bound trading period within two standard deviations away from average prices has causes insufficient price sample collection. Secondly, lagging higher prices after two standard deviations from the average prices during the trend following the period has reasons for overpriced sample collection.

This research introduces an ergodic theory to create a new model. Range bar variable as a mediator to make a recent sample of a non-periodic bar within two standard deviations away from average prices with an expectation to collect a successful price trend formation sample. Ergodic theory is enhancing to support ergodic process variable as moderator to analyze a new sample of a non-periodic bar within two standard deviations away from average prices with the expectation to collect undervalued price sample to detect early price trend. The early trend detection period occurs within two standard deviations from average prices after creating a new selection of a non-periodic bar during the range-bound trading period. Noted that range-bound trading period forms within two standard deviations away from average prices. In comparison, the trend following the period occurs after two standard deviations from the average prices.

1.1 Background of the studies

1.1.1 Summary

Price trend performance in trading foreign exchange is an important issue that has received much attention in practical brokerage trading activities. In the past, attention has been giving to improving prior literature' gaps in stock market analyses. However, there is little price momentum, and the trend-following technical analyses focus on USD/CNY pair currency. Hence, this research intends to introduce range bar and ergodic process variables to detect early price trends within two standard deviations away from average prices to predict the performance result of trading in USD/CNY pair currency. Both range bar as a mediator and ergodic process as a moderator would motivate the proposed research to solve the research gaps. They have not been proving in creating a new model to detect early trends within two standard deviations from average prices for USD/CNY pair currency. The range bar as a mediator would replace

60 minutes of time interval to create a new sample of a non-periodic bar to prevent failure price trend formation during the range-bound trading period within two standard deviations away from average prices. This solution could solve challenges currently experienced by prior researchers to collect successful price trend formation samples to justify hedge position, Hu et al., (2014); Fong et al., (2012); Fong and Tai (2009); Szakmary and Lanchester (2015). This research is further enhanced to include an ergodic process as a moderator to analyze a new sample of a non-periodic bar within two standard deviations away from average prices to prevent lagging higher prices during trend-following period. This additional solution could solve challenges currently experienced by prior researchers to collect undervalued price samples to justify hedge position, Liu et al., (2006); Hu et al., (2014); Mengqi et al., (2018).

During range-bound trading period (Investopedia 2020), price tends to consolidate after experiencing trending either upward or downward directional. During the price consolidation phase, prices bounce back at resistance or support levels within a range-bound period and two standard deviations from average prices. A resistance level is found at the upper level to resist price going upward, and hence the price will bounce downward at resistance level upon contact. A support level is found at the lower level to support price going down, and hence the price will bounce upward at support level upon contact. These range-bound trading processes are essential to consolidate volume at this phase before resuming for trending momentum. This research intends to introduce a range bar as a mediator with the expectation of choosing successful price trend-formation during the range-bound trading period.

According to (Wikipedia 2019), the ergodic theory proposes that the time mean of their input properties is equal to the mean over the entire time sequence space for specific operating systems. For input properties, we can use ergodic theory to detect early price trends as a preventive lagging higher prices during the trend-following period. Consequently, a price trends formation within two standard deviations is possible without sacrificing late breakout that exhaust resistant or supportive levels.

USD/CNY pair currency is the second-worst performance result among Asia, and intraday data is available. However, this research found that USD/INR pair currency and USD/MYR pair currency performed at -12.62% and -12.07%, respectively, but intraday data were not available. Hence, USD/INR and USD/MYR pair currencies samples were not selected.

Table 1: The differences in USD/CNY pair currency results (2015 to 2019)

Countries currencies	2015-05-31	2019-12-31	Differences
USD/CNY	6.2033	6.9634	-12.25%
USD/SDG	1.3473	1.3487	-0.10%
USD/HKD	7.753	7.7784	-0.33%
USD/MYR	3.6519	4.0927	-12.07%
USD/JPY	124.121	108.053	12.95%
USD/TWD	30.8323	30.0475	2.55%
USD/INR	63.7226	71.7635	-12.62%
USD/IDR	13,182	13,943	-5.77%
USD/KRW	1,111.29	1,163.06	-4.66%

(Source: barchart.com/forex)

Most empirical studies of price momentum are attributing towards cash and futures market data in the presence of technical analyses. The usage of technical analyses could be dated back to the early 17th century. Such analysis analyzed the fluctuation price of rice in Japan. Hence, in the modern-day, the application of technical analyses would have been extended to moving averages to analyze price momentum and time series to identify the formation of patterns in a foreseeable future market return. Hence, the technical analyses use moving averages to analyze historical stock price data and time series to detect future returns based on price momentum supported by prior researchers such as Chevallier and Lelopo (2014); Sougata et al., (2018); Shaen et al., (2019).

Prior researchers supported the trend-following, the methodology used to analyze market trends in a biased direction to detect price trends, Hu et al., (2014); Li et al., (2016); Mengqi et al., (2018). That said, they concluded there could be market inefficiency that led to price trends moving in a bias direction away from market imbalances, either upward or downward. This trend-following was implying to improvement in technical analyses that relied upon the price momentum in general.

Recent studies, Li et al., (2017) investigated trend-following a technical analysis to benchmark with a high probability of 50% profitable methods to invest in the Chinese commodity futures market. Trend-following used an old method to detect price trends in after two standard deviations away from the average prices. However, he concluded that there was a limitation as to data

snooping to achieve high probability given at 50% of winning chances. There was no conclusion in China as to which trend-following methods produced the most reliable profitability results. Trend-following was correlated with the recent market collapse in China stock markets, resulting in a loss of negative -38.54% in the past four and half years. Compared to USD/CNY pair currency, the similarity of losses sustained at a negative amounted to -12.25% was evidence of the trend following old methods to detect a lagging higher price trend after two standard deviations from the average prices. There is an urgent need to find a proven method to replace old trend-following to determine early price trends within two standard deviations away from average prices.

In recent studies, in the literature of ergodic Markov equilibrium, Braido (2013) studied recursive exchange economies with short sales. His papers suggested that agents maximize discounted expected utility whose asset structure was typical in general have been testing among real securities, infinite-lived stocks, options, and other derivatives. He concluded that the main result showed a competitive equilibrium process that was a stationary condition and had an invariant ergodic measure. He further claimed that ergodic was utilizing in finance for time series analysis of structural asset pricing models. Rydlewski and Snarska (2014) studied geometric ergodicity of skewed to analyze the relationship between volatility and the stock return. Their various empirical reports concluded that volatility tends to rise during bad news and flatten with good news. They study the effect of skewness of the 500 equities index.

This research tends to present a range bar to replace 60 minutes of time interval to create a new sample of a non-periodic bar within two standard deviations away from average prices. The intention is to prevent lagging higher price after two standard deviations from the average prices during the trend-following with the expectation to select undervalued price sample on early price trend detection of USD/CNY pair currency trading in the foreign exchange market. Further, to select a successful price trend formation sample, the intention is to prevent failure price trend formation before the trend following period. This research is further enhancing to include an ergodic process to analyze a new non-periodic bar sample within two standard deviations from the average prices.

1.1.2 Terminology of Chinese currency

The renminbi, denoted as RMB, is the official currency of the People's Republic of China, and USD/CNY pair currency is listed as a top 10 significant currency reserve as reported by Wikipedia. The yuan is the basic unit of measurement of the renminbi currency and is refers to Chinese yuan currency. The difference between yuan and renminbi is that the latter is the official currency name issued by the monetary Bank of China. Since 2006, the USD/CNY pair currency exchange rate has been seeing floating within an approved base rate predetermined references to a trading basket of world currencies. Wikipedia

also mentioned that the Chinese government had released an announcement to allow flexibility of the exchange rate of USD/CNY pair currency and liberalize foreign exchange trading. Due to the internationalization of rapid foreign exchange trading of USD/CNY pair currency, its utilization has been rated among the world currencies as the 8th most traded currency in 2013, 5th by 2015, and 6th in 2019. As a result of its internationalization usage, on October 1st, 2016, USD/CNY pair currency became the first emerging foreign exchange market to list in the International Monetary Fund's special drawing rights among the reputable basket of world currencies. The USD/CNY pair currency value has depreciated to 12.25% in the past four and half years.

1.1.3 Development of USD/CNY pair currency in foreign exchange

Wikipedia reported the history of yuan currency circulated during the Republic of China era, primarily denominated in the unit of yuan. Each currency unit was distinguished and classified by its currency name. Such usage labeled as fabi, a legal tender paper note, the physical coins of gold yuan, and the silver yuan. The People's Bank of China first introduced the renminbi currency in December 1948. Such memorable events had occurred a year before the planned establishment of the country People's Republic of China. Since then, the revaluation of yuan had predetermined in 1955 at the rate of 1 new yuan was equal to 10,000 old yuan to abolish the hyperinflation that plagued China during the years of governing by the Kuomintang period. Since then, from 1949 until the late 1970s, the USD/CNY pair currency was rated overvalued by its foreign exchange market as part of the country implementing to control imported manufactured machinery to revolutionize the industrial era. The overvalue USD/CNY pair currency permitted the government to provide banking facilities to release loans to import machinery and heavy equipment to fast track to develop an industrial state at a relatively cheaper imported cost.

The foreign exchange market of China has seen yet another transition era by the mid-1990s to implement its currency value to be determined by supply and demand arises from export and import activities. Gradually the Chinese government permitted market forces to float the USD/CNY pair currency at foreign exchange markets. However, in early 1980, any exporters who earned their profits from foreign exchange market transactions could sell the excess to the state agency responsible for monitoring the China foreign exchange rates.

1.1.4 Trend following

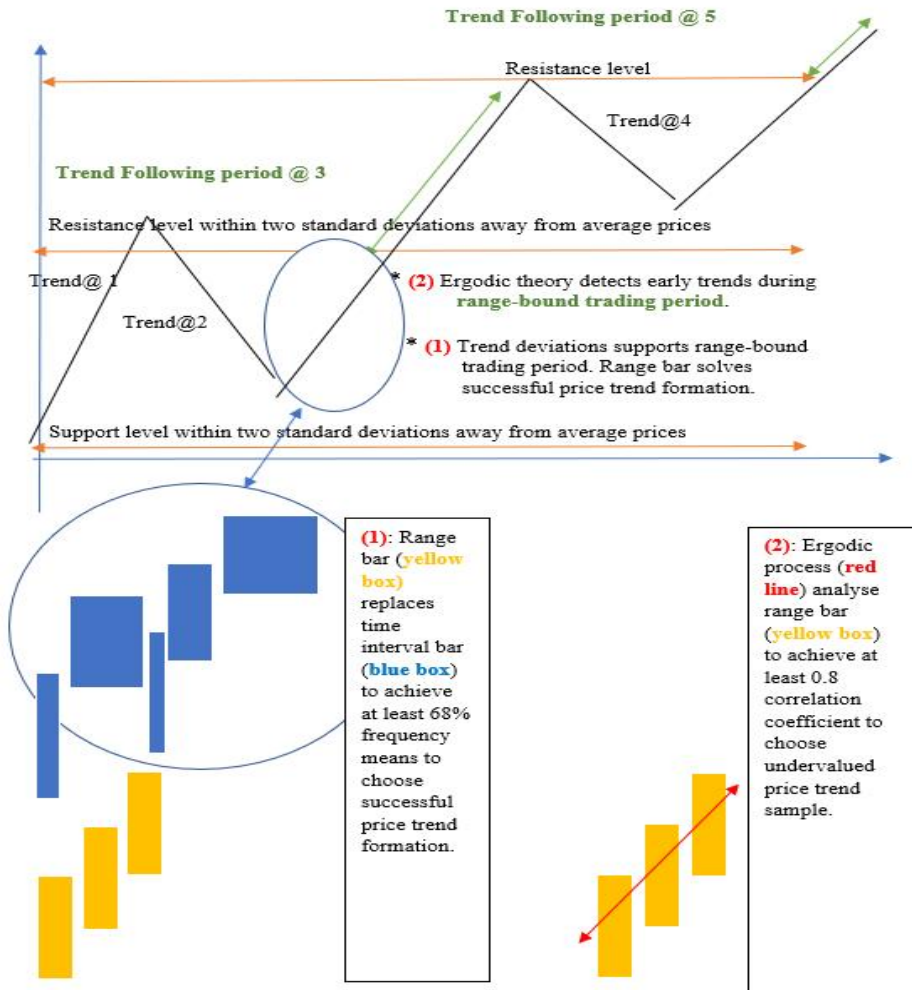


Figure 1: Trend following graphical chart
(Source: Universiti Putra Malaysia)

Price trending occurs when the current price is exceeded two standard deviations from the average prices. The price trend demonstrates when the current price is far from support or resistance levels, as indicated above in Figure 1 of trend following graphical chart and supported by Coval (2009). In his paper, he mentioned the first mechanism, to long and short trading signals were produced by the two moving price averages indicators, at a longer time interval period and a shorter time interval period, respectively. Then he noted that the second mechanism of trading signals produced using a stock price that lagged higher after two standard deviations from the average prices given new price highs and price lows from time interval period. He concluded that the mechanism would have accessed these regulations to predict the directional price movement of change.

In a nutshell, he further analyzed the trading trend that could only occur at trend third and trend 5th as shown in Figure 1, given such configuration as if when the short period crosses the long period of moving averages to prove a direction either bearish or bullish. The current price hit below the lowest range-bound support level, as shown in Figure 1, which confirmed a bearish direction breakdown. Secondly, the current price must hit above the highest range-bound resistance level indicated at trend third or trend 5th, as shown in Figure 1, to confirm a trend breakout of bullish direction. He noted that these combination methods should apply to confirm a trading activity existed in a mature late trend. Thus, he mentioned that a buy or sell signal would have generated late entry into the maturity price trend, which could risk exhausted or declined momentum prices. For example, the resistance price level and the price trend 3rd after seeing the current price are experiencing an increases momentum from price trend first to price trend 3rd. The question then there is no guarantee that the selling price is higher than price trend third given it already bought at lagging higher entry of price mature that could decline at price trend fourth. This phenomenon explains the collapses of stock markets and could influence foreign funds buying behavior on regional equity stock exchanges and foreign exchanges.

There is a significant need to investigate an early price trend detection model that detects buy low and sell high. For example, the buy at price trend 1st as indicated in Figure 1 before the price trend pattern occurs at trend 3rd as suggested by prior literature according to the trend following method. After that, the sell at price trend third peak resistance level before exhausting and declining at price trend fourth. Such buy low at price trend first and sell high at price trend the third methodology serves the proposed paper.

1.2 Problem Statements

Current methodology, namely trend following, detect price trend after two standard deviations from the average prices, has caused two problems faced by prior researchers. Without this research, prior researchers face the first gap of failure price trend formation during a range-bound trading period within two standard deviations away from average prices. The second gap is lagging higher prices after two standard deviations from the average prices. Prior researchers are experiencing difficulty in collecting low valuable price samples to justify hedge position. Prior researchers challenged to collect an overpriced sample to justify the hedge position. Given such gaps, this proposed research introduces an ergodic theory and trend deviations to create a new model to detect early trends within two standard deviations away from average prices. The range bar as a mediator to replace the minutes of a time interval. It creates a new sample of the non-periodic bar within two standard deviations away from average prices to prevent failure price trend formation during the range-bound trading period. The first research objective is supported by trend deviations whereby the range bar is expecting to choose successful price trend formation within two standard deviations away from average prices after creating a new sample of the non-periodic bar. This research is further enhanced to include ergodic theory to support ergodic process as moderator to analyze a new sample of the non-periodic bar to prevent lagging higher price after two standard deviations from the average prices during trend following period. The influence of the ergodic theory for the second research objective is expecting to choose an undervalued price sample on early price trend detection. They noted that the early price trend detection period occurs after creating a new sample of a non-periodic bar during a range-bound trading period within two standard deviations away from average prices.

Recently with the absence of this research proposal, from May 2015 to December 2019 (barchart.com/forex), USD/CNY pair currency suffered a loss of negative -12.25%. The loss indicates a severe need for expectation to detect early price trends within two standard deviations away from average prices. This research proposes a mediator variable of range bar price and a moderator variable of ergodic process. This research motivates to investigate range bar and ergodic process because both newly introduced variables have yet tested in early price trend detection. It aims to construct a significant relationship with the expectation to prevent failure price trend formation within two standard deviations away from average prices during the range-bound trading period and lagging higher price prevention after two standard deviations from the average prices during the trend following period.

Given the continuous foreign exchange of USD/CNY pair currency market devaluation in the absence of range bar and ergodic process to detect an early trend, in reality, it has become a critical problem for fund managers to differentiate their services from competitors. The intense competition among licensed bankers in trading foreign exchange markets drives these fund

managers to learn range bar and ergodic process to detect the early trend and determine the effectiveness with the expectation to improve market liquidity.

1.3.1 Research Questions

Mainly, this research attempt to address the questions as follows:

Range bar price is moderator variable:

Research Question 1: What is the impact of range bar as a mediator to choose successful price trend formation within two standard deviations away from average prices?

The ergodic process is moderator variable:

Research Question 2: What is the impact of an ergodic process as a moderator to choose undervalued price samples within two standard deviations from the average prices on early price trend detection?

1.4 Research Objectives

First research objective: To identify the impact of range bar to choose successful price trend formation within two standard deviations away from average prices.

Second research objective: To determine the ergodic process's impact on choosing undervalued price samples within two standard deviations from the average prices on lagging higher price prevention.

1.5 Significant of the study

There is not much research of technical analyses to utilize trend-following to predict the foreign exchange market in China. This research proposes introducing a range bar as a mediator variable to replace 60 minutes of time interval to create a new sample of a non-periodic bar. It aims to prevent failure price trend formation during a range-bound trading period with the expectation to choose successful price trend formation. Subsequently an ergodic process as a moderator variable is includes to analyze a new sample of a non-periodic bar. It aims to prevent lagging higher price during the trend-following period

with the expectation to choose undervalued price. The results of this research on an early price trend detection would improve current trend following method. This research would formulate a new contribution knowledge to solve regional trading in foreign exchange markets.

1.5.1 Theoretical significant

The existing literature review relies on price momentum and trend following to detect lagging higher price after two standard deviations. This research proposal an ergodic theory and trend deviations to create a new model to detect early trend within two standard deviations. It introduces range bar to replace 60 minutes of time interval to create a new sample of a non-periodic bar to prevent failure price trend formation during a range-bound trading period with the expectation to choose successful price trend formation. This analysis further includes an ergodic theory to support the ergodic process to analyze a new sample of a non-periodic bar to prevent lagging higher price during trend with an expectation to choose undervalued price sample on early price trend detection for USD/CNY pair currency in trading foreign exchange market. The ergodic theory uses a filtering noise model as suggested by prior researcher Shogo et al., (2018) to detect early price trend formation. This newly discovered combination of range bar and an ergodic process variable would become a universal trend model for global optimization and usage across all currencies in trading foreign exchange markets in the world.

1.5.2 Practical significant

This research practically contributes to corporate finance who specialize in valuation on financial instruments and modelling working capital improvement. First, valuation on financial instrument could detect an early trend of the derivatives and conclude an undervalue fair value of such instrument. Secondly, practitioners who uses derivatives to hedge on commodity costs, currencies, and interest rates, could model an improvement on working capital conversation of asset into cash equivalent. Such practical contribution could reveal a new application on valuation and modelling of corporate finance.

Thirdly, this research bridges the knowledge and skill gap to improve fund performance to understand the range bar and ergodic process to determine reliable early price trend formation. The profitability of fund managers would eventually benefit job employment potential for local graduates who seek a career entry into the regional foreign exchange market industry. Most importantly, this research would contribute to significant trading volume for USD/CNY pair currency among traders seeking to understand range bar price and ergodic process to detect early price trend formation. More importantly, this proposes that research could save USD54 billion annually of China foreign exchange transactions based on results performed in Chapter 4. The research

could replicate in other countries, especially China's Shanghai Stock Exchange Composite Index, which has suffered -38.54% market losses in the past four and half years. Recent literature research has proven that China is still using trend following, one of the old methods to detect lagging higher price trend entry point in a maturity trend pattern. Thus, this research would benefit China's Shanghai Stock Exchange Composite Index to recover from the current market collapse.

1.6 Structure of the Research

This study is organized into five chapters; chapter one is an introduction, chapter two describes literature reviews and hypotheses development, chapter three describes research methodology, chapter four discusses the results of the data analysis, and chapter five summarizes, concludes the research, and provides recommendations.

1.7 Summary

Early price trend detection would eventually solve the problem statements presently troubles by prior literature and current practitioners. Due to conceptual gaps and challenges, it also extends the need to design research questions and objectives to test the hypotheses' development.

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