

**MODELING THE EFFECT OF EXCHANGE RATE
ON RICE TRADE IN CHINA USING FINITE
MIXTURE MODEL WITH BAYESIAN
METHOD**

CHEN TING

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APPRECIATION

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ABSTRACT

With the rapid expansion of data availability, statistical modeling has become essential for analyzing intricate economic and trade relationships. Despite the increasing application of advanced statistical methods in international trade research, this study employing the Finite Mixture Model (FMM) with Bayesian estimation for time series data remain scarce. Given the heterogeneity and structural complexity inherent in trade data, FMM is particularly well-suited for capturing latent patterns and underlying market dynamics. Meanwhile, Bayesian method provides a robust framework for parameter inference, offering flexibility in handling model uncertainty and improving the reliability of estimates. This research investigates the impact of exchange rate fluctuations on China's rice import and export by applying FMM fitted with the Bayesian method. Specifically, it identifies the presence of two components representing stable and volatile periods in the time series data, models their structural characteristics, and examines the relationship between exchange rate movements and rice trade. The findings indicate that rice export prices and import quantities exhibit a statistically significant negative correlation with the exchange rate, whereas import prices and export quantities show a statistically significant positive correlation with the exchange rate. These results highlight the asymmetric impact of exchange rate fluctuations on different aspects of rice trade, emphasizing the importance of accounting for multiple underlying structures within the data. By integrating FMM with Bayesian estimation, this research provides a nuanced understanding of the exchange rate-trade nexus, offering valuable insights for policymakers in designing trade and foreign exchange policies. The findings underscore the significance of adopting advanced statistical techniques to analyze heterogeneous economic data. Specifically, this study extends the literature by demonstrating the effectiveness of Bayesian FMM for heterogeneous agricultural trade data, contributing to both methodological advancements and empirical research on agricultural trade.





ABSTRAK

Dengan perkembangan pesat dalam ketersediaan data, pemodelan statistik menjadi elemen penting dalam menganalisis hubungan ekonomi dan perdagangan yang kompleks. Walaupun kaedah statistik lanjutan semakin banyak digunakan dalam penyelidikan perdagangan antarabangsa, kajian ini menggunakan Model Campuran Terhingga (FMM) dengan kaedah Bayesian untuk data siri masa masih terhad. Memandangkan kewujudan heterogeniti dan struktur dalam data perdagangan, FMM sesuai untuk mengenal pasti pola laten dan dinamik pasaran yang mendasari. Sementara itu, penganggaran Bayesian menyediakan kerangka kerja yang kukuh bagi inferens parameter, menawarkan kebolehpercayaan dalam menangani ketidakpastian model dan meningkatkan kebolehpercayaan penganggaran. Kajian ini mengkaji kesan turun naik kadar pertukaran terhadap eksport beras di China dengan menggunakan FMM yang dipadankan dengan kaedah Bayesian. Secara khususnya, kajian ini mengenal pasti kewujudan dua komponen yang mewakili tempoh stabil dan tidak menentu dalam data siri masa, memodelkan ciri-ciri struktur komponen, dan menganalisis hubungan antara pergerakan kadar pertukaran mata wang dengan perdagangan beras. Dapatan kajian menunjukkan bahawa harga eksport beras dan jumlah import beras mempunyai hubungan negatif yang signifikan secara statistik dengan kadar pertukaran mata wang, manakala harga dan jumlah eksport beras menunjukkan hubungan positif yang signifikan secara statistik dengan kadar pertukaran mata wang. Hasil ini menunjukkan kesan asimetri turun naik kadar pertukaran terhadap pelbagai aspek perdagangan beras, menekankan kepentingan untuk mengambil kira pelbagai struktur asas dalam data. Dengan pengintegrasian FMM dan anggaran Bayesian, kajian ini memberikan pemahaman yang lebih mendalam mengenai hubungan di antara kadar pertukaran mata wang dan perdagangan, serta menawarkan pandangan berharga kepada pembuat dasar dalam merangka polisi perdagangan dan pertukaran mata wang asing. Dapatan kajian ini menegaskan kepentingan pemilihan pendekatan statistik yang lebih maju dalam menganalisis data ekonomi yang heterogen. Secara khususnya, kajian ini meluaskan literatur sedia ada dengan menunjukkan keberkesanan FMM Bayesian bagi data perdagangan pertanian yang heterogen, sekali gus menyumbang kepada kemajuan metodologi dan penjelasan empirik dalam perdagangan pertanian.



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LIST OF ABBREVIATIONS

AIC	Akaike Information Criterion
ADF	Augmented Dickey-Fuller
BIC	Bayesian Information Criterion
BME	Bayesian Maximum Entropy
BRSS	Bivariate Ranked Set Sampling
CDER	Center for Drug Evaluation and Research
CBER	Center for Biologics Evaluation and Research
CNY	Chinese Yuan
CSMAR	China Stock Market and Accounting Research
dMRI	Diffusion Magnetic Resonance Imaging
EQ	Export Quantity
EP	Export Price
ERPT	Exchange Rate Pass-Through
EXCHG	Exchange Rate
FDA	Food and Drug Administration
FMM	Finite Mixture Model
GARCH	Generalized Autoregressive Conditional Heteroskedasticity
IQ	Import Quantity
IP	Import Price
KPSS	Kwiatkowski-Phillips-Schmidt-Shin
MC	Monte Carlo
MCMC	Markov Chain Monte Carlo
NEER	Nominal Effective Exchange Rate
NARDL	Nonlinear Autoregressive Distributed Lag
PP	Phillips-Perron
PROC FMM	Procedure for Finite Mixture Model
RMB	Renminbi
REER	Real Effective Exchange Rate
SIC	Schwarz Information Criterion
USD	United States Dollar



CHAPTER 1

INTRODUCTION

1.1 Introduction

Food is crucial for every country and holds even greater significance for China. As the world's most populous nation and the second-largest economy, China's food security challenges are becoming increasingly serious. With limited arable land per capita, immense population pressure, and a diet heavily reliant on direct food consumption, the Chinese government places a high priority on maintaining a basic balance between domestic food supply and demand. The government is also very cautious about using international food trade to address domestic surpluses and shortages (Wang et al., 2022). In today's globalized economy, food imports and exports play an increasingly significant role in maintaining domestic food balance and have a growing impact on China's economy and society. As the national economy develops, the food situation becomes more complex, and changes in food imports and exports have an increasingly significant impact on national food security (Wang et al., 2023).

Rice, one of China's primary food crops, is vital to the country's food security. It serves as a staple food for over half of the world's 7.7 billion people and holds significant economic, social, political, and cultural value in most Asian countries



(Hekmatnia et al., 2024). Globally, rice is the most widely consumed food crop, the second most produced, and the third most cultivated. Approximately 90% of the world's rice production occurs in Asia, with China and India, the largest producers, contributing to over half of the global rice output (Bhandari, 2019; Chen & Zhao, 2023). Ensuring the stability of rice production is crucial for protecting farmers' interests, guaranteeing national food security, and achieving sustainable agricultural development (Tang et al., 2022).

China, as one of the world's largest producers and consumers of rice, plays a crucial role in the global rice trade. Despite its strong domestic production capacity, China imports high-quality rice varieties to meet the increasingly diverse consumer demands and to supplement supply during domestic production shortfalls. At the same time, China's rice exports, primarily targeted at Asia, Africa, and the Middle East, cater to the demand for staple food in these regions. In recent years, fluctuations in China's rice trade volumes have been influenced by factors such as domestic production conditions, international market dynamics, and government policies (Chen & Zhao, 2023). Notably, since the 2005 reform of the Chinese Yuan exchange rate, currency fluctuations have significantly impacted the price competitiveness and trade volumes of China's rice imports and exports (Chen et al., 2023). Therefore, understanding the relationship between exchange rates and rice trade is essential for formulating effective food security policies and trade strategies.

In just a few decades, China's foreign trade economy has transformed from a





closed-door policy to becoming the world's largest exporter, a development that can be considered a miracle in the history of global trade (Zheng & Li, 2022). The significant achievements of China's economic development to its current stage are inseparable from the driving force of import and export trade, which holds a crucial position in the development of the nation's economy. As a monetary tool for regulating foreign trade, the exchange rate plays a vital role not only in import and export activities but also in ensuring the stable development of the domestic economy (Auboin & Ruta, 2013).

To analyze a country's economic and trade situation, statisticians collect, organize, and interpret data, employing various statistical methods to examine economic issues. Among the many statistical techniques available, the Finite Mixture Model (FMM), also known as the latent class model, has been widely applied in economics, finance, and agricultural trade studies. FMM is particularly popular in the field of statistics due to its proven effectiveness and versatility in modelling complex data (McLachlan et al., 2019).

With the advancement of computer technology, statisticians increasingly apply Bayesian method to fit FMM for analyzing time series data sets. Due to its unique properties, the Bayesian method has become one of the commonly used parameter estimation techniques in large sample data analysis. Its asymptotic properties and consistency provide reliable results (Phoong & Ismail, 2014). Phoong et al. (2022) implement a Bayesian finite mixture model to identify the number of components in time series data and construct predictive relationships between economic variables such



as exchange rates and tourism expenditure. Wang et al. (2019) propose a Bayesian finite mixture model that integrates variable selection and handles mixed-type variables, demonstrating its effectiveness on real clinical electronic health records.

In the context of agricultural trade, exchange rate fluctuations have been shown to exert heterogeneous effects on import and export prices and quantities, particularly for staple commodities such as rice, which are sensitive to both policy changes and international market conditions (Wiseman et al., 2021).

Therefore, to study the impact of the exchange rate on China's rice import and export trade, this research employs the Bayesian method to fit the Finite Mixture Model.

This chapter outlines the overall content structure of the study and sets the stage for the subsequent chapters. It begins with an overview of the research background and problem statement, followed by an introduction to the study's conceptual framework. After discussing the purpose of the study, the chapter clarifies the research questions and objectives, which form the basis for the research propositions. The significance and novelty of the study are then explained, highlighting the positive outcomes anticipated for policy making and academic research. The scope of the study is defined, and its limitations are acknowledged. The chapter concludes with definitions of relevant terms and concepts.

1.2 Research background

To further contextualize the importance of this study, the following discussion



elaborates on the theoretical background and empirical relevance of exchange rates and rice trade in China.

The finite mixture model (FMM) offers a natural way to represent heterogeneity through a limited number of latent classes. Due to its flexibility and extensive application in statistics, there has been a growing body of literature on FMM, covering both theoretical and practical aspects, in statistical and scientific publications over the past decades (Zhang & Huang, 2015). In the realm of statistics, FMM is employed to model various types of heterogeneous data that include a finite number of unobserved subpopulations. As a blend of multiple distributions, FMM is used to model statistical distributions (Masyn, 2013). This model has been widely applied across numerous fields, including biological, physical, and social sciences, such as agriculture, economics, medicine, marketing, biology, and psychiatry.

Several statistical estimation methods can be used to fit FMM, such as the method of moments, the minimum distance method, maximum likelihood estimation, and the Bayesian method. However, the method of moments and the minimum distance method are not implemented in this study due to their inadequate properties. The method of moments is reliable and valid only with small sample sizes, while the minimum distance method is typically applied in distance measurements studies. Maximum likelihood estimation was not adopted in this study because it can be sensitive to initial parameter values and may converge to local maxima instead of the global maximum, particularly in complex models characterized by high dimensionality or non-linearities (McLachlan





et al., 2019). The Bayesian method, in contrast, provides a robust framework for parameter estimation by incorporating prior knowledge, handling model uncertainty, and generating a complete posterior distribution, offering greater flexibility and reliability in capturing complex relationships in data (Breuer & Schütt, 2023). Thus, the Bayesian method is used to fit FMM in analyzing the time series data for this study.

The COVID-19 pandemic, which began in Wuhan, China, in December 2019, has had a profound impact on the global economy. As the virus rapidly spread across the world, many countries implemented strict lockdown measures to curb its transmission. These measures, including movement restrictions, temporary business closures, and disruptions to international flights, significantly hindered economic activities (Faramarzi et al., 2024). The agricultural sector, particularly the trade of staple foods like rice, was not immune to these disruptions. Hence, China, as both a major importer and exporter of rice, faced significant challenges in its rice trade due to the pandemic's effects on global supply chains and market dynamics (Pan et al., 2020).

The 2023-24 El Niño event has underscored the significant impact of climatic anomalies on global agricultural production and trade, with particular emphasis on rice production in major exporting countries like India. This El Niño phenomenon has caused severe drought conditions, leading to reduced rice yields and heightened global food security concerns (Cao et al., 2023). Coupled with ongoing geopolitical tensions and trade restrictions, this climatic event highlights the fragility of global food supply chains.





In this context, studying food trade plays an important role in food security. The exchange rate plays a pivotal role in international trade by affecting the competitiveness of a country's exports and the cost of its imports (Lal et al., 2023). For China, understanding how fluctuations in the exchange rate influence its rice trade is essential for developing effective trade policies and strategies. The shift in 2005 from a fixed exchange rate to a managed floating exchange rate system has added complexity to this dynamic, making it even more important to investigate the current impact of exchange rate on rice trade (Chen & Zhao, 2023).

Despite the extensive literature on the relationship between exchange rates and trade, specific research on how exchange rates fluctuations influence rice trade in China is limited (Bahmani-Oskooee et al., 2023; Guo & Chen, 2023; Imane et al., 2023). Given China's significant role in the global rice market, this gap in research presents a critical area of study.

Existing literature often does not provide a detailed analysis of the specific components of trade data, such as structural breaks, trends, and seasonal patterns, which are crucial for understanding the nuanced effects of exchange rates fluctuations. Most studies focus broadly on the relationship between exchange rates and trade without delving into these critical details (Chen et al., 2024). This lack of detailed analysis can lead to an incomplete understanding of the factors driving trade dynamics, particularly in the context of staple foods like rice.

To address these gaps, this study employs the Finite Mixture Model (FMM) using





the Bayesian method to analyze the relationship between exchange rate and China's rice imports and exports. The Bayesian method offers flexibility and robustness in dealing with complex data structures and can provide more accurate and reliable insights into the dynamics of rice trade (Bharadiya, 2023). By using FMM, this study will identify and model the different components of the trade data, providing a more comprehensive understanding of how exchange rates fluctuations impact rice trade.

Rice, being a staple food, plays a critical role in China's food security and economic stability. China's rice market has been subjected to various economic and policy changes over the years (Li et al., 2022). The shift from a primarily agrarian economy to a more industrialized and market-oriented economy has influenced its agricultural trade dynamics. The exchange rates, which determines the relative value of the Chinese Yuan against other currencies, has significant implications for the cost of rice imports and the competitiveness of rice exports (Mao, 2019; Nagurney et al., 2023). Understanding this relationship is essential for policymakers to develop strategies that stabilize the rice market and ensure food security.

Moreover, the application of the Bayesian method within the FMM framework provides a sophisticated approach to capturing the complexities of the rice trade data. The Bayesian method is known for its ability to incorporate prior information and update it with new data, making it particularly useful for analyzing time series data with structural breaks and seasonal pattern (Rosenberg & Young, 1999). This method's flexibility allows for a more nuanced analysis of the factors affecting rice trade,





providing insights that traditional statistical methods might overlook.

This research will offer policymakers valuable insights into the impact of exchange rate fluctuations on rice trade, enabling the development of more informed and effective trade policies. Additionally, it will contribute to academic literature by addressing a critical gap in the research on the relationship between exchange rate and agricultural trade in China. Moreover, it will provide practical benefits for traders and investors, offering a clearer understanding of the factors influencing rice trade and helping them make more informed decisions.

In conclusion, the fluctuations in exchange rates present significant challenges for China's rice trade. To manage these challenges effectively, it is crucial to investigate the relationships among these variables in depth. This study aims to model the relationship between exchange rate and China's rice imports and exports using the Bayesian method within the framework of Finite Mixture Models. The findings will provide valuable insights for policymakers, economists, and investors, aiding them in navigating the complex dynamics of international trade amidst ongoing global economic uncertainties.

1.3 Problem statement

The 2023-24 El Niño event has highlighted the profound impact of climatic anomalies on global agricultural production and trade, with significant emphasis on rice production in major exporting countries like India. As Singh, Sah, and Singh mentioned





in the article, the 2023-24 El Niño event and its possible global consequences on food security with emphasis on India, the El Niño phenomenon has led to severe drought conditions, resulting in reduced rice yields and heightened global food security concerns (Singh et al., 2023). This climatic event, coupled with ongoing geopolitical tensions and trade restrictions, underscores the fragility of global food supply chains. El Niño-induced climate hazards pose high risks to food security. The El Niño event will persist and significantly impact China in the summer of 2024 (Li et al., 2023).

China is a major player in the global rice market, serving as both a significant importer and exporter. Understanding the dynamic interplay between exchange rate and rice trade is crucial for grasping the economic forces at play. Fluctuations in the Chinese Yuan against other currencies can greatly influence the cost of rice imports and the competitiveness of rice exports (Feng et al., 2022). The shift from a fixed exchange rates regime to a managed floating exchange rates system in 2005 introduced additional complexities. Therefore, it is essential to develop robust analytical models to accurately capture these dynamics and their impact on China's rice trade.

In this context, understanding the relationship between exchange rate and the trade of rice is crucial for mitigating economic disruptions and ensuring food security. Despite the importance of this relationship, there is a notable gap in research focusing on China's rice imports and exports. While numerous studies have explored the broader impacts of exchange rates on trade, research specifically focusing on how exchange rates fluctuations influence rice trade in China remains limited (Renhong et al., 2024).





Additionally, the existing studies present varying conclusions, highlighting a need for further investigation and a more nuanced understanding of this relationship (Herrero & Tuuli, 2010; Wu et al., 2024). Given China's significant role in the global rice market, this gap in research presents a critical area of study.

The exchange rate plays a pivotal role in international trade by affecting the competitiveness of a country's exports and the cost of its imports. For China, understanding how fluctuations in the exchange rate influence its rice trade is essential for developing effective trade policies and strategies. The shift in 2005 from a fixed exchange rates to a managed floating exchange rates system has added complexity to this dynamic, making it even more important to investigate the current impact of exchange rate on rice trade (Du et al., 2021).

To address these gaps, this study aims to employ the Finite Mixture Model (FMM) using the Bayesian method to analyze the relationship between exchange rate and China's rice imports and exports. The Bayesian method offers flexibility and robustness in dealing with complex data structures and can provide more accurate and reliable insights into the dynamics of rice trade. By using FMM, the study will be able to identify and model the different components of the trade data, providing a more comprehensive understanding of how exchange rate fluctuations impact rice trade.

In conclusion, the fluctuations in exchange rates present significant challenges for China's rice trade. To manage these challenges effectively, it is crucial to investigate the relationships among these variables in depth. This study aims to model the



relationship between exchange rate and China's rice imports and exports using the Bayesian method within the framework of Finite Mixture Models. The findings will provide valuable insights for policymakers, economists, and investors, helping to navigate the complex dynamics of international trade in the context of ongoing global economic uncertainties.

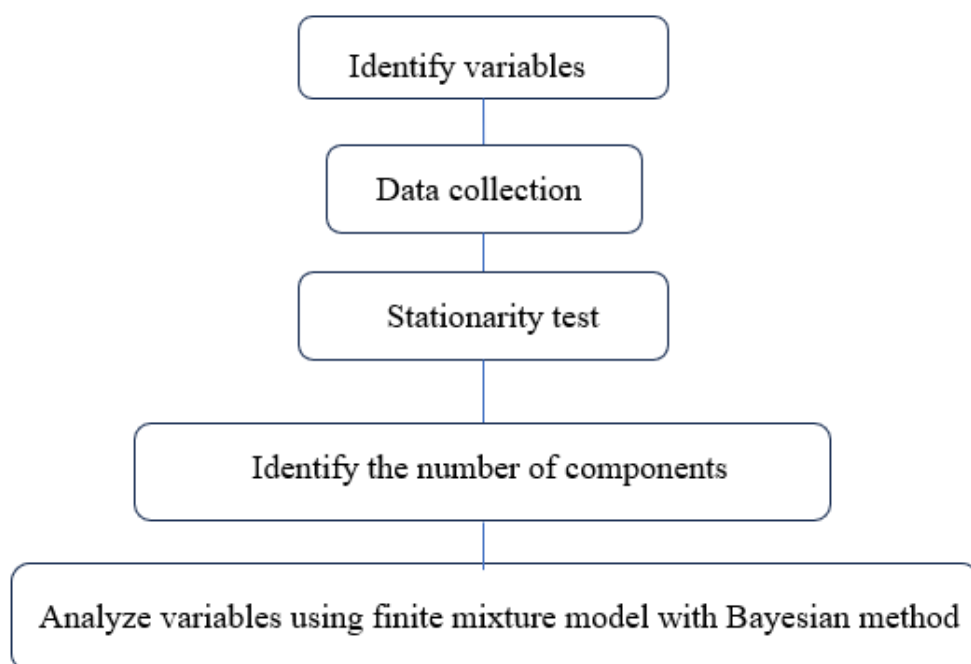
Existing studies on exchange rate and rice trade in China mainly rely on single-regime econometric models, which implicitly assume homogeneous relationships over time. Such approaches fail to capture structural heterogeneity and latent regimes that may exist in rice trade data due to policy shifts, market shocks, and external events. As a result, the true impact of exchange rate fluctuations on rice import and export prices and quantities may be misrepresented. This study addresses this gap by identifying latent components in the data using a Bayesian Finite Mixture.

1.4 Conceptual framework

The conceptual framework provides a guiding structure for this study, which focuses on examining and modeling the relationship between the exchange rate and China's rice import and export prices and quantities. Utilizing the Bayesian method, this study aims to analyze these interactions comprehensively. Figure 1.1 illustrates the conceptual framework employed, offering a clear summary of the primary objectives of this research.

Figure 1.1

Conceptual Framework



As referring to Figure 1.1, the variables of this study needed to be identified as the

first step. This is followed by data collection, where the relevant data for these variables are gathered. Next, a stationarity test is conducted to ensure the time series data is normal distributed over time. After confirming stationarity, the number of components or latent classes within the data is identified. Finally, the identified variables are analyzed using the Bayesian method to model and interpret the results effectively.

1.5 Research Objectives

There are few objectives stated in this study with the aim of achieving the purpose of study:

- i. To identify the number of component exist for the exchange rate and prices

and quantities of rice import and export in China using the Finite Mixture Model.

- ii. To model the exchange rate and the prices and quantities of rice imports and exports in China using a Finite Mixture Model fitted with the Bayesian method.
- iii. To find the relationship between the exchange rate and the price and quantities of rice imports and exports in China using Finite Mixture Model fitted with Bayesian method

1.6 Research questions

In order to accomplish the research objective, there are few research questions stated in this study which are:

- i. What are the components exist for the exchange rate and prices and quantities of rice import and export in China using the Finite Mixture Model ?
- ii. What is the modelling for the exchange rate and the price and quantities of rice imports and exports in China using Finite Mixture Model fitted with Bayesian method?
- iii. Is there any relationship between the exchange rate and the price and quantities of rice imports and exports in China using Finite Mixture Model fitted with Bayesian method?



1.7 Significance of Study

The significance of this study lies in several key areas. By focusing on the relationship between exchange rate and China's rice imports and exports using the Bayesian method within Finite Mixture Models (FMM), this study provides a deeper understanding of the complex trade dynamics in one of the world's largest rice markets. This can help policymakers and economists better grasp how currency fluctuations impact trade flows (Lal et al., 2023).

The insights gained from this study can assist government officials in designing and implementing more effective trade and economic policies. By understanding the influence of exchange rate on rice trade, policymakers can make more informed decisions to stabilize and promote economic growth (Hayakawa & Kimura, 2009).

Additionally, this study contributes to the statistical field by demonstrating the application and effectiveness of the Bayesian method in fitting FMM for trade data. This methodological advancement can be valuable for other researchers and statisticians seeking to model similar economic phenomena.

Investors can benefit from the findings by gaining a clearer picture of how exchange rate affect the rice market. This information can be used to develop more accurate and risk-averse investment strategies, leading to better investment outcomes. By examining data from January 2005 to May 2024, the study not only provides a historical context of the trade relationships but also aids in predicting future trends. This





can be particularly useful for long-term planning and forecasting in the agricultural trade sector.

Understanding the interplay between exchange rate and agricultural exports is crucial for broader economic planning and stability. As agriculture remains a vital part of China's economy, this study's findings can contribute to sustaining and enhancing agricultural productivity and trade.

In summary, this study's significance is multifaceted, offering valuable insights for statisticians, policymakers, and investors, and contributing to a more comprehensive understanding of China's rice trade.

1.8 Novelty of study



The novelty of this study lies in its comprehensive analysis of the relationship between exchange rate and China's rice imports and exports using the Bayesian method within the framework of Finite Mixture Models (FMM). FMM is an unsupervised learning technique initially introduced by McLachlan and it have gained increasing popularity in recent years due to its efficacy in identifying underlying patterns within data (Figueiredo & Jain, 2002). While the Bayesian approach is a well-established method known for its flexibility and robustness, its application in fitting FMM for trade data remains underexplored (Fletcher et al., 2023). This study aims to demonstrate the effectiveness of the Bayesian method in modeling complex trade data, specifically within the context of the rice market in China.





Furthermore, this study goes beyond merely identifying the number of components in the time series data. It also aims to determine the specific representation of these components, which is crucial for understanding different conditions such as structural breaks, trends, and seasonal patterns in the data. Existing literature often stops at quantifying the number of components, but this study delves deeper to provide insights into what each component represents, using historical events and timelines as reference points. This approach not only enhances the understanding of the underlying dynamics in China's rice trade but also offers a more detailed methodological contribution to the field.

1.9 Scope and Limitation of Study



This study investigated the relationship between exchange rate and the prices and quantities of rice imports and exports in China. The modelling process for the sampled data was conducted using the Bayesian method. To conduct this research, all data were obtained from the China National Bureau Statistics and China Stock Market and Accounting Research Database (CSMER).

In this study, two primary limitations were identified: time constraints and country selection. The data used in this study spans from July 2005 to May 2024. This specific period was chosen due to significant economic reforms in China, particularly the shift in exchange rates policy in 2005. In 2005, China moved from pegging the Chinese Yuan (CNY) or Renminbi (RMB) solely to the USD to a managed floating exchange rates system based on market supply and demand, with reference to a basket of currencies.





This reform made the exchange rates more flexible, allowing for a clearer analysis of its impact on trade (Cui, 2014). Additionally, starting data collection from 2005 ensures the use of more detailed and reliable economic and trade data, which became more consistent and accurate post-2005. This period avoids earlier economic disruptions and provides a more stable and continuous dataset, enabling a more accurate analysis of the relationship between exchange rate and China's rice imports and exports.

The study focused exclusively on China. China is one of the largest consumers, producers, and traders of rice globally. China is a significant player in the global rice market, both as an importer and exporter (Bhandari, 2019). Its policies and economic activities significantly impact the international rice market. By concentrating solely on China, the study can provide a more in-depth and nuanced understanding of the relationship between exchange rate and rice trade. This focused approach allows for a thorough examination of China's specific economic conditions and policies, leading to more precise conclusions.

1.10 Operational Definition

The terms used in this study are defined as follows:

1.10.1 Exchange rate

The exchange rate is essentially the price of one country's currency expressed in terms of another's. It is determined in organized and efficient markets, much like the prices of assets such as stocks, bonds, or real estate. Since these assets are durable, their





current prices reflect both current events and expectations of future events. Therefore, any new information that changes individuals' expectations about an asset's future price will impact its current price. The assets influencing exchange rate include domestic money supplies, so the key factors determining exchange rate movements include the factors affecting the demand and supply of domestic currencies (Batten & Thornton, 1985). In this study, the exchange rate of Chinese Yuan against the US Dollar is used to simulate its relationship with China's rice imports and exports.

1.10.2 Rice import and export

Rice is a cereal grain that is a staple food for a large portion of the world's population, particularly in Asia. It is the seed of the grass species *Oryza sativa* (Asian rice) or *Oryza glaberrima* (African rice) (Muthayya et al., 2014). Rice is typically grown in flooded fields called paddies, although it can also be cultivated in upland conditions. The grain is harvested, processed, and often milled to remove the outer husk, producing white rice. Brown rice, which retains the bran layer, is another common variety. Rice is a versatile ingredient used in various culinary traditions, providing essential nutrients and energy (Liu et al., 2019).

Rice import and export involve the transportation of rice from one country to another. Rice import refers to bringing rice produced in foreign countries into the domestic market, while rice export involves shipping domestically produced rice to international markets. China's primary rice export destinations include South Korea, Egypt, Turkey, and Japan. As the world's largest rice importer, China mainly sources



its rice from India, Vietnam, Thailand, Pakistan, and Myanmar (Zhao et al., 2021). The exchange rate determines the value of one country's currency relative to another's. This study used the exchange rate of the Chinese Yuan against the USD to model its relationship with China's rice imports and exports price and quantities.

1.11 Summary

The Finite Mixture Model (FMM) has become popular in the modeling field due to its flexibility and versatility. The Bayesian approach provides flexibility and robustness in handling intricate data structures, offering more precise and dependable insights into the dynamics of the rice trade. Consequently, this study employs FMM to model the relationship between the exchange rate and China's rice imports and exports using the