AUSTRALIAN AGRICULTURAL EXPORTS: PERSPECTIVE EXCHANGE RATE, TRADE BALANCE, AND ENVIRONMENT

A thesis submitted by

Mohammad Abul Kashem
B.Sc. (Honors) M.Sc. (Triple)

For the award of
Doctor of Philosophy
2023

ABSTRACT

Increase of agricultural output and export is an important prerequisite to maintaining the economic growth of a country. The prospect of Australian agriculture is considered very bright because of its natural endowments. Assessment of the export potential of Australian agricultural products and their probable environmental consequence have not attracted much attention of the researchers so far. So the issues are still less investigated. Therefore, this thesis has investigated empirically some broad theoretical issues in case of Australian agro-forest and fish (AFF) exports which are the validity of famous Marshall-Lerner (ML) condition, Orcutt (1950) hypothesis, price and exchange rate elasticities, ramification of trading agreements, and the impact on Australian environment and of global climate change. This research is a thesis by publication; hence thesis chapters are constructed by articles and every paper has its own independent style, data period (mostly 1988-2022) and research techniques. In the first paper, to determine the impact of exchange rate on the agricultural trade balance (TB), we have applied the linear autoregressive distributed lag (ARDL) model to estimate the ML condition. The findings support the ML condition in case of the major share of Australian AFF trade. The implication of this finding is that if the market force depreciates the real exchange rate, Australian AFF products TB may improve in the long-run. Similarly, to examine the recent high volatility for Australian exchange rate on the overall AFF TB, we examined the validity of Orcutt (1950) hypothesis in the second paper. It is found overwhelming support in favor of his claim for the AFF products trade between Australia and her top five trading partners. The results reveal the sheer dominance of exchange rates over relative prices in the agricultural trade flow of Australia. Policy implication of this finding is that if Australia intends to improve AFF sector TB, instead of domestic price level, nominal exchange rate manipulation would be a better option. In the third paper, we have delved and analyzed the impact of AFF trade on the Australian environmental condition. Both linear and non-linear ARDL model is applied to discern the asymmetry impact on environment. The findings reveal that improvement of the AFF TB is harmful for Australian environment, and AFF import related economic activities are environmentally more efficient than AFF export related activities. The fourth paper focuses on the impact of trading agreements on Australian AFF exports. In the last two decades, Australia has joined approximately two dozens of trading agreements. Our results reveal that "trade diversion" and "trade creation" have been occurred due to those bilateral and multilateral trading agreements for Australian AFF products. This may have a positive impact in the short-run but could have negative consequence in the long-run since AFF commodity trade is perilously lopsided to a few countries due to trading agreements. Likewise, the fifth paper has attempted to shed light on identifying the relative importance of domestic and foreign price levels, and real exchange rate as major determinants of AFF exports. Our investigation shows that bilateral real exchange rate, Australian export price levels, and importing countries import price levels are the key determinants of Australian AFF commodity exports. Another major finding of the paper is that similarly to theoretical prediction, trade elasticities are higher in the long-run than in the medium-run, and higher in the medium-run than in the short-run. In the sixth paper, we have reviewed and assessed the impact of climate change on the Australian AFF exports. Our results have manifested that rapid global warming or climate change has negatively affected Australian AFF export growth. Specifically, environmental degradation and average yearly temperature increase of Australia triggered by the exponential growth of CO_2 emissions have empirically negative impact on Australian AFF export growth. Finally, all these research findings above have important policy implications for Australia and all other countries in the world particularly with respect to the agricultural commodity trade.

CERTIFICATION OF THESIS

I, Mohammad Abul Kashem, declare that the PhD Thesis entitled “*Australian Agricultural Exports: Perspective Exchange Rate, Trade Balance, and Environment*” is not more than 100,000 words in length including quotes and exclusive of tables, figures, appendices, bibliography, references, and footnotes.

This thesis is a bona fide work of Mohammad Abul Kashem except where otherwise acknowledged, with the majority of the contribution to the papers presented as a thesis by publication undertaken by the student. The work is original and has not previously been submitted for any other award, except where acknowledged.

Date: 15 June 2023

Endorsed by:

.

Principal Supervisor Professor Mohammad Mafizur Rahman

Associate Supervisor Professor Rasheda Khanam

Student and Supervisors’ signatures of endorsement are held at the University

STATEMENT OF CONTRIBUTION

The agreed share of contribution for the candidate and co-authors in the presented publications in this thesis is as follows:

Paper 1:
Kashem, M. A., Rahman, M. M., & Khanam, R. (2022). Improving Australia's trade balance: A case study of agro-forest and fish products. Australian Economic Papers, Volume 61, Issue 3 September 2022, Pages 494-533. DOI: https://onlinelibrary.wiley.com/doi/10.1111/1467-8454.12257

The overall contribution of **Mohammad Abul Kashem** was about 70% to the concept development, data collection, statistical analysis, writing the manuscript, and revising the final submission. ***Mohammad Mafizur Rahman*** contributed about 20%**:** assisted in designing the study, supervised data analysis and the writing of the manuscript. ***Rasheda Khanam*** contributed about 10%**:** updated the research design, reviewed the article, and wrote the manuscript.

Paper 2:
Kashem, M.A.., Rahman, M. M., & Khanam, R. (2023). Orcutt Hypothesis and Australian Trade Balance: A case study of agro-forest and fish products (Under review).

The overall contribution of **Mohammad Abul Kashem** was 70% to the concept development, data collection, statistical analysis, writing the manuscript, and revising the final submission. ***Mohammad Mafizur Rahman*** contributed 15%**:** assisted in designing the study, supervised data analysis and the writing of the manuscript. ***Rasheda Khanam*** contributed 15%**:** updated the research design, reviewed the article, and wrote the manuscript.

Paper 3:
Kashem, M. A., Rahman, M. M., & Khanam, R. (2023). Price and exchange rate sensitivity of Australian Agro, Forest, and Fish exports to major destinations (Under review).

The overall contribution of **Mohammad Abul Kashem** was 70% to the concept development, data collection, review of the article, and the writing of the manuscript. ***Mohammad Mafizur Rahman*** contributed 20%**:** assisted in review of the article, updated the research design, and supervised the analysis. ***Rasheda Khanam*** contributed 10%**:** assisted in data analysis, writing the manuscript and reviewed the article.

Paper 4:
Kashem, M. A., Rahman, M. M., & Khanam, R. (2021). Does trading agreement divert Australian AFF exports? (Submitted for publication).

The overall contribution of **Mohammad Abul Kashem** was 65% to the concept development, data collection, review of the article, and the writing of the manuscript. ***Mohammad Mafizur Rahman*** contributed 20%**:** assisted in designing the study, supervised data analysis and the writing of the manuscript. ***Rasheda Khanam*** contributed 15%**:** updated the research design, reviewed the article, and wrote the manuscript.

Paper 5:
Kashem, M. A., Rahman, M. M., & Khanam, R. (2023). Environmental Consequence of Australian Agricultural Trade**:** An Asymmetric Analysis. Published in Sustainable Development, Volume 6, Issue 5, October 2023, Pages 33-47. https://doi.org/10.1002/sd.2814

The overall contribution of **Mohammad Abul Kashem** was 70% to the concept development, data collection, analysis, review of the article and writing the manuscript. ***Mohammad Mafizur Rahman*** contributed 20%**:** supervised the drafting of the manuscript, updated the research design, and reviewed the article. ***Rasheda Khanam*** contributed 10%**:** assisted in designing the study and reviewed the article.

Paper 6:
Kashem, M. A., Rahman, M. M., & Khanam, R. (2021). Impact of Climate Change on the Australian Agricultural Exports (Submitted for review).

The overall contribution of **Mohammad Abul Kashem** was 70% to the concept development, data extraction and analysis, interpretation, and drafting the manuscript. **Mohammad Mafizur Rahman** contributed 15%**:** assisted in designing the study, supervised data analysis and the writing of the manuscript. **Rasheda Khanam** contributed 15%**:** updated the research design, reviewed the article, and wrote the manuscript.

ACKNOWLEDGEMENTS

First and foremost, I express heartiest gratitude to the creator of this universe, the most merciful Allah. I thank Him for showering his blessings on me and for being at my side at every step of my research. This thesis would not have been completed without the support from a number of good people. It is my privilege to acknowledge the support of some special people who stood by me at each step of this research.

I also would like to express my sincerest gratitude to my supervisor, Associate Professor Mohammad Mafizur Rahman, for his valuable guidance, support, and encouragement throughout my research. His insight and expertize in the filed were invaluable and helped me to shape my research. I would also like to thank mu sub supervisor, Professor Rasheda Khanam, for her kind guidance and support. I am deeply thankful to her for continuous support, patience, and motivating works of encouragement. Furthermore, I would like to thank my colleagues and friends who were always there to help me whenever I needed it. Particularly, staffs of graduate school were highly generous and helpful in throughout my journey in the USQ. Their support and guidance were instrumental in helping me and for completing this research. Last but not least, I would like to thank my family for their unconditional love and support throughout my entire journey. Their constant encouragement and faith on me kept motivated during this tough time of my life. I am really thankful to all of them for their invaluable professional help and mental supports.

The PhD project was significantly financed by the University of Southern Queensland. Thanks to them for accepting the financial responsibility associated with my study. Their financial and moral support enabled me to remain focused on my research. I would also like to thank the staff at the Bangladesh Bank (my work place), for welcoming and allowing me to access their online and print publications without charge. A big thank you to all of them. Ms. Barbara Harmes, accepted to do proofreading of the entire research i.e., detecting and correcting topographical errors to conform with standard usage. Thanks for her support which has enable me to improve the quality of presentation of this thesis.

A lot of thanks also to my family: my parents Afroja Akter, Tahseen Anjum, and Tazmin Arshya for their dependable love and support, and for teaching me by their life the importance of appropriate education, wisdom, patience, and working hard. Their lived examples have become a dependable pillar for my life. I also wholeheartedly remember my late parent Mohammad Abdur Rahman and Zaheda Khatun for their love and affections that helped me to come up to this stage of my life. My immense gratitude to my siblings and friends for their continued accompaniment, encouragement, and support.

To the Bangladesh Bank Community whom we lived and worked together during my research, thank you for creating an inspiring living and working environment, for being good and supportive colleagues.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

AFF	Agro, Forest, and Fish
AIC	Akaike Information Criterion
AR	Autoregressive
ARB	Agricultural Trade Balance
ARDL	Autoregressive Distributive Lag
ARMA	Autoregressive Moving Average
AUD	Australian Dollar
A-UK FTA	Australia United Kingdom Free Trade Agreements
BTA	Bilateral Trading Agreements
CAB	Current Account Balance
CES	Constant Elasticity of Substitution
CGEA	Computational General Equilibrium Analysis
CPI	Consumer Price Index
CUSUM	Cumulative Summation
CUSUMSQ	Cumulative Summation Square
DFAT	Department of Foreign Affairs and Trade
DID	Difference in Difference
DOTS	Directory of Trade Statistics
DW	Stat Durbin Watson Statistics
ECM	Error Correction Model
EKC	Environmental Kuznet Curve
ER	Exchange Rate
EU	European Union
FDI	Foreign Direct Investment
FEM	Fixed Effect Model
FTA	Free Trading Agreements
GATT	General Agreement on Tariff and Trade
GCC	Gulf Cooperation Council
GDP	Gross Domestic Product

GHGs	Green House Gasses
HQIC	Hannan - Quinn Information Criterion
HS	Harmonized System
IFS	International Financial Statistics
IMF	International Monetary Fund
IPAT	Impact, Population, Affluence, and Technology
JB Stat.	Jarque Bera Statistics
KM	Kilometer
LM	Lagrange Multiplier
MA	Moving Average
MLC	Marshall-Lerner Condition
MTA	Multilateral Trading Agreements
NAFTA	North America Free Trade Agreements
NER	Nominal Exchange Rate
OLS	Ordinary Least Square
PTA	Preferential Trading Agreements
PVAR	Panel Vector Autoregressive Regression
REER	Real Effective Exchange Rate
REM	Random Effect Model
RER / REXR	Real Exchange Rate
RESET	Regression Equation Specification Error Test
SIC	Schwarz Information Criterion
SITC	Standard International Trade Classification
TA	Trading Agreements
TB	Trade Balance
TOT	Terms of Trade
TPP	Trans-pacific Partnership
UAE	United Arab Emirates
UN	United Nations

UNCTAD	United Nations Conference on Trade and Development
US	United States
USD	United States Dollar
VAR	Vector Autoregressive Regression
WB	World Bank
WDI	World Development Index
WTO	World Trade Organization

List of published articles included in the thesis

Environmental Consequence of Australian Agricultural Trade: An Asymmetric Analysis.

Impact of Climate Change on the Australian Agricultural Exports

CHAPTER 1

AUSTRALIAN AGRICULTURAL EXPORTS: PERSPECTIVE EXCHANGE RATE, TRADE BALANCE, AND ENVIRONMENT

1.1.INTRODUCTION

Since the breakdown of the Breton Woods System in the early 1970s, when previously fixed exchange rates among major currencies were allowed to float, researchers across the world have shown their eagerness to analyse the effects of exchange rates on international trade balance. However, results of those researches have failed to reach in any consensus due to variations across countries and regions. Such variation has led researchers to investigate various exchange rate dynamics, namely the impact of exchange rate volatility on trade balance, Marshall-Lerner (ML) condition, the J-curve, the S-curve, the Orcutt (1950) hypothesis, HLM effect, Dutch disease and Balassa - Samuelson effect, etc. for different countries and regions. The impact of exchange rate change on international trade of a country or region is ambiguous predominantly for three uncertain reasons. Firstly, it is not clear whether the Marshall-Lerner (ML) condition is valid. Secondly, sectoral level general equilibrium effects may lead to a deterioration of a sector's net external position following a real exchange rate depreciation due to the resources and consumption relocation for exchange rate change and finally, a consideration of how much liberalised a country's international trade border is. Most of the existing studies evaluate the impact of exchange rate on these three dynamic issues on aggregate trade, ignoring the potential differences of this impact across sectors. There is limited attention in individual sectors like agriculture, manufacturing, service as well as further segregated subsectors. Thus, whether the change of the exchange rate contributes to the change of net external position of a country's particular sector such as agricultural, fish and forest (AFF) products international trade balance is a fundamental and basic empirical question that may either improve or hurt the sector. Bahmanee-Oskooee (1985) has taken the initiative to cater to this gap by analyzing exchange rate impacts on sectoral trade balances. However, either carefully or inadvertently, the agricultural sector is omitted from his analysis. Therefore, the objective of this thesis is to empirically examine the efficacy of different theoretical exchange rate phenomena on the net external trade balance of Australian AFF products. Earlier studies for different countries and regions focused mainly on industrial or manufacturing products but not in non-durable AFF products **(**Backus *et.al.*, 1994, Bahmani-Oskooee *et.al.* 2012, Gomes and Paz, 2005, Parikh, and Shibata, 2004, and Senhadji, 1998**)**. Due to their non-durable characteristic, high dependence on nature and long gestation period for production and difference in inventory preserving techniques, the response of the exchange rate changing on AFF products may differ from the response of the durable manufacturing products. For this facet of AFF products this thesis also generates a topical innovation and an attempt reduce the gap in the empirical research.

In the late 1970's and 1980's, a novel notion of market based open economy oriented idea gained popularity among economists who termed it as neoclassical economics. The notion is simple and argues that the market has a magical power that ensures optimal resource mobilization in the economy (Michael, 1975). Thus, everything should be rendered on the hand of market and for making market more functional, the level of intervention by the government and regulators should be as low as possible. Government intervention is only expected when the market fails to reach an equilibrium condition automatically (Schmidt, 2018). Later, nations reached in a decision under the aegis of the United Nations Conference on Trade and Development (UNCTAD) talks that each country in the world would work to abolish all kinds of tariff and non-tariff barriers to facilitate the trade among nations and make the world market more functional. Based on the same ideology, a consensus among nations was reached in 1995 when the General Agreement on Tariff and Trade (GATT) was converted into a trading organization named the World Trade Organization (WTO) that would oversee and monitor the global trading market to provide updated policy suggestions through research and rational thoughts. Accordingly, various round table talks were arranged amongst the nations (for instance Uruguay Round in 1995, Doha Round in 2001, Cancun Round 2003 etc.). However, later it is seen that countries are highly diversified in their thoughts and views, and, therefore, almost all trading rounds are failed. This failure of trading talks has induced the nations for the formation of the bilateral and multilateral trading agreements among the regional and likeminded nations (Schott, 2004, and Looney, 2018). Assessments of impact of such trading agreements on national income, international trade balance, and exchange rate are still continued by academicians and researchers across the world. The topic is trending in the empirical research world by the economists and financial scientists and, therefore, some chapters of this thesis are devoted to exploring the issues on Australian AFF sectors.

Meanwhile, due to increasing economic activities such as income and trading expansion are causing global environmental degradation which creates a great threat to the survival of human civilization and global ecosystems (Kahuthu, 2006). Increasing export activities among the nations are partly responsible for the concerns of environmental pollution as well as global climate change.

Therefore, this publication-based thesis also has explored how Australian AFF trade is responsible for this issue of the current world. Further, in chapter IV, we have tried to examine how AFF trade is affected by this problem and the asymmetric nature of the impact by AFF trade balance.

In short, due to the above backdrop, this thesis has conducted research to test the validity of ML condition, Orcutt (1950) hypothesis, and environmental impact for Australia versus its major five AFF product trading partners; China, USA, Japan, South Korea, and Thailand. These five partners constitute more than 50% of the Australian AFF product trade. So, the research is important in order to explore and represent the issues for its major share of AFF trade with the rest of the world.

1.2.THE SIGNIFICANCE OF THE STUDY

Exchange rate movements of a country determine the interconnectivity between domestic and foreign prices for traded goods. Thus, exchange rates play an important role in defining equilibrium and relative prices of different commodities in the economies of both trading partner countries. As exchange rates impact the equilibrium price of any trading and non-trading goods of the economy, they have direct influence in determining both international and national demand of those goods. Table 01 shows the five-year average growth of Australian aggregate and sectoral exports. The sectors are divided by Ministry of Trade, Tourism and Investment in Australia for the period 1990-2019. The figures in the table have mainly highlighted the growth and fall of all four sectors of the Australian exports although the overall exports show a stable condition. The highest volatile growth performance is displayed by mineral and fuel sector followed by other and manufacturing sectors. The notable point of this table 1 is that agricultural sector export growth for this period has shown relatively stable conditions. Additionally, the correlation coefficient between the five-year average of real exchange rate and aggregate trade balance of Australia is 0.78. But the correlation coefficient between the five-year average of real exchange rate and AFF trade balance of Australia is -0.21. Exchange rates under the flexible exchange rate regime are highly volatile and hence a highly frequent rate must be used to understand the impact in trade balance. So, the correlation coefficient of the exchange rate of five years averaged with any other variable may not gain a reliable result. Such high correlation between exchange rates and the aggregate trade balance of Australia can be explained noting that depreciated exchange rates bring prosperity for the Australian non-agricultural trade balance. It can be inferred that the exchange rate may not have a perceptible influence in the AFF trade balance of Australia. More econometric inquiry in the later part of this thesis may confirm the actual influence.

Table 01: Australian average Exchange Rate and average exports growth from 1990 to 2019.

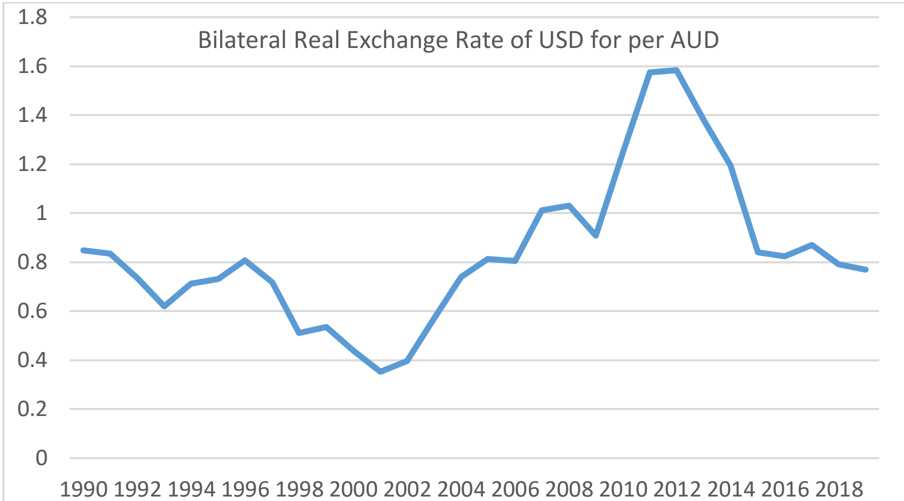
Exports Growth Rate	1990-95	1996-00	2001- 05	2006-10	2011-15	2016-19
RER per USD	0.7469	0.6023	0.5739	1.0015	0.8136	1.3141
Total Exports	7.8	6.1	9.5	8.7	7.4	13.4
Manufacturing	1.9	4.28	2.91	8.1	4.1	3.2
Mineral &Fuel	14.67	24.0	5.9	9.23	13.7	12.4
Agriculture	2.67	7.6	6.0	10.2	3.9	2.76
Others	16.5	2.7	8.6	4.3	3.2	8.0

Source: Ministry of Trade, Tourism and Investment, Australia

Though agricultural export performance is in a relatively stable position, trade balance shows a different story. Agricultural trade balance is gradually declining whereas the remaining exports including the overall trade balance of Australia is increasing. Figures 04, 05 and 06 are showing the true position and contribution of the agricultural sector in the overall trade balance of Australia. Agricultural trade balance moves in a reverse trend compared to the trade balance movement of other sectors. Though export has shown a mild growth over this period, declining of trade balance means that agricultural import growth has surpassed the export growth and this dominating import growth has shown trade balance declining over the period. It also confirms that the agriculture sector individually has very little influence in defining the overall trade balance of Australia. An increase of export in lower rate and increase of import in a relatively higher rate reflect the fact that agricultural export of a particular country depends mainly on supply capacity while increase of import contradicts the fact that agricultural product demand is income inelastic in case of Australia. However, it may also reflect the fact that exchange rate uncertainty or volatility may have a more significant effect on agricultural trade balance relative to its impact elsewhere. This may be due to the positive impact of the exchange rate which will be noted with the application of the econometric model in the subsequent sections.

Now, under the current flexible exchange rate regime, the exchange rate movement of a country depends on the international capital flows and macroeconomic factors determining these flows including trade balance and the monetary policy of the country (Orden, 2002). This trade balance is the aggregate trade balance. The aggregate trade balance in the Australian economy has been gradually increasing for last three decades and the speed of increase in recent years is marked. It is also observed by the graphical representation of the monthly real exchange rate of the Australian Dollar against the US Dollar that since 2010, the Australian Dollar is depreciating. It may be considered that such depreciation may have important role in the increase of overall trade balance of the country.

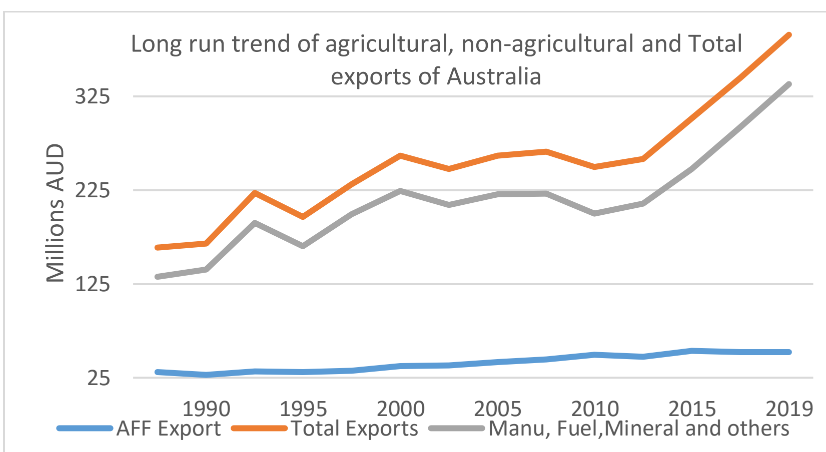
Figure 01: Bilateral real exchange rate between AUD and USD.



Source: Reserve Bank of Australia and Penn World Table

The agricultural sector has a very limited contribution in the overall trade balance of Australia (20 percent in overall exports and 10 percent in overall import in 2019). Therefore, in many instances, the exchange rate determining policies are implemented without considering the agriculture sector or agriculture trade balance of a country. Disregarding the impact of the exchange rate on the agricultural sector may have an adverse impact on agricultural trade balance. Without investigation of this impact, a firm decision cannot be reached, however econometric investigation of this research will provide clear answers.

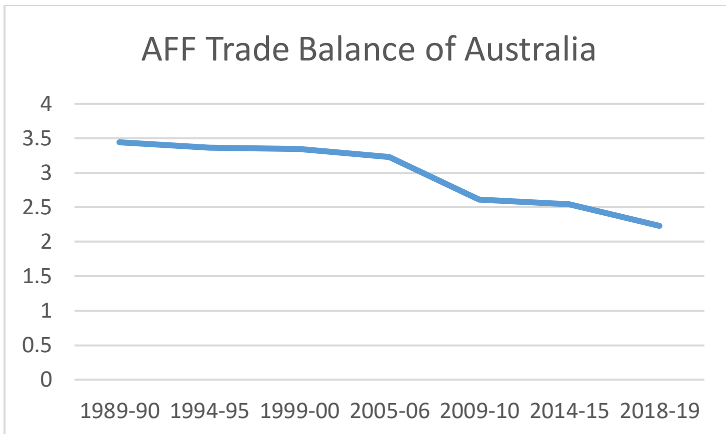
Figure 02: Trend of Australian aggregate exports, AFF and remaining sectors 1990-2019.



Source: Ministry of Trade, Tourism and Investment, Australia

The true contribution of the AFF sector to aggregate exports and the trade balance of Australia is depicted in figures 04 and 05 respectively. In figure 04, the total export (Red) curve is the summation of the AFF (Blue) and Manufacturing, Fuel, Mineral and Others sectors (Green) curves. It can be seen that the contribution of the AFF sector in total export is minimal. The recent export trend for the AFF sector to aggregate exports of Australia is ranging from 15 to 20 percent. Similarly, the recent trend of imports from the AFF sector to aggregate imports of Australia is below 10 percent (not reported in the figures). It is clear that the AFF sector has a minimal contribution to overall trade i.e. export and imports of Australia.

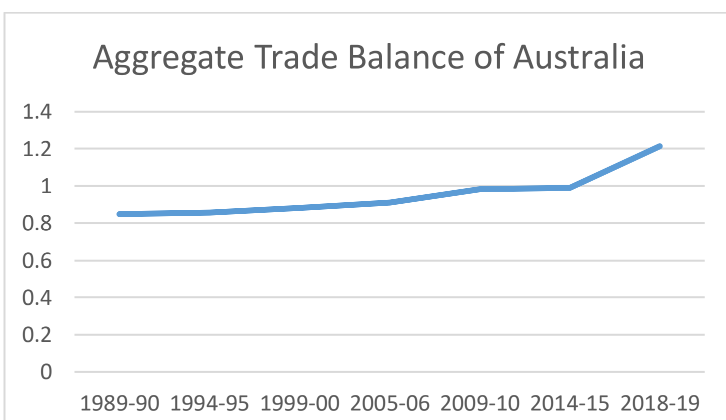
Figure 03: Agricultural trade balance of Australia: 1989-2019



Source: Ministry of Trade, Tourism and Investment, Australia

The aggregate trade balance is moving with the Australian exchange rate, however, the AFF trade balance is moving in an opposite way to the usual trends. It can be seen that where the exchange rate is defined in the Australian economy with the overall trade balance of Australia, the agricultural sector is a sector that is considered to be an exchange rate taker not an exchange rate maker. All other sectors impose exchange rates on agriculture sector as defined internally.

Figure 04: Aggregate trade balance of Australia: 1989-2019



Source: Ministry of Trade, Tourism and Investment, Australia

With abundant land and a highly mechanized agricultural sector, coupled with gradual depreciation of the exchange rate it is clear that the Australian agricultural trade balance should have improved in last two to three decades. That is, where export earnings and the import cost of the agricultural sector should be seen to have increased and decreased respectively. But the observed trend is the opposite of this phenomenon. The sector requires a thorough investigation which has not yet been undertaken by any researcher. Careful econometric operation with country and commodity level disaggregated data may provide clearer answers.

1.3.RESEARCH OBJECTIVES AND QUESTIONS

The objective of this study is to define and measure the impact of exchange rate variations on the trade balance of Australian AFF product with its five main trade partner countries.

1.3.1. *Specific Objectives*

1. To define and measure the ML condition phenomenon in the case of Australian AFF products trade.
2. To identify whether Orcutt (1950) hypothesis is validated in the case of Australian AFF products trade.
3. To examine the price and exchange rate sensitivities on Australian AFF product exports.
4. To detect the impact of trading agreements on Australian AFF product exports.
5. To identify whether there exists a symmetric or asymmetric impact of environmental pollution on Australian AFF product exports.
6. To explore the impact of climate change on Australian AFF exports.

1.3.2 Research Questions

1. Is the ML condition valid for Australian AFF goods?
2. Is Orcutt's (1950) hypothesis applicable in the case of Australian AFF commodities trade?
3. Are Australian AFF products export more sensitive to exchange rate than price?
4. Does the trading agreement divert Australian AFF products exports destination?
5. Is the impact of environmental pollution on Australian AFF product exports symmetric?
6. Are Australian AFF exports affected by climate change?

1.3.3. *Research Hypothesis*

The following hypotheses will be tested during this study

1. Hypothesis 1: ML condition is valid for Australian AFF product exports?
2. Hypothesis 2: Orcutt's (1950) hypothesis is applicable in case of Australian AFF products exports?

3. Hypothesis 3: In the case of Australian AFF product exports exchange rate is more sensitive than price.
4. Hypothesis 4: Trading agreements divert Australian AFF product export destinations.
5. Hypothesis 5: Impact of environmental pollution on Australian AFF product exports is symmetric.
6. Hypothesis 6: Global climate change affects Australian AFF exports.

1.4.DATA, METHODOLOGY AND ETHICAL STANDARDS

1.4.1. Data

This research will use secondary data. Data will be collected and compiled from an Australian government website (www.data.gov.au). Alternate data will be collected from published official publications of IMF namely International Financial Statistics (IFS) and Directory of Trade Statistics (DOTS). For estimation purpose, collected data will be tabulated and compiled as per the plan to thesis report. Various statistical and econometric models, methods and software will be used to analyze the collected data. Additionally, data will be filtered for de-trending and consideration of the time series or stochastic properties of the data.

1.4.2. Definition of trade balance

The trade balance is usually measured by the difference between the value of total exports and total imports. However, this study proposes to measure it as the ratio of the bilateral exports value (X) to the bilateral imports value (M) of Australian AFF product. The X/M ratio or its inverse has been used in many empirical investigations of the trade balance-exchange rate relationship (Lowinger 2001, Gupta-Kapoor and Ramkrishnan 1999). One benefit for its use is that the ratio is not sensitive to the unit of measurement and can be interpreted as a nominal or real trade balance (Bahmani-Oskooee, 1991). Furthermore, as noted by Boyd et. al. (2001), the ratio in a logarithmic model gives the ML condition exactly rather than as an approximation.

1.4.3. Research Methodology

This research will use a Gravity model that notes that trade balance between two countries is proportionately related to their income levels and inversely related to their geographical distance. Mathematically the function stands as follows:

$$\text{Trade Balance} = f(Y_1 * Y_2)/d$$

Bahmani-Oskooee (1985) has modified this model further where he has opined that as exports of a country depend on its supply capacity and as the distance between two countries are time invariant, they can be removed from the trade balance model. Against this shortened version of Gravity model, the exchange rate has been added as it is the prime target variable of his research where also it is assumed that trade balance is positively related to exchange rate depreciation and negatively related to appreciation.

Bahmani-Oskooee's (1985) model which is predominantly modified to Augmented Gravity Model is econometrically an autoregressive distributed lag (ARDL) type model that is already used for detecting nonlinear short and long-run impact of exchange rate variations in many commodity level bilateral trades. This model is free from the assumption of the conventional models which is that impact of exchange rate is symmetric and linear. The inherent meaning of this assumption is that the degree that depreciation improves the trade balance must completely worsen by the same extent of appreciation. This assumption may be invalid for a number of reasons. When the exchange rate of a country depreciates, a favourable international substitution effect is enjoyed by that country's commodities. This effect may not eliminate completely if exchange rate appreciates. Additionally, a price shows downward rigidity. When exchange rate appreciates, price may not come down to the extent that it was increased due to the exchange rate depreciation. Finally, asymmetry of the effect may arise from the common behaviour of traders. Traders can have different speed and degree of reactions and expectations when the exchange rate depreciates than when it appreciates. For example, when exchange rates depreciate, suppliers may react in a faster way to satisfy the larger demand stemming from depreciation. Conversely, they may not react as fast to rate appreciation due to current stockpile of their inventory of inputs and previously produced outputs.

In the case of environmental issues, models will be crafted based on the IPAT model where it is considered that impact (I) is a product of three factors: population (P), affluence (A), and technological stage (T) of the country (Thomas and Rosa, 1994). It is considered a high standard and sophisticated model for modern environmental consequence analysis among the environmental scientists as it represents the human factors and production activities of an economy. This model is highly recommended by researchers especially for environmental academic research.

1.5. CONTRIBUTION OF THE RESEARCH

While relevant contributions of this research are noted in the earlier sections they can be summarised and further substantiated as follows:

The agricultural sector requires special policy support largely because this sector cannot adjust itself as rapidly to technical change as other sectors of the economy (Hallett, 1968). This research offers a number of alternative policies for Australian authorities in stimulating AFF exports and trade balance. It also provides policy suggestions by identifying the factors and AFF trade related channels which affect environmental for Australia. We hope the Australian government and central banks will able to fathom the complexities of exchange rates on AFF trade balance with its main trading partners. The central bank will receive knowledge to allow the design of an exchange rate policy for the prosperity, increased profit and survival strategies for AFF farms and industries. The noted policies will be effective for Australia, and involve either export subsidies or imposing import tariff, a mixture of both, or an alternative non-tariff policy to be adopted instead of direct currency depreciation. The later policy works through changes in the nominal exchange rate and the former policy through changes in relative export prices. The Australian government will receive updated empirical knowledge on the factors of AFF exports which are creating environmental hazards for Australia. For example, if Orcutt's (1950) hypothesis is supported and if the governmental concern is the speed with which exports adjust to either policy, depreciation should be preferred to input subsidies for exporting sectors and import tariffs for that product. Depreciation of the exchange rate is still an accepted instrument worldwide and does not conflict with WTO conventions. As direct devaluation policy is not within current considerations of the Australian central bank, it may influence exchange rates to change in a more favourable direction through monetary and fiscal policies or input subsidies. It is believed that to promote economic growth, employment and development of a sector, trade and exchange rate policies are always paralleled with monetary and fiscal policies of a country as they are highly interconnected and interdependent to one another (Guzman, et. al. 2018). This research will determine the level that trade and exchange rate policies in Australia should be expressed for the improvement of the AFF trade balance in designing an effective monetary and fiscal policy in Australia.

1.6.REFERENCES

Backus, D.K., P.J. Kehoe, and F.E. Kydland (1994). "Dynamics of the trade balance and the terms of trade: The J-curve?" American Economic Review, Vol. 84, Issue (1): PP 84–103.

Bahmanee-Oskooee (1985). Devaluation and the J-curve: some evidence from LDCs. The review of Economics and Statistics, 1985 – JSTOR

Bahmani-Oskooee (1985), Devaluation and the J-curve: Some evidence from LDCs. The review of Economic and Statistics. Vol. 67. No. 3. PP 500- 504.

Bahmani-Oskooee, M., H. Harvey, and S.W. Hegerty (2012). Brazil-U.S. commodity trade and the J-curve, Working paper, University of Wisconsin-Milwaukee.

Bahmani-Oskooee, M.1991. “Is There a Long-Run Relation between the Trade Balance and the Real Effective Exchange Rate of LDCs?” Economics Letters, 36, 403-407.

Boyd, Derick, and Caporale, Gugielmo Maria and Smith Ron (2001) “Real Exchange Rate Effects on the Balance of Trade: Cointegration and the Marshall-Lerner Condition,” International Journal of Finance Andconomics, 6, 187-200.

Gomes, F. and L. Paz (2005). “Can real exchange rate devaluation improve the trade balance? The 1990-1998 Brazilian case,” Applied Economics Letters, Vol. 12, Issue 9, PP 525–8.

Guptar-Kapoor, Anju and Ramakrishnan, Uma (1999). Is There a J-Curve? A New Estimation for Japan, International Economic Journal, Vol. 13, 71-79.

Guzman, M. Ocampo, JA. and Stiglitz, JE. (2018). Real exchange rate policies for economic development. World Development, Vol. 110, PP 51-62

Hallett, G. (1968) The Economics of Agricultural Policy, University College of South Wales and Monmouthshire, Cardiff, Published by Basil Blackwell, Oxford.

Kahuthu, A. (2006). Economic Growth and Environmental Degradation in a Global Context. Environment, Development and Sustainability. Vol. 8, PP 55–68

Looney RE. (2018) Handbook of International Trade Agreements: Country, regional and global approaches. Rutledge International Hand Book.

Lowinger, Thomas C. (2001). J-Curve: Evidence from East Asia, manuscript presented at the 40th Annual Meeting of the Western Regional Science Association February 2001 in Palm Springs, CA

Michael, De Vroey (1975). The Transition from Classical to Neoclassical Economics: A Scientific Revolution. Journal of Economic Issues, Vol. 9, Issue 3. PP 26-47.

Orcutt (1950). Measurement of price elasticities in international trade. The Review of Economics and Statistics, 1950 - JSTOR.

Parikh, A. and M. Shibata (2004). Dynamics of the relationship between the terms of trade and the trade balance in developing countries of Asia, Africa, and Latin America, Journal of Quantitative Economics 2: 104–21.

Samuelson, PA. (1964). Theoretical notes on trade problems. Review of Economics and Statistics.

Schmidt, P. (2018). Market failure vs. system failure as a rationale for economic policy? A critique from an evolutionary perspective. Journal of Evolutionary Economics. Vol. 28, PP 785–803.

Schott, JJ. (2004) Free trade agreements: boon or bane of the world trading system. Free Trade Agreements: US Strategies and Priorities. Book. Chapter 1. Columbia University Press.

Senhadji, A. S. (1998). “Dynamics of the trade balance and the terms of trade in LDCs: The S-curve,” Journal of International Economics, Vol. 46, Issue 1, PP. 105–31.

Thomas, D. and Rosa, EA (1994). Environmental Impacts of Population, Affluence and Technology. Human Ecology Review. Vol. 1, No. 2 PP. 277-300 (24 pages)

CHAPTER 2

IMPROVING AUSTRALIA’S TRADE BALANCE: A CASE STUDY OF AGRO-FOREST AND FISH PRODUCTS

Abstract

The impact of the exchange rate on the trade balance has been discussed for many years. However, the issue has not been discussed in sufficient depth, especially in relation to the trade balance of agricultural products. This paper will gauge this impact on Australia, which has much potential for agro-based trade in the world market. We have applied the Bahmani-Oskooee and Hosny (2013) approach of the linear autoregressive distributed lag (ARDL) model to estimate the Marshall-Lerner Condition (MLC) regarding the trade of Australian agro-forest and fish (AFF) products with its five major partner countries. Quarterly data will be used for the period 1988Q1-2020Q4. Our findings support the MLC in case of the major share of Australian AFF trade. The implication is that if the market force depreciates Australian exchange rate (ER), the country’s AFF trade balance (TB) will improve in the long-run.

Keywords: Agricultural Trade Balance, Marshall-Lerner Condition, Australia.
JEL Classification: F12, F14

2.2. INTRODUCTION

Ever since the breakdown of Breton Woods System in the early 1970s, when previously fixed exchange rates (ERs) among major currencies were allowed to float, researchers across the world have shown their interest in the effects of ER on international trade. However, the results of their research in this issue have failed to reach any consensus and vary across countries, regions and commodities. Such a variation has led researchers to investigate various ER dynamics, namely impact of exchange rate changes on trade balance (TB) for countries or regions or commodities. The impact of ER changes on the international trade of a country or region is ambiguous, predominantly for three uncertain impacts: which are, firstly, it is not clear whether the Marshall-Lerner Condition (MLC) is valid; secondly, sectoral level general equilibrium effects may lead to a deterioration of a sector's net external position following a real exchange rate (RER) depreciation due to the resources and consumption relocation for ER change and; thirdly, the degree of openness of a country's international trade border. Most of the existing studies have evaluated the impact of ER on aggregate trade of the above mentioned dynamic issues, ignoring the potential differences of this impact across sectors. Very limited attention has been paid to individual sectors like agriculture, manufacturing, service or their further segregated subsectors.

Thus, whether the change in the exchange rate contributes to the change of net external position of a country's particular sector such as agricultural, fish and forest products is still a fundamental and basic empirical question. It may either improve or hurt this sector. Bahmani-Oskooee (1985) has taken initiative to fill this vacuum somewhat by analyzing the impact of ER on sectoral TB. However, either carefully or inadvertently, the agricultural sector is omitted from his analysis. Therefore, the objective of this paper is to empirically examine the validity of MLC - a famous theoretical phenomenon that foreshadows the impact of ER- regarding the net external TB of Australian AFF products with her five trading partners: USA, Japan, China, Korea and Thailand. Earlier studies for different countries and regions focused mainly on industrial or manufacturing products but not on non-durable AFF products **(**Backus et.al., 1994, Bahmani-Oskooee et.al. 2012, Gomes and Paz, 2005, Parikh, and Shibata, 2004, and Senhadji, 1998**)**. Due to their non-durable characteristic, high dependence on nature, long gestation period for production, and the difference in inventory preserving techniques, the response of ER changing on AFF products may differ from the response of the durable manufacturing products. Further, the impact may differ from other countries' AFF products for land abundant Australia - the most basic input of agricultural output. For this facet of AFF products this research is also a topical innovation and an attempt to fill up a long vacuum of the empirical research world.

Table 1: Contribution to AFF Trade by major 5 partners for the period 1988-2020.

Trading Partner of Australia	Percentage of Total AFF Imports	Percentage of Total AFF Exports
USA	11.23	8.31
Japan	10.15	13.01
China	8.16	20.50
Korea	7.25	7.22
Thailand	6.13	5.82

Source: Department of Foreign Affairs and Trade, Australia

Table 1 shows the trade picture of Australia with her five major trading partners. These five countries have constituted about 43 percent and 55 percent of Australian AFF imports and exports respectively in 2020. Since Australia is a land abundant country and AFF production needs intensive use of land resources, Australia has much scope to enlarge its contribution by AFF in its total trade share. By considering the above backdrop, this article takes the initiative to test the validity of the MLC between Australia versus her major five AFF products trading partners.

To that end, we present the literature review in Section II, outline the models and econometric technique in Section III, explain the results and, report the result summary in Section IV, and draw the conclusions in Section V.

2.3. LITERATURE REVIEW

Depreciation usually increases and decreases import and export prices respectively in terms of foreign currency. So foreigners see that exports are less expensive and the countrymen get that imports are more expensive. Thus it is widely believed that TB improves when depreciation takes the place of the ER of a country. However, later Marshall and Lerner have shown that TB change is mostly a phenomenon of elasticities of import and export, not only of ER. Thus, it is now an established fact that the MLC approach is one kind of rule of thumb that is used to predict whether RER depreciation improves the TB of a country. There have been many studies on this issue across countries, regions, and periods, some of those have already paid attention to the test of the ER sensitivity and status of the MLC in context of Australia. All of these studies are chronologically tabulated in Appendix 4.

First, Arndt and Dorrance (1987) take steps to analyze the Australian J-Curve, using a self-generated tabular approach for their paper. Based on their findings they opine that nobody can rule out of having J-curve effect on the current account (CA) balance of Australia. However, they conclude that not only ER but also the efficacy of MLC, the competitive power of Australian exporting goods, exogenous factors to change of terms of trade (TOT), and level of domestic or national aggregate spending are key factors to TB improvement.

However, in the next Felmingham (1988) reaches in a converse conclusion. He examines the impact of TOT change on Australian TB using an approach presented by Haynes and Stone (1982).calculating and subsequently constructing a table comprising series of Australian TB and TOT. He also defines TB by import-export ratio. Subsequently, he attempts to relate TB with the current and past values of TOT, and decides that there is no evidence of the Australian J-curve. His findings have subsequently been discussed and economists suggest that one probable weakness of his method is that perhaps his calculated TOT may have had a very low correlation with the actual ER of Australia at that time. Depreciation can change the TOT in either direction depending on the product of elasticities of the exports demand and imports supply. So, a more effective method to examine the impact of depreciation on TB is to relate the TB directly to ER not with else what Felmingham (1988) has not done.

To overcome the weakness of Felmingham's (1988)'s study, Karunaratne (1988) tries to investigate the link of Australian TB not only to its TOT, but also to REER. He also concludes that change in REER does not have any significant influence on the Australian CAB. His methodology also later criticized by Bahmani-Oskooee (2015) who has considered that there could be strong multicollinearity between the TOT and REER when they are both included in the same model which was perhaps not understood and, hence, addressed by Karunaratne.

None of the above three studies provides any concrete evidence of the nexus between Australian ER and TB in either the short-run, or the long-run. However, using quarterly data for the period of 1977Q1-1988Q4, Bahmani-Oskooee & Pourhyderian (1991) have got sufficient indication that J-curve notion is valid for Australia in the short-run; Further, their results show that devaluation of Australian Dollar also improves the TB in the long-run.

Bahmani-Oskooee and Niroomond (1998) criticize all the above researches noting that they have not followed proper econometric techniques due to the non-advancement of time series techniques until their study period. It is true that none of the above studies has tested unit root of the data used though all of them rely on the data with time series dimension. To overcome this fault they use Johansen co-integration technique for 30 countries time series data of different periods individually. Our country of interest, Australia, is also included in this research paper using the annual data for the period of 1960-1992. Addressing all the time series properties of the data this study finds econometrically significant evidence of MLC for Australia for the first time.

Gradually, more studies start to emerge for Australia. Mahmud et. al. (2004) checks MLC for six developed countries, Australia, Germany, Japan, Norway, UK and the USA by using the non-parametric technique resorting Kernel estimation approach to estimate import and export price elasticities to gauge the MLC. Their results suggest that MLC is valid only for Norway.

Bahmani-Oskooee *et. al.* (2005) further investigates the short- and long-run effect of REER depreciation on Australian aggregate TB with 23 trading partners on a bilateral basis. The study also uses the aggregate trading data for the USA, Japan, China, Korea, and Thailand, - the top five partners, they consider for this study where quarterly data over the 1973–2001 period and co-integration technique of ARDL bound testing and Error Correction (ECM) method are used. The results show that among the trading partners related to this study except Korea no other four countries support the J-curve phenomenon for Australia.

Again, Bahmani-Oskooee and Wang (2007) have criticized all the above studies because they are conducted by the data either between Australia and the rest of the world or between Australia and its individual trading partners aggregate data bases. So, these studies are suffering from aggregation bias. To overcome from this fault, Bahmani-Oskooee and Wang (2007) have used disaggregated data between Australia and its second largest trading partner - the USA. They test for the annual US-Australia bilateral trading data for totally 108 industries for the period of 1962–2003 using ARDL bounds testing and ECM approach for co-integration. Out of this 108 categories of products only 23 were AFF commodities. In this research they were able to discover J-curve effects only for 8 AFF commodities out of 23.

Furthermore, Bahmani-Oskooee and Wang (2009) have conducted another research adding two more years' data for the period of 1962-2005. In this paper they again use disaggregate trade data between Australia and the USA by commodity, and have estimated import and export demand models for the same 108 commodities. The results from the bounds testing approach to co-integration and ECM method indicate that in the long-run 41 export industries and 70 import industries are sensitive to the Australian RER.

Further, Bahmani-Oskooee et. al. (2017) criticized the study of Bahmani-Oskooee et. al. (2005) for using linear model. Using a linear ARDL approach Bahmani-Oskooee *et. al.* (2005) find that Australian bilateral trade, with each of the 23 partners, follows the J-curve effect in the model with the UK only. However, incorporating the ARDL model that allows for non-linear adjustment of RER changes, they find that the J-curve effect is valid for four more partners (India, Italy, South Africa & UK).

Bahmani-Oskooee and Harvey (2019) have applied non-linear models and asymmetric analysis approaches for testing the J-curve between Australia and her second largest trading partner - the United States – by using disaggregated data. However, this new approach also does not yield any significantly different outcomes to those of aggregate data or linear and symmetric analyses. They apply this new approach for the industry specific data to the trade flows of 123 industries traded between the United States and Australia and give evidence of an asymmetric J-curve in 28 industries. Additionally, they find short-run asymmetric effects of RER changes on the TB of almost all studies, short-run impact asymmetric effects in 27 industries, and significant long-run asymmetric effects in 56 industries.

We would like to keep our literature review limited to Australian perspective only, so, we have focused the RER-TB nexus on the Australian economy only. The findings from the above studies are mixed. All the papers before Bahmani-Oskooee and Wang (2007) suffers from aggregation bias where a significant price elasticities with one trading partner could be more than offset by an insignificant price elasticity with another partner. Neither do they follow proper econometric techniques. Moreover, some studies are not concentrated on the MLC meaning that the Australian AFF sector suffers from major knowledge gap regarding the MLC.

We have found only two studies on the MLC for Australian TB. Since they are pursued by aggregate data, these studies may suffer from aggregation bias. None of the papers above has concentrated on the MLC of Australian AFF products. According to our knowledge this is the first attempt to investigate the validity of the MLC for Australian AFF products. Since AFF commodities have some special properties that are dissimilar to industrial products, AFF products'

TB may exhibit different behavior than those of industrial commodities. Further, Australia has a vast land property, unlike the most of the countries in the world. AFF products need intensive use land input in the production process, so, the study has more importance for Australia than other countries involved in AFF trade since a land abundant country has a relatively higher potential for AFF trade. Likewise, AFF products have contributed only 20 percent to total Australian exports and 10 percent in overall imports in 2020. Since there are huge unemployed land in Australia the country has much scope for further improvement in AFF TB by producing more AFF products. It is therefore clear that the study may have ample importance for the overall Australian economy and the agricultural sector in particular.

2.4. THE MODEL, ECONOMETRIC TECHNIQUE AND DATA

Following Bahmani-Oskooee and Hosny (2013), Australian import demand from the partner country for commodity i would be as follows:

$$\text{Ln } IM^{1}{}_{i} = a + b \ln Y_{AUS.} + c \text{ Ln } \left(\frac{PIMi}{PDAUS}\right) + e_i \qquad (1)$$

Where IM_i is the imports of commodity i by Australia from the partner country, Y_{AUS} is Australian Real GDP, PM_i is the price of the imported product i and, PD_{AUS} is the domestic price level in Australia. In this model, Australian Real GDP and PIM_i/PD_{AUS} - the relative Import Price Index -- are assumed as the key determinants of imports. Considering the usual notion of the conventional economic theories, the sign of the estimated b and c should be positive and negative respectively.

To obtain comparatively more stable estimated coefficients, Bahmani-Oskooee and Hosny (2013) also recommends to convert equation (1) into a dynamic adjustment model by incorporating the short-run dynamic adjustment mechanism. Econometricians usually re-specify equation (1) by converting it into an Error Correction Model (ECM) proposed by Peseran *et. al*. (2001). Thus, our dynamic specification stands as equation (2) below, keeping coherence with the suggestion of Peseran *et al.* (2001) and Bahmani-Oskooee and Hosny (2013). Our empirical estimation will be based on time series analysis using data for the period of 1988Q1- 2020Q4 where the linear ARDL estimation technique is employed.

$$\Delta lnIM_t^i = \alpha + \sum_{j=0}^{n} \beta_j \Delta lnY_{AUS,I-J} + \sum_{j-0}^{n} \gamma_j \Delta \ln\left(\frac{PIMi}{PD_{AUS}}\right))_{t-j} + \sum_{j=1}^{n} \lambda_j \, \Delta lnIM_{t-j}^i + \sigma_0 lnIM_{t-1}^i + \sigma_1 lnY_{AUS,J-1} + \sigma_2 \ln\left(\frac{PIM}{PD_{AUS}}\right)_{T-1} + \varepsilon_t \qquad (2)$$

In equation (2) Pesaran *et. al.* (2001) recommends to apply a standard F-test with new critical values to establish the joint significance of the lagged level variable as a sign of co-integration. They also tabulated new critical values to interpret the degree of integration of the variables used in the model (2). Undeniably, variables could be I(0) or I(1), which are very common features of almost all macroeconomic variables. Hence, we believe that there is no need for pre-unit root testing. However, we have calculated and found they are stationary either in level or in first-differenced form, and (ready to share them on request). Once equation (2) is estimated, the coefficient estimates of the first-differenced variables reflect short-run effects. The long-run effects, i.e., the income and relative import price elasticities in equation (2) are obtained by the estimates of σ_1 and σ_2 that are normalized on σ_0.

Next, we formulate the demand function of partner countries X (= USA, Japan, China, Korea, and Thailand) for Australian AFF commodity exports of i (EX_i) as a function of the country's X income (Y_X) as in (3):

$$\text{Ln } EX^1{}_i = a' + b' \ln Y_{x.} + c' \text{ Ln } \left(\frac{PEXi}{PDx}\right) + e'_i \quad (3)$$

Again, we expect an estimate of b' and c' should be positive and negative respectively. Furthermore, the ECM model associated with equation (3) yields the following shape:

$$\Delta lnEX_t^i = \alpha' + \sum_{j=0}^{n} \beta'{}_j \Delta lnY_{X,I-J} + \sum_{j-0}^{n} \gamma'{}_j \Delta \ln\left(\frac{PEXi}{PD_X}\right)_{t-j} + \sum_{j=1}^{n} \lambda'{}_j \Delta lnEX_{t-j}^i + \sigma'{}_0 lnEX_{t-1}^i + \sigma'{}_i lnY_{X,J-1} + \sigma'{}_2 \ln\left(\frac{PEX}{PD_X}\right)_{T-1} + \varepsilon'{}_t \quad (4)$$

Once again, equation (4) is estimated, the short-run effects inferred by the estimates of coefficients related to first-differenced variables, and long-run effects are accompanied by the estimates of σ'_1 and σ'_2 normalized on σ'_0.

The ML condition will be satisfied if the both conditions are satisfied which are normalized relative price elasticities, σ_2 and σ'_2 are (i) negative and significant respectively in both model (2) and (4), and (ii) the summation of absolute values is more than one. The data, variables and traded AFF commodities are noted in Appendix 1 and Appendix 2, respectively.

2.5. RESULTS, DISCUSSION, AND RESULTS SUMMARY

Now we can discuss the results of the estimated error-correction models (2) and (4) for each of the five countries for individual AFF products that have been traded between Australia and five individual countries for the quarterly data over the period of 1988Q1-2020Q4. For this purpose we rely on the model of Bahmani-Oskooee and Hosny (2013) to estimate export and import demand elasticities, enforcing a maximum of four lags for each individual model for each first differenced variable using the latest version of E-views. In this case, we have used the Akaike Information Criterion (AIC) to define the optimum number of lags. Thus, every reported result is considered an optimum model. For our purpose, to infer the validity of MLC we need only long-run elasticities of the ECM model (2) and (4). So, we only report the estimated long-run coefficients of export and import demand functions. Since the short-run coefficients, are not related to our present concern; they are presentable on request. As estimation models are the same for each pair of countries, here we briefly point out the inference techniques.

Table 2: Bound of the ARDL F-test when sample size is 130 and degrees of freedom is 2

ARDL Bounds Test for the sample period 1988Q3-2020Q4 (observation = 132)

F-statistic with degrees of freedom k = 2 for each model of each country fair

Critical value Bounds Tabulated by Peseran

Significance	I(0) Bound	I(1) Bound
10%	2.63	2.35
5%	3.10	3.87
1%	4.13	5.00

Since the model is an ARDL type of error-correction model (ECM), we firstly have to confirm a significant F-statistic about the co-integration between dependent (first differenced of export or imports) and independent variables (income and relative price of exports and imports). This F-test statistic distribution table is tabulated by Peseran *et. al.* (2001) where a significance of calculated F-statistic indicates that relationship among the dependent and independent variables are meaningful (Table 2). After achieving a confirmed co-integrated relationship we can set out for other diagnostic tests. We report here five other relevant diagnostic tests. We estimated the error component term (ECT) widely known as ECM_{t-1} with imposing optimum lag. It is known as speed of convergence to the long-run equilibrium where higher value of significant negative ECM confirms higher speed towards convergence. The Lagrange Multiplier (LM) test result is used for testing the presence of serial correlation. Since our quarterly data size is 132 and Breush-Godfrey Serial Correlation LM test statistic is distributed as λ^2 with 2 (two) degrees of freedom with a critical value of 5.99. The RESET test developed by Ramsey is also reported to infer the functional specification of the model. This statistic is also distributed as λ^2 with degrees of freedom 1 (one) for each model. We have also applied the CUSUM and CUSUMSQ tests to determine stability of the short-run and long-run coefficient estimates where stable coefficients are denoted by "S" and the unstable ones by "US". Finally, we also tested the goodness of fit of the every model. To test this, instead of R^2, we have reported the numerical value of the adjusted-R^2. Since adding the unnecessary variable also increases R^2, we believe that adjusted-R^2 gives the true picture of goodness of fit of a model. The discussion of the results of the application of this econometric techniques for the five major AFF trading partner countries of Australia is noted below:

To this end, Table A1 of Appendix 5 reports the results of the import demand model and Table B1 is for the export demand model of Australia and US bilateral commodity level AFF trade. It is notable that as our sample size is 132 t-statistic, that is at least 1.646 (10% degrees of freedom) it is considered to be significant. By inspecting Table A1, it can be seen that the relative price of import coefficients has a negative and significant coefficient for 59.76% of AFF products imported to Australia from the USA, while in 56% of AFF products the income elasticity is positive, and the remaining 44% of them is negative. The negative elasticities imply that as the Australian economy grows, she produces very close substitute goods those belong to these 46% AFF products, which helps the country to lessen imports. However, net imports of Australian AFF trade will be increased as income increases since positive income elasticities are higher than negative ones. Table B1 presents the estimates of the demand by the US economy for Australian exports. It seems that as one of the major AFF trade partners of Australia, US income as a main long-run determinant of Australian exports in most of the AFF products, since 82% of total AFF trade carries a positive and significant coefficient. From Tables A1 and B1 it is observed that 59.76% and 61.63% of Australian AFF imports and exports with the USA satisfy the MLC, i.e., the sum of the absolute values of import and export price elasticities are greater than one, and relative price elasticities are individually negative and significant for both export and import demand functions.

Australian imports and exports with Japan are reported in Table A2 and B2 of Appendix 5, respectively. The relative price of import coefficients has negative and significant coefficient for

17 products amounting to 62.77% of AFF products imports of Australia from Japan. Eleven of these products, amounting to 47% of products, have price elasticity with more than one meaning that they are relatively price elastic. Total 91% AFF products imports have the income elasticity positive meaning that Australia has no substitute for those Japanese AFF products. That is, Australia has sufficient scope to think about to focus on AFF trade to reduce imports from Japan to improve the trade balance. Now, Table B2 for the estimates of the Australian exports demand by Japanese economy can be considered. It seems that as one of the Australian major partners, Japanese income is a main long-run determinant of Australian exports in most the AFF products, since they carry positive and significant coefficients. Negative relative exports price elasticity with significant t-statistics are revealed by about 54% AFF exports by Australia to Japan. From Tables A2 and B2 it is observed that about 62.77% and 53.82% of Australian AFF imports and exports respectively satisfy the MLC.

Table A3 and B3 of Appendix 5 report the results of the fitted imports and exports demand models respectively for Australian AFF products with China. By the visual inspection of Table A3 it is clear that the relative price of import coefficients are negative and significant for 74.05% of AFF products imports of Australia from China. Income elasticity is positive, and significant for 100 AFF imports meaning that imports are increased as income increases of Australia as she has no substitutable capacity for these AFF products. Additionally, the results of the bound tests confirm that Australian imports are co-integrated with Australian income or relative import prices or both for 100% of Australian AFF imports from China. Next, Table B3 describes the AFF exports function to China. Our estimation shows that for 88.99% AFF exports of Australia, Chinese income is a long-run determinant of Australian AFF products exports, since it carries a positive and significant coefficient. However, our main concern is regarding coefficients of relative exports price. It is significant and negative for more than 96% of exports to China which means that Australian AFF exports to China is highly price elastic. Finally, from Tables A3 and B3 it is observed that for 74% imports and 69% exports respectively between China and Australia AFF trade tends to satisfy the MLC.

Our next focus is on Table A4 and B4 of Appendix 5 to understand the status of Australian and Korean bilateral trade of AFF products. Table A4 shows that the relative price of import coefficients are negative and significant for about 53% of AFF products. While in 81% AFF products, the income elasticity is positive, meaning that Australian imports from Korea increase as the Australian income increases. Positive and significant elasticities imply that the Australian economy has no direct or indirect substitutability for 81% of Korean products. Next, Table B4 review the Australian AFF products demanded by the Korean economy. The relative price term carries a negative and significant coefficient for about 65% of total Australian AFF exports to Korea which are also passed by the bound test. From Tables A4 and B4 it is observed that about 53% Australian AFF imports and 65% Australian AFF exports satisfy the MLC.

Lastly, we look at the Table A5 and B5 which do the same work for the AFF commodity level import and export demand model of Australia with Thailand. It is observed that the relative price of import coefficients have negative and significant coefficients for 52.29% of AFF products are imported to Australia from Thailand. For 82% AFF products the income elasticity is positive. The positive elasticities imply that as the Australian economy grows, the country needs to import more goods from Thailand as she is unable to produce substitutes for those AFF products, which would worsen her trade balance. To analyze AFF exports to Thailand, we look at the Table B5. Like the above four countries Thai income is also a dominant long-run determinant of Australian exports for most of the AFF products, since it carries a positive and significant coefficient. Additionally, 78.26% of AFF trade carries negative and significant relative export price elasticity, implying that Australian AFF exports to Thailand are highly price elastic. Among them, 78.12% of exports satisfy almost all econometric tests, indicating that the estimated functions are reliable. From Tables A5 and B5 it is observed that for 52.29% and 78.12% Australian AFF imports and exports, respectively, with Thailand satisfying the MLC.

The summary of the above discussed results is presented in Table 3 below so that decision on MLC can be done easily.

Table 3: Percentage of AFF Imports and Exports of Australia Endorsing MLC

Name of Australian Trading Partner	Percentage Share of Imports Endorses ML Condition	Percentage Share of Exports Endorses ML Condition
1.United States	60	62
2.Japan	63	54
3.China	74	69
4.Korea	53	65
5.Thailand	52	79

Table 3 shows what percentage of Australian AFF trade with her major five partners satisfy the MLC condition. It is clear that the majority of the AFF trade share confirms the efficacy of this condition so it can be claimed that the depreciation of the Australian Dollar (AUD) either by market forces or by any other means would improve the Australian AFF TB in the long-run. This finding has important implications for policy makers of Australia. Moreover, the results suggest that some relevant policies, like export promotion for raising the return on export and import substitution measures, must be taken into consideration to improve the AFF TB, and also ER depreciation through monetary and fiscal policy can be an easy way in this regard.

2.6. CONCLUSION AND POLICY IMPLICATIONS

Economists have been discussing the issue of ER impact on TB at least for the last five decades. Hence, there is a great deal of research on this topic. One of the branches of this topic is investigation of Validity of Marshall-Lerner Condition (MLC). MLC states that if the sum of the price elasticities of import and export demands of a country adds up to more than one, currency depreciation is expected to improve the country's TB in the long-run. The findings of this research state that this condition is valid for the majority portions of imports and exports by Australian AFF goods for each of her major five partners. It can be now concluded that depreciation of the Australian Dollar either due to market forces or for anything else that may improve the AFF TB of Australia with the major trading partners.

To avoid aggregation bias we estimated our proposed model by commodity-wise data. Further, since the data used in this paper is time series in nature we have conducted unit root test to select the right model for estimation. Accordingly, we adopted the ARDL technique for the purpose of estimation. The results of our model indicate that the MLC phenomenon works for the fitted data and model; that is after passing through of depreciated RER, TB will ameliorated. This happens, perhaps, due to the increase and decrease of the profit margin of Australian AFF exporters and importers, respectively. Our estimation technique and results are reliable. Therefore, we believe any policy based on findings of this paper will bring good fortune for the Australian AFF trade balance. Further, besides ER, income also plays an important role in determining the Australian AFF TB with the major five AFF trade partners.

Australia follows a principle of free market and liberalized borders in trade policy. The country also follows a market based flexible exchange rate policy. Therefore, the country does not have any option to manipulate its ER for the improvement of trading account (trade balance), current account, foreign exchange reserve etc. In this backdrop, the country can use monetary and fiscal policy to convey the ER to its' intended direction. In this way, Australian central bank has the scope to depreciate ER. Our findings suggest if the Australian central bank and government initiate proper monetary and fiscal measures, respectively, the AFF TB of Australia will be improved.

Last but not least, our findings oppose the proposition of Burda and Gerlach (1992) that durable products should be relatively more sensitive to the changes of ER than non-durable products. Since AFF products are mostly non-durable in nature and MLC is confirmed by major parts of exports and imports for each of the five largest AFF trade partners of Australia, it is clear that this proposition is not supported by our current study.

2.7. REFERENCES

Arndt, H. W., and Dorrance, G., (1987) "The J-Curve," The Australian Economic Review, 1st Quarter, 1987, PP 9-19.

Felmingham, B. S., (1988) "Where is the Australian J-Curve?" Bulletin of Economic Research, January 1988, PP 43-56.

Karunaratne, Neil Dias, (1988) "Macro-Economic Determinants of Australia's Current Account, 1977-1986," Weltwirtschaftliches Archiv, Band 124, Heft 4, 1988, PP 713-728

Bahmani-Oskooee and Pourheydarian, M. (1991) "The Australian J-curve: A Reexamination", International Economic Journal, vol. 5, PP. 49–58.

Syed F Mahmud, Aman Ullah and Eray Yucel, (2004) "Testing Marshall-Lerner Condition: A non-parametric approach", Applied Economic Letters, 11, PP 231-236.

Bahmani-Oskooee, M. and Niroomand, F. (1998). "Long-run Price Elasticities and the Marshall–Lerner Condition Revisited", Economics Letters, Vol. 61, PP 101–109.

Bahmani-Oskooee, M. and Wang, Y. (2007). "US–China Trade at the Commodity Level and the Yuan–Dollar Exchange Rate", Contemporary Economic Policy, Vol. 25, PP. 341–361

Bahmani-Oskooee, M., Goswami, G. G. and Talukdar, B. K. (2005) "The Bilateral J-Curve: Australia Versus Her 23 Trading Partners". Blackwell Publishing Ltd/University of Adelaide and Flinders University 2005.

Bahmani-Oskooee, M., and Wang, Y. (2007) “The J-curve at the Industry Level: Evidence from Trade between the US and Australia”. Journal compilation. Blackwell Publishing Ltd/University of Adelaide and Flinders University.

Bahmani-Oskooee, M., and Wang, Y (2008) “Impact of Exchange Rate Uncertainty on Commodity Trade between the US and Australia”. Australian Economic papers. The Authors Journal compilation, 2008 Blackwell Publishing Ltd/University of Adelaide and Flinders University

Bahmani-Oskooee, M., and Wang, Y (2009) “Exchange Rate Sensitivity of Australia’s Trade Flows: Evidence from Industry Data”. The Manchester School VOL 77 No. 1 January 2009 PP. 1463–6786 1–16

Bahmani-Oskooee, M., Shafiullah, M. and Islam, Faridul (2009) “The Bilateral J-Curve in Australia: a Nonlinear Reappraisal”. Flinders University and University of Adelaide and John Wiley & Sons Australia, Ltd

Bahmani-Oskooee, M., and Harvey, H. (2019). “A nonlinear approach to the U.S.–Australia commodity trade and the J-curve: Evidence from 123 industries”. Australian Economic papers. 2019 John Wiley & Sons Australia, Ltd. 38, PP. 318–363

Bahmani-Oskooee, M. and Baek, J (2015) “The Marshall_Lerner Condition at commodity level: Evidence from Korean-US trade”. Economic Bulletin, Volume 35, Issue 2.

Bahmani-Oskooee, M. and Hosny A. (2013) “Long-run price elasticities and the Marshall=Lerner Condition: Evidence from Egypt-EU commodity trade”, European Journal of Development Research, 25, PP. 695-713.

Bahmani-Oskooee (1985), “Devaluation and the J-curve: Some evidence from LDCs”. The review of Economic and Statistics. Vol. 67. No. 3. PP. 500- 504.

Backus, D. K., P. J. Kahoe, and F. E. Kydland (1994), “Dynamics of the trade balance and the Terms of Trade: J-curve”. American Economic Review, 84 (1994): PP. 84-103.

Burda, M. C. and Gerlach, S. (1992). ‘Intertemporal Prices and the US Trade Balance’, American Economic Review, Vol. 82, PP. 1234–1253.

Pesaran, M. H., Shin, Y. and R. J. Smith, (2001), “Bounds testing approaches to the analysis of level relationships”. Journal of Applied Econometrics, 16, PP. 289–326.

Senhadji, (1998), Time-series estimation of structural import demand equations: a cross-country analysis, IMF Staff Paper., 45 (2) (1998), PP. 236-268

Gomes, F. and L. Paz (2005). “Can real exchange rate devaluation improve the trade balance? The 1990-1998 Brazilian case,” Applied Economics Letters 12(9): PP. 525–528.

Parikh, A. and M. Shibata (2004). “Dynamics of the relationship between the terms of trade and the trade balance in developing countries of Asia, Africa, and Latin America,” Journal of Quantitative Economics 2: PP. 104–21.

Senhadji, A. S. (1998). “Dynamics of the trade balance and the terms of trade in LDCs: The S-curve,” Journal of International Economics 46(1): PP. 105–31.

2.8. APPENDIX 1

2.8.1. Data and Information and Sources

Quarterly data over the 1988Q1 – 2020Q4 period are used to carry out the empirical analysis. The data categories and source are as follows:

2.8.1. List of Variables

IMi = For each Commodity i, IM is the volume of Australia Imports from the trading partner country X. It is defined as the ratio of the value of Australian Imports from the trading partner X over the respective import price index of commodity i.

EXi = For each commodity i, EX is the volume of Australian exports to the trading partner country X. It is defined as the ratio of Australian exports to the trading partner country X over the respective exports price index of commodity i.

Bilateral Imports and exports values are collected from the Department of Foreign Affairs and Trade of Australian Government. (Data period 1988Q1-2020Q4)

Y_{AUS} = Australian Real GDP. The data come from International financial Statistics (IFS), published by IMF.

Y_X = Real GDP of Australian Trading partner country X (=US, Japan, China, Korea, & Thailand). Data source: IFS.

PMi = For each commodity i, PM is import price index of Australia, collected from IFS

PD = Domestic Price Level in Australia, CPI data is used as proxy data for PD collected from IFS.

PXi = For each commodity i, PX is defined as export price index of Australia, collected from IFS.

P_{AUS} = The Price Level in the US. CPI data used as proxy for P^{AUS} collected from IFS.

2.8.2. APPENDIX 2

List of AFF Commodities Traded by Australia considered in this research

A = Live Animals

B = Meat and edible meat offal

C = Fish and crustaceans, molluscs, and other aquatic, invertebrates

D = Diary Produce

E = Animal originated products

F = Trees and other plants, live

G = Fresh vegetables and certain roots and tubers

H = Fruit and nuts, edible

I = coffee, tea, mate, and spices

J = Cereals

K = Products of milling Industry

L = Oil seeds and oleaginous fruits

M = Lac; gums, resins and other vegetable saps and extracts

N = Vegetable plaiting materials

O = Animal or vegetable fats and oils and their cleavage products

P = Cocoa and Cocoa preparations

Q = Preparations of cereals, flour, starch or milk

R = Preparations of vegetables, fruit, nuts, or other parts of plants

U = Food Industries, residuals, and Wastes Thereof

V = Tobacco and manufactured tobacco substitutes

W = Salt

X = Milk, milk powder, butter, cheese etc.

Y = Root crops and plants

Z = Dry edible nuts and vegetables

A1 = Round wood, swan wood, timber etc.

B1 = Aquaculture, hatcheries and nurseries products

C1 = Fertilizers originated from natural products

D1 = Tanned, processed and raw hides

E1 = Non-fish sea extracts

F1 = Organic fertilizer and active agents

G1 = Residues and waste from the food industries; prepared animal fodder

I1 = Products of animal origin, not elsewhere specified or included

J1 = Wool, fine or coarse animal hair, and animal hair yarn

L1 = Fur skins, leather etc.

M1 = Feathers and downs prepared

S = Miscellaneous edible preparations

T = Beverages, spirits and vinegars

N1 = Furniture

O1 = Miscellaneous edible products

P1 = Sugars and sugar confectionary

2.8.3. APPENDIX 3

Literature on Nexus between Exchange Rate and Trade Balance of Australia

Author (Publishing Year)	Data Type & Period	Australian Trading Partner Name	Methodology Used	Dependent Variable	Explanatory Variable(s)	Result of Ex. Rate Sensitivity, or ML Condition
Arndt & Dorrance (1987)	Yearly, 1955-1985	Rest of the World	Tabular Form	Exports-Imports	Number of Macroeconomic Variables like Elasticities of Exports, & Imports, International Competitiveness, Terms of Trade, & National Spending	Elasticities of supply and demand for imports and exports; Competitiveness of Trading Goods; Changes in the terms of trade; and Domestic Spending
Felmingham (1988)	Yearly, 1958-1986	Rest of the World	OLS	Ratio of Imports and Exports	Different Macroeconomic Variables	No evidence of the Australian J-curve
Korunaratne (1988)	Yearly, 1960-1986	Rest of the World	Haynes and Stone (1982)	Exports, and Imports	REER, Money Supply, Economic Growth	REER has no significant impact on Australia's CAB
Bahmani-Oskooee & Pourhyderian (1991)	Quarterly, 1977-1988	11 OECD Countries	OLS	Exports-Imports	Domestic RGDP, World RGDP, Domestic Money Supply, World Money Supply, Domestic Price Level and World Price Level.	J-curve is valid in the long-run for Australia
Bahmani-Oskooee & Niroomond (1988)	Annual, Aggregated, 1960-1992	30 OECD Countries	Johansen Co-integration Technique	Export, Import	Ratio of Domestic Import Price & Domestic Price Level, Importer GDP, World GDP	MLC is satisfied for All 30 countries
Mahmud et. al. (2004)	Quarterly, Aggregated, 1957-2000	Australia, Germany, Japan, Norway, the UK	Non-Parametric	Export, Import	Ratio of Domestic Import Price & Domestic Price Level, Importer GDP, World GDP	MLC is satisfied only in case of Fixed Exchange Rate Regime

		and the USA				
Bahmani-Oskooee et. al. (2005)	Quarterly, Aggregated, 1973-2001	23 Trading Partners	ARDL, ECM	TB = Import Export Ratio	Exporter Income, Importer Income, Real Ex. Rate	Very Limited Support for J-curve Phenomenon
Bahmani-Oskooee & Wang (2007)	Annual, 108 Commodities, 1962-2003	The USA	ARDL, ECM	TB = Import Export Ratio	Exporter Income, Importer Income, Real Ex. Rate	64 commodities have short-run, & 35 commodities have long-run impact by REX depreciation
Bahmani-Oskooee & Wang (2008)	Annual, 107 Commodities, 1962-2003	The USA	ARDL, ECM	Exports, Imports	Exporter Income for Export model, Importer Income for import model, Real Ex. Rate, Variance of 12 Month REX	60% commodities have short-run impact. But very few commodities have long-run impacts. Number of commodities having Impact for Imports are double than Exports
Bahmani-Oskooee & Wang (2009)	Annual, 108 Commodities, 1962-2005	The USA	ARDL, ECM	Exports, Imports	Exporter Income, Importer Income, Real Ex. Rate	Exports of 41 and Imports of 70 commodities are REX sensitive
Bahmani-Oskooee et. al. (2017)	Quarterly, Aggregated, 1971-2015	23 Countries	ARDL, ECM	TB = Import Export Ratio	Exporter Income, Importer Income, Real Ex. Rate	J-curve notion valid only for 5 countries
Bahmani-Oskooee & Harvey (2019)	Monthly, 123 Commodities, 2002-2018	The USA	ARDL, ECM	TB = Import Export Ratio	Exporter Income, Importer Income, Real Ex. Rate	23 industries support J-curve notion only in the short-run

2.8.4. APPENDIX 4

Table A1: The **Results of the Fitted Model to Australian Imports from the USA**

Item	Contribution in total imports	Contribution by Significant items	Import from the USA										Absolute Value of Import Elasticity	Absolute Value of Export Elasticity	Summation of Elasticities
			Ln(RGDP)	Ln(RIMP)	Constant	F-Test	ECM(t-1)	LM	RESET	CUSUM	CUSUMSQ	Adj-R^2			
A	3.36	3.36	-0.9598	-0.6298	10.1266	16.3757	-0.1228	0.5818	1.9164	S	S	0.21	0.6298	0.7389	1.37
			(-3.7259)	-2.0719	-3.8258		-1.7329								
B	3.30	3.30	-1.2029	-0.4130	- 14.0342	35.2595	-0.1831	0.5643	16.3728	S	S	0.10	0.4130	0.9215	1.33
			(-2.5346)	-1.8165	-2.6957		-1.7344								
C	3.36		-0.1497	0.0888	-1.2969	42.3983	-0.0409	2.6418	0.4206	S	US	0.13	0.0888	0.0876	
			(-1.2702)	0.5650	-1.1349		-0.4445								
D	3.40	3.40	-0.2688	-0.6658	-4.0967	43.4960	-0.5183	0.0746	14.0175	S	S	0.11	0.6658	0.7415	1.41
			(-1.599)	-2.4289	-2.1726		-1.7714								
E	3.57		-0.1079	-0.0008	-0.9562	28.6470	-0.6597	2.9437	2.0795	US	S	0.18	-0.0008	0.0737	
			(-1.0897)	-0.0067	-1.0493		-0.9852								
F	1.87	1.87	-0.4593	-0.6119	-3.6103	42.3843	-0.2014	0.9555	0.9555	US	S	0.22	0.6119	0.5866	1.20
			(-3.0044)	-2.2632	-2.4769		2.4617								
G	3.72	3.72	-0.1320	-0.3172	-0.7719	27.6913	-0.1208	0.9397	19.1127	S	S	0.13	0.3172	0.8691	1.19
			(-2.2184)	-2.8010	-1.6154		-1.6779								
H	2.57	2.57	-0.7315	-0.7868	-8.5003	43.6697	-0.2418	0.9703	10.4699	US	S	0.14	0.7868	0.2934	1.08
			(-4.556)	-4.4631	-4.6852		-1.8156								
I	2.87		-0.0331	-0.1561	-0.4221	34.4620	0.0551	24.5170	10.3569	S	US	0.20	0.1561	0.4981	
			(-0.3863)	-1.2591	-0.5745		0.4896								
J	3.10	3.10	-0.3927	-0.1605	-3.7040	31.9244	-0.2113	0.2079	0.1428	S	S	0.28	0.1605	1.1702	1.33
			(-2.1958)	-1.6520	-2.0107		-1.9439								
K	3.15		-0.3895	-0.0736	-4.1238	43.0849	-0.0169	2.3318	2.0304	US	US	0.09	0.0736	0.2286	
			(-2.6764)	-0.5410	-2.7783		-0.1870								
L	3.93		0.0538	0.1162	0.3394	33.0474	-0.0028	1.1287	2.1017	S	US	0.11	0.1162	0.1688	
			0.7353	0.6523	0.4627		-0.0312								
M	3.32	3.32	0.1247	-0.7749	-1.1889	32.6245	-0.1133	1.0919	0.7999	US	S	0.18	0.7749	0.3707	1.15

			1.0309	-1.7648	-1.1005		-1.7455								
N	2.87	2.87	-0.1069	-0.5454	0.4761	30.1601	-0.2202	3.2678	17.2678	S	S	0.10	0.5454	1.0501	1.60
			-0.8896	(-1.8649)	0.4096		-1.7424								
O	3.49		0.3466	-0.2696	-3.8898	44.0286	-0.1247	5.0593	0.4015	US	S	0.08	0.2696	0.2072	
			2.7567	-1.5255	-2.7651		-0.9786								
O1	3.88	3.88	0.4165	-0.2345	-3.8532	44.0922	-0.1477	0.9183	21.4847	S	S	0.09	0.2345	1.2101	1.44
			3.8457	-2.2381	-4.0163		-1.6858								
P1	3.58	3.58	0.1948	-0.2442	-2.2161	28.4390	-0.2294	0.7013	12.2248	US	S	0.08	0.2442	0.8264	1.07
			1.7053	-1.8962	-1.9518		-1.6916								
P	3.36		-0.0686	-0.4826	-0.0658	39.1044	-0.0112	3.8966	16.7922	S	US	0.10	0.4826	0.4897	
			-0.4786	-2.7339	-0.0473		-0.1228								
Q	3.69		0.0366	-0.3221	-0.8932	33.1720	0.0502	7.0807	8.5126	S	S	0.23	0.3221	0	
			0.2668	-2.7351	-0.6947		0.4796								
R	3.99	3.99	0.3393	-0.2034	-3.7084	42.4244	-0.1653	0.7463	1.0365	S	S	0.31	0.2034	0.8737	1.08
			2.4649	-1.7415	-2.7036		-1.7079								
S	4.26	4.26	0.4080	-0.8743	-4.1218	33.8331	-0.2227	0.1211	29.2505	US	S	0.07	0.8743	0.2065	1.08
			1.7790	-1.9211	-1.9150		-2.2743								
T	4.34		0.4075	-0.1671	-4.4058	44.5184	0.1531	36.1372	10.4831	S	US	0.24	0.1671	0.4278	
			2.3996	-1.3113	-2.3510		1.1178								
U	4.57	4.57	0.5973	-0.4906	-5.0289	9.0765	-0.4368	0.8389	0.0151	S	S	0.22	0.4906	1.1233	1.61
			2.3873	-2.1268	-2.2699		-1.8395								
V	3.43	3.43	-0.3344	-0.3761	4.9232	40.8721	-0.6628	1.2509	0.8123	US	S	0.16	0.3761	1.9925	2.37
			-1.8934	-1.7655	2.4145		-2.8306								
W	3.74		0.0528	0.0682	-0.0156	20.9924	-0.0421	8.2262	5.9769	S	S	0.17	0.0682	0.2044	
			0.9024	0.4662	-0.0239		-0.3925								
X	3.77	3.77	0.7708	-0.4738	-8.9554	35.9753	-0.2663	0.2525	1.7614	S	S	0.18	0.4738	0.6305	1.10
			3.2306	-1.7855	-3.4547		-1.7014								
Y	4.74		0.1608	-0.1050	-1.5274	24.9533	-0.0799	6.0589	7.1748	S	S	0.17	0.1050	0.2129	
			1.7217	-0.7295	-1.7712		-0.0825								
Z	4.77	4.77	0.1482	-0.8384	-1.3945	35.6958	-0.5633	0.3287	0.3287	US	S	0.27	0.8384	0.1932	1.03

	0		1.6988	-2.2237	-1.8194		-2.3367								
A1	0	0	…	…	…	…	…	…	…	…	…	…	0.00	1.2142	1.21
Total	100.00	59.76	…	…	…	…	…	…	…	…	…	…	…	…	…

Table B1: **The Results of the Fitted Model to Australian Exports to the USA**

Export to USA													Absolute Value of Import Elasticity	Absolute Value of Export Elasticity	Summation of Elasticities
Item	Contribution	Significant	Ln(RGDP)	Ln(REXP)	Constant	F-Test	ECM(t-1)	LM	RESET	CUSUM	CUSUMSQ	Adj- R^2			
A	2.98	2.98	0.3384	-0.7389	-2.6258	30.8554	-0.1090	0.0252	0.5573	US	S	0.09	0.6298	0.7389	1.37
			1.6678	-2.0013	-1.1221		-2.0103								
B	5.77	5.77	0.2209	-0.9215	-2.5654	30.1012	-0.7739	2.3643	1.1756	S	S	0.19	0.4130	0.9215	1.33
			2.2964	-1.9915	-2.3967		-1.8619								
C	4.42		0.0273	0.0876	0.0038	30.3521	-0.2152	15.4144	30.2153	S	S	0.20	0.0888	0.0876	
			0.2883	0.6001	0.2229		1.7464								
D	4.09	4.09	0.1451	-0.7415	-1.0980	20.5996	-0.4216	1.2999	3.5320	S	S	0.13	0.6658	0.7415	1.41
			1.7421	-1.8409	-0.9212		-2.2228								
E	3.63		0.3184	0.0737	-3.7884	34.5164	-0.0014	0.2273	0.3868	US	US	0.06	0.0008	0.0737	
			1.6026	0.3887	-1.6545		-0.0158								
F	3.02	3.02	-0.1792	-0.5866	2.8984	35.3663	-0.6504	1.3702	13.2954	S	S	0.27	0.6119	0.5866	1.20
			-2.4325	-1.9421	2.8702		-1.8418								
G	3.10	3.10	0.8723	-0.2691	-1.4559	39.5417	-0.0868	1.9711	1.8856	US	S	0.12	0.3172	0.8691	1.19
			2.6668	-1.6619	-0.9678		-1.9521								
H	4.21	4.21	0.4148	-0.2934	-4.2835	24.7941	-0.4417	1.7409	14.1675	US	S	0.18	0.7868	0.2934	1.08
			2.5373	-1.7183	-2.4819		-1.7721								
I	2.33		1.3001	0.4981	-15.4957	39.0607	-0.0129	1.3715	4.1437	S	S	0.15	-0.1561	0.4981	
			4.1713	1.9634	-4.0954		-1.9812								
J	2.02	2.02	0.4942	-1.1702	-8.4605	29.1891	-0.8839	0.9066	0.6012	S	US	0.11	0.1605	1.1702	1.33
			1.8809	-1.8820	-1.2713		-3.0434								
K	4.40		0.2012	-0.2286	-2.7746	25.4669	0.0469	5.3218	4.5849	S	S	0.10	0.0736	0.2286	
			1.7673	-1.5231	-1.9435		0.4808								
L	3.92		0.1474	-0.1688	-1.9018	35.9269	-0.0061	0.5510	1.3612	S	S	0.06	0.1162	0.1688	
			0.8637	-0.7795	-0.9957		-0.0676								
M	3.39	3.39	0.3503	-0.3707	-3.4754	36.4711	-0.3262	0.6276	10.8550	US	S	0.20	0.7749	0.3707	1.15
			1.9127	-1.9596	-1.1737		-2.2868								
N	0.71	0.71	-0.5583	-1.0501	5.4103	27.7169	-0.4162	1.3287	0.4353	S	S	0.15	0.5454	1.0501	1.60
			-1.3398	-1.7319	1.0922		-1.6766								

O	3.43		1.3067	-0.2072	-16.5179	23.2931	0.0174	12.5075	27.3799	S	US	0.25	0.2696	0.2072	
			4.4223	-1.0660	-4.5397		0.1800								
O1	3.35	3.35	0.3715	-1.2101	-4.7417	44.2206	-0.2074	3.1144	0.6557	S	S	0.15	0.2345	1.2101	1.44
			3.2504	-1.8251	-3.3176		2.1802								
P1	4.30	4.30	-0.1693	-0.8264	2.3057	36.2424	-0.2608	1.7994	0.0486	S	S	0.14	0.2442	0.8264	1.07
			-1.2923	-1.9195	1.4986		-2.1583								
P	2.35		1.1775	0.4897	-13.6656	19.8659	-0.0229	4.8770	13.8689	S	US	0.28	0.4826	0.4897	
			4.6412	1.6423	-4.6247		-0.2498								
Q	0												0.3221	0	
R	3.79	3.79	0.5828	-0.8737	-7.1413	41.8912	-0.0914	2.6071	7.0169	S	S	0.19	0.2034	0.8737	1.08
			3.6292	-1.8631	-3.6803		-2.3198								
S	3.66	3.66	0.4174	-0.2065	-5.4825	37.1193	-0.1433	0.5593	2.5051	US	S	0.09	0.8743	0.2065	1.08
			2.2747	-1.9660	-2.3899		-3.0366								
T	5.06		0.1391	0.4278	-0.9236	36.9875	-0.1769	30.5338	9.5261	S	S	0.18	0.1671	0.4278	
			1.1980	3.7524	-0.6643		-1.2308								
U	3.57	3.57	1.3675	-1.1233	-17.0383	35.4665	-0.2532	1.8719	2.3262	S	US	0.13	0.4906	1.1233	1.61
			3.3582	-2.3747	-3.3938		-2.2348								
V	1.34	1.34	2.2320	-1.9925	-24.9899	16.3557	-0.3787	1.0362	1.0362	S	S	0.19	0.3761	1.9925	2.37
			4.0998	-3.8156	-4.0270		-1.9950								
W	3.84		0.1559	-0.2044	-2.0280	40.3070	-0.0124	1.5231	13.4631	S	S	0.15	0.0682	0.2044	
			1.0775	-1.2395	-1.2234		-0.1360								
X	4.90	4.90	0.6394	-0.6305	-1.1321	33.8081	-0.9185	0.4345	-0.7714	S	S	0.11	0.4738	0.6305	1.10
			1.8513	-1.7618	-0.8107		-3.2017								
Y	4.99		-0.0686	0.2129	1.7030	37.3599	-0.0099	0.8612	14.3713	S	US	0.17	0.1050	0.2129	
			-0.4095	0.7526	0.7934		-0.1080								
Z	5.04	5.04	-0.2553	-0.1932	3.6176	34.8952	-0.3843	0.2584	33.5122	US	S	0.13	0.8384	0.1932	1.03
			-1.0244	-1.7234	1.2992		-2.1445								
A1	2.39	2.39	1.3706	-1.2142	-17.5252	8.8040	-0.1256	0.7844	0.7844	US	S	0.21	0.00	1.2142	1.21
	0		4.1268	-2.5406	-4.2449		-2.3545								
Total	100.00	61.63	….	….	….	….	….	….	….	….	….	….	…	…	…

Table A2: **The results of the Fitted Model to Australian Imports from Japan**

Item			Imports from Japan			

	Contribution in total imports	Contribution by Significant items	Ln(RGDP)	Ln(RIMP)	Constant	F-Test	ECM(t-1)	LM	RESET	CUSUM	CUSUMSQ	Adj-R^2	Absolute Value of Import Elasticity	Absolute Value of Export Elasticity	Summation of Elasticities
A	4.42	4.42	1.9678	-2.2048	-20.8539	7.4503	-0.5028	1.4751	0.7576	S	S	0.31	2.2048	1.0922	3.30
			2.4513	-2.5579	0.0239		-6.4138								
B	2.28	2.28	-1.4534	-2.2440	17.1473	25.5439	-0.1795	0.2979	2.3185	S	S	0.24	2.2440	0.1585	2.40
			-1.4912	-2.0851	1.5211		-1.8167								
C	3.77		0.0873	-4.9365	-0.0781	30.6034	-0.3975	0.5348	10.6198	S	US	0.34	4.9365	0.3129	
			0.7496	-2.9300	-0.0593		-3.6973								
D	2.14	2.14	0.1041	-11.4100	0.9321	5.9842	-0.2343	1.4280	9.3766	S	US	0.18	11.4100	1.0157	12.43
			0.1720	-5.4849	0.1441		-2.4672								
E	3.62	3.62	0.5304	0.8776	-4.8789	7.1713	-0.1661	1.2771	0.4824	S	S	0.22	0.8776	1.1095	1.99
			1.7441	2.3039	-1.3377		-1.7347								
F	3.53	3.53	1.8136	-2.7158	-19.8350	10.6951	-0.1911	1.8047	2.9997	US	s	0.20	2.7158	0.5523	3.27
			2.8799	-1.8475	-2.7636		-2.0985								
G	2.14		0.5593	-2.1710	-12.4954	26.4032	-0.0845	2.1625	10.6539	S	S	0.16	2.1710	0.1488	
			0.2234	-1.9845	-0.9628		-1.8843								
H	2.41		0.7627	-0.4118	9.0352	26.2828	-0.2547	0.0552	1.0604	US	US	0.23	0.4118	0.0522	
			0.6347	-0.3205	0.5158		-0.6268								
I	4.17	4.17	7.2575	-1.2008	2.2619	18.4778	-0.5757	2.1097	4.1369	S	S	0.38	1.2008	0.1753	1.38
			4.2908	-1.8850	3.5126		-3.0663								
J	4.63		2.4159	-1.2708	3.0943	8.6600	-0.4008	2.6982	5.4635	S	S	0.22	1.2708	0.1561	
			1.7056	-2.4631	2.3601		-5.5307								
K	1.86	1.86	0.6634	-0.1279	-7.4202	19.0565	-0.0915	0.2605	0.8498	US	S	0.48	0.1279	1.1169	1.24
			0.7643	-2.2078	1.6070		-1.9856								
L	1.06		0.3082	-0.2986	-3.4694	12.4412	-0.0256	3.4236	1.0030	S	US	0.14	0.2986	0.1992	
			0.5277	-0.4797	-0.5159		-1.1832								
M	3.56		4.2918	-1.2905	6.5225	20.3703	-0.3537	45.9569	21.2147	US	S	0.26	1.2905	0.3302	
			2.4408	-1.8724	2.8251		-3.3188								
N	3.89	3.89	3.9160	-2.2443	0.7448	25.2034	-0.0645	0.9852	0.3371	US	S	0.25	2.2443	0.3194	2.56
			0.9311	-2.5057	3.3667		-3.5220								
O	4.47	4.47	2.2385	-2.2517	0.1583	28.9018	-0.1261	0.7492	1.2139	S	S	0.18	2.2517	0.8489	3.10
			0.4934	-2.4482	0.3195		-2.4017								
O1	3.73		0.6859	-1.6860	-10.4509	42.3114	-0.2424	12.1326	37.8437	S	S	0.33	1.6860	0.0801	

			4.4773	-3.8974	-4.3470		-2.5702								
S1	3.75		0.4848	-1.5472	-4.4333	33.758 8	-0.3429	11.865 0	62.7327	US	S	0.29	1.5472	1.5163	
			3.0943	-3.2489	-2.7116		-3.9148								
P	3.84		0.2529	-1.2906	-2.1754	28.235 8	-0.2086	44.628 7	9.7795	US	US	0.24	1.2906	0.3937	
			1.8471	-1.8607	-1.3114		-2.1454								
Q	3.86	3.86	0.3937	-0.7232	-4.0485	46.053 7	-0.1278	2.2258	0.5617	S	S	0.29	0.7232	0.3309	1.05
			2.0741	-1.9709	-1.9577		-2.9658								
R	3.87		0.9202	-1.5289	-8.9915	42.959 9	-0.4638	18.800 2	60.3773	S	US	0.32	1.5289	0.8244	
			4.4193	-3.5513	-4.2562		-4.5357								
S	3.88	3.88	-0.3421	-0.8538	-0.6545	33.605 2	-0.3348	1.8046	11.2913	US	S	0.32	0.8538	0.7637	1.62
			-4.0356	-2.1309	-0.6413		-2.0150								
T	0.18		1.0935	-2.3262	-3.9129	17.079 9	-0.2614	5.1948	0.5917	S	US	0.28	2.3262	1.1959	
			0.7937	-1.7688	-0.7431		-0.2851								
U	4.46	4.46	6.1498	-3.1826	-7.2730	32.713 7	-0.0697	0.8698	1.7416	US	S	0.41	3.1826	1.1926	4.38
			3.2772	-2.0734	-2.0754		-1.9970								
V	4.56	4.56	0.9887	-1.3127	11.8014	24.081 5	-0.1841	0.5392	0.3199	S	S	0.24	1.3127	0.0888	1.40
			0.9141	-2.0112	2.9229		-1.9251								
W	6.65	6.65	2.3525	-3.1818	4.1057	10.689 0	-0.5492	0.8129	0.6445	S	S	0.12	3.1818	1.2531	4.43
			1.9215	-2.2888	3.7047		-2.8294								
X	4.29		0.7141	-0.5894	-6.5678	33.455 6	-0.2205	28.905 5	17.3177	US	US	0.35	0.5894	0.0276	
			3.4533	-1.7408	-3.1389		-2.4736								
Y	2.55	2.55	-0.0006	-0.9183	0.7074	7.0238	-0.3271	0.0214	0.8629	S	S	0.16	0.9183	0.1922	1.11
			-0.0198	-2.0547	0.1888		-2.1949								
C1	6.43	6.43	0.6888	-1.5291	6.3566	7.5316	-0.2464	2.0514	0.4029	S	S	0.25	1.5291	0	1.53
	0		3.7780	-1.8046	8.6623		-5.3472								
A1															
Total	100	62.77	…	…	…	…	…	…	…	…	…	…	…		

Table B2: **The Results of the Fitted Model to Australian Exports to Japan**

Exports to Japan													Absolute Value of Import Elasticity	Absolute Value of Export Elasticity	Summation of Elasticities
Item	Contribution	Significant	Ln(RGDP)	Ln(REXP)	Constant	F-Test	ECM(t-1)	LM	RESET	CUSUM	CUSUMSQ	Adj-R^2			
A	3.27	3.27	1.7619	-1.0922	-1.3259	8.4507	-0.4037	1.5086	2.1042	S	US	0.12	2.2048	1.0922	3.30
			1.7589	-1.8725	-0.9308		-2.1611								
B	4.88	4.88	0.3318	-0.1585	0.2046	24.6493	-0.2404	0.7019	2.0698	S	S	0.17	2.2440	0.1585	2.40
			1.8518	-2.3992	0.5321		-2.7484								
C	4.24		0.1836	0.3129	0.9034	33.9940	-0.2651	47.5613	13.1573	S	US	0.16	4.9365	0.3129	
			0.9032	3.2884	1.8736		-3.6117								
D	4.25	4.25	0.0044	-1.0157	-0.8682	33.8377	-0.2449	0.4326	1.0297	S	S	0.19	11.4100	1.0157	12.43
			0.0773	-2.6420	-1.7335		-3.6639								
E	3.41	3.41	0.0772	-1.1095	0.2087	30.6027	-0.1156	0.1748	0.5504	S	S	0.16	0.8776	1.1095	1.99
			0.3865	-1.7627	0.4832		-1.7064								
F	2.17	2.17	0.1682	-0.5523	0.7244	26.5986	-0.1306	1.5897	6.1883	US	S	0.13	2.7158	0.5523	3.27
			1.4192	-2.3397	1.3912		-2.3095								
G	3.15		-0.1525	0.1488	0.4177	25.0838	0.1315	15.2052	8.8079	S	S	0.22	2.1710	0.1488	
			-0.3169	1.3868	1.2244		0.9158								
H	3.47		0.6456	0.0522	-1.0049	39.3930	-0.1545	0.3948	0.0004	US	US	0.18	0.4118	0.0522	
			1.3874	0.7410	-1.3228		-0.1982								
I	2.16	2.16	-0.0108	-2.1753	0.1771	32.9180	-0.0838	1.3716	2.5599	S	S	0.15	1.2008	0.1753	1.38
			-0.0214	-1.8892	0.1832		-2.2456								
J	4.28		0.4253	-0.1561	0.6227	39.2799	-0.1613	0.3048	0.9242	S	US	0.19	1.2708	0.1561	
			0.1588	-1.9843	1.9441		-3.0548								
K	3.72	3.72	0.2953	-1.1169	0.7340	31.9187	-0.3206	0.8875	0.3762	S	S	0.14	0.1279	1.1169	1.24
			2.6212	-1.7880	1.5931		-2.2454								
L	4.15		0.6403	-0.1992	-0.7266	28.0172	-0.4442	0.0595	0.0595	S	US	0.09	0.2986	0.1992	
			1.7245	-2.4411	-1.2007		-2.0541								
M	1.48		1.8445	0.3302	-3.3999	35.5841	0.0085	0.1764	0.0145	S	S	0.21	1.2905	0.3302	
			1.8780	1.4909	-1.7982		0.0881								
N	0.77	0.77	0.4300	-0.3194	-0.5176	7.5338	-0.0957	0.1563	0.1563	S	S	0.26	2.2443	0.3194	2.56
			0.4909	-4.1385	-0.3137		-2.6091								
O	3.25	3.25	0.4883	-0.8489	-0.3669	22.4790	-0.1518	0.9923	1.2234	S	US	0.16	2.2517	0.8489	3.10
			1.7712	-2.6387	-0.7796		-2.2479								
O1	3.51		0.6164	0.0801	1.2576	28.9947	0.0773	16.5642	6.9837	US	US	0.16	1.6860	0.0801	
			0.8982	1.0102	0.9795		0.6974								
S1	3.95		1.6651	-1.5163	-0.0004	39.4935	-0.6346	0.3827	0.0920	S	S	0.08	1.5472	1.5163	
			2.6870	-1.7483	-0.0005		-1.8897								
P	3.38		2.3866	0.3937	-3.0762	60.7339	-0.4207	1.0399	14.2889	S	S	0.03	1.2906	0.3937	

			5.3851	4.6829	-4.7762		-5.6440								
Q	3.42	3.42	0.8817	-0.3309	-0.8469	35.4040	-0.1294	0.5463	0.4335	S	S	0.12	0.7232	0.3309	1.05
			2.8635	-3.6635	-1.8285		-1.9764								
R	3.47		0.5755	-0.8244	-0.5173	23.0125	-0.4705	3.3521	0.3436	US	S	0.13	1.5289	0.8244	
			1.7452	-2.3177	-0.9486		-1.9181								
S	3.47	3.47	0.8864	-0.7637	-0.5979	30.4517	-0.3168	0.8964	0.7081	S	S	0.17	0.8538	0.7637	1.62
			2.0833	-2.4112	-0.7748		-1.7247								
T	3.49		1.2636	-1.1959	-1.6531	32.6484	-0.3135	0.2271	0.3662	US	S	0.16	2.3262	1.1959	
			3.4832	-2.8509	-3.0968		-1.9246								
U	3.89	3.89	0.1963	-1.1926	0.0975	33.3367	-0.1129	0.8457	0.8315	S	S	0.17	3.1826	1.1926	4.38
			0.8009	-2.0648	0.2316		-2.4508								
V	1.87	1.87	-0.3117	-0.1888	0.7664	29.3337	-0.1106	0.1553	0.1731	US	US	0.15	1.3127	0.0888	1.40
			-0.3916	-2.2353	0.4869		-2.1163								
W	3.94	3.94	-0.4938	-1.2531	2.1103	27.5939	-0.1247	0.7821	0.9715	S	S	0.15	3.1818	1.2531	4.43
			-1.8405	-3.3366	2.7678		-2.0626								
X	5.24		0.2409	-0.0276	-0.1887	25.4089	-0.0329	30.9115	14.0887	S	S	0.15	0.5894	0.0276	
			0.9988	-0.2819	-0.4418		-0.2780								
Y	5.61	5.61	0.2977	-0.1922	-0.0787	25.3944	-0.1467	1.7989	2.0832	S	S	0.14	0.9183	0.1922	1.11
			1.0310	-2.1189	-0.1771		-2.4397								
Z	3.74	3.74	1.6196	-0.6196	-0.5156	40.5473	-0.2122	0.6656	0.6247	US	S	0.16	1.5291	0	1.53
			1.8065	-1.7065	-0.9286		-2.2531								
A1	2.37		-0.7029	-0.7029	2.1572	33.1666	-0.1756	0.7293	0.7293	S	US	0.17			
	0		-1.0306	-1.0306	1.8455		-1.8450								
Total	100.00	53.82											…		

Table A3: **The Results of the Fitted Model to Australian Imports from China**

Item	Contribution in total imports	Contribution by Significant items	Imports from China										Absolute Value of Import Elasticity	Absolute Value of Export Elasticity	Summation of Elasticities
			Ln(RGDP)	Ln(RIMP)	Constant	F-Test	ECM(t-1)	LM	RESET	CUSUM	CUSUMSQ	Adj-R^2			
C	11.37	11.37	0.4883	-2.2366	-5.1835	36.9799	-0.1100	0.3893	1.6240	S	S	0.43	2.2366	0.0184	2.2550
			2.1544	-2.4291	-2.1402		-2.0234								
D	7.53	7.53	0.6786	-0.1157	-7.4684	35.5378	-0.4600	0.1482	0.4481	S	S	0.27	0.1157	1.0501	1.1658
			2.4897	-2.9737	-2.4709		-2.4512								
H	10.80	10.80	0.2307	-2.2707	-0.1419	45.3968	-0.0893	2.0285	2.5589	US	S	0.36	2.2707	0.1852	2.4559
			1.7521	-1.6835	-1.5645		-2.0897								
U	6.87	6.87	1.1095	-0.8357	-5.7143	34.0100	-0.0677	0.8909	10.9702	S	S	0.11	0.8357	0.1841	1.0198
			2.7131	-2.9637	-0.7223		-1.9842								
L1															
M1															
N1															
O	8.89		0.3578	-0.0530	0.1236	47.3080	-0.1040	0.0016	1.5483	S	US	0.14	0.0530	0	
			2.4124	-1.1850	1.3585		-2.3022								
E	8.84	8.84	0.2423	-2.3527	2.4541	42.5149	-0.1771	0.0305	0.7115	S	S	0.16	2.3527	0	2.3527
			2.9144	-2.6705	0.9818		-3.1160								
J	6.25		0.4212	-0.5695	6.0260	36.0855	-0.0950	8.7967	0.1289	S	S	0.28	0.5695	0	
			2.3699	-1.3746	1.4550		-2.3645								
P	8.02	8.02	1.1854	-1.3257	-12.9627	38.2603	-0.2620	-0.2451	4.3985	US	S	0.18	1.3257	0	1.3257
			3.8692	-1.8449	-3.8086		-2.8603								
I	9.89	9.89	0.1746	-1.0232	-1.8509	44.8170	-0.0492	-0.2765	0.0074	S	S	0.19	1.0232	0	1.0232
			2.4105	-2.2605	-2.3647		-1.6674								
B	10.73	10.73	1.1207	-1.1832	-11.9245	47.0207	-0.2451	-0.1522	1.0349	US	S	0.21	1.1832	0	1.1832
			4.4089	-4.3187	-4.3604		-2.8963								
L	10.81		0.2972	-0.1548	-2.8268	47.2021	-0.2765	-0.1805	1.6918	US	US	0.25	0.1548	0	
			2.5784	-1.0115	-2.4639		-2.4512								
Total	100.00	74.05	…	…	…	…	…	…	…	…	…	…	…	…	…

Table B3**: The Results of the Fitted Model to Australian Exports to China**

Exports to China													Absolute Value of Import Elasticity	Absolute Value of Export Elasticity	Summation of Elasticities
Item	Contribution	Significant	Ln(RGDP)	Ln(REXP)	Constant	F-Test	ECM(t-1)	LM	RESET	CUSUM	CUSUMSQ	Adj-R^2			
C	19.14	19.14	0.0058	-0.0184	0.1489	33.5983	-0.1791	0.0007	0.0138	S	S	0.43	2.2366	0.0184	2.2550
			1.7616	-1.8459	0.2189		-1.9751								
D	19.15	19.15	0.0065	-1.0501	0.1619	33.8938	-0.4386	2.1969	2.1351	US	S	0.27	0.1157	1.0501	1.1658
			1.7047	-1.7216	1.4367		2.0106								
H	15.01	15.01	0.0068	-0.1852	1.1565	34.0162	-0.0398	0.2060	0.0950	S	S	0.36	2.2707	0.1852	2.4559
			1.5550	-2.5357	0.3521		-1.7556								
U	16.16	16.16	0.0099	-0.1841	0.4506	36.5127	-0.1135	0.0061	0.3345	US	S	0.11	0.8357	0.1841	1.0198
			2.4163	-1.8072	2.9499		-3.0862								
L1	11.01	…	-0.0029	-0.9368	1.0334	32.4109	-0.1462	1.0151	0.0021	S	US	0.12	…	…	…
		…	-0.5794	-2.8769	0.3794		-3.3396						…	…	…
M1	3.93	…	0.0005	0.1632	-0.0975	27.4214	-0.1924	4.1701	1.1294	US	US	0.17	…	…	…
		…	0.0698	0.8453	-0.4221		-1.5736						…	…	…
N1	15.60	…	0.1749	-0.3667	4.2006	41.6608	-0.1257	0.4778	9.9281	S	S	0.19	…	…	…
	…	…	2.6774	-3.1381	5.1274		-3.0392	…	…	…	…	…	…	…	…
O	…	…	…	…	…	…	…	…	…	…	…	…	0.0530	0	
	…	…	…	…	…	…	…	…	…	…	…	…			
E	…	…	…	…	…	…	…	…	…	…	…	…	2.3527	0	2.3527
	…	…	…	…	…	…	…	…	…	…	…	…			
J	…	…	…	…	…	…	…	…	…	…	…	…	0.5695	0	
	…	…	…	…	…	…	…	…	…	…	…	…			
P	…	…	…	…	…	…	…	…	…	…	…	…	1.3257	0	1.3257
	…	…	…	…	…	…	…	…	…	…	…	…			
I	…	…	…	…	…	…	…	…	…	…	…	…	1.0232	0	1.0232
	…	…	…	…	…	…	…	…	…	…	…	…			
B	…	…	…	…	…	…	…	…	…	…	…	…	1.1832	0	1.1832
	…	…	…	…	…	…	…	…	…	…	…	…			
L	…	…	…	…	…	…	…	…	…	…	…	…	0.1548	0	
	…	…	…	…	…	…	…	…	…	…	…	…			
Total	100	69.46	…	…	…	…	…	…	…	…	…	…	…	…	…

Table A4: **The Results of the Fitted Model to Australian Imports from Korea**

Item	Contribution in total imports	Contribution by Significant items	Imports from Korea										Absolute Value of Import Elasticity	Absolute Value of Export Elasticity	Summation of Elasticities
			Ln(RGDP)	Ln(RIMP)	Constant	F-Test	ECM(t-1)	LM	RESET	CUSUM	CUSUMSQ	Adj-R^2			
A	3.03	3.03	-0.0458	-1.3206	0.4496	39.9886	-0.0443	1.1759	1.6844	S	S	0.28	1.3206	1.0025	2.32
			-0.6600	-1.7761	2.4802		-2.1520								
B															
C	3.04	3.04	0.1327	-1.2545	-0.0109	33.7398	-0.0480	0.6129	0.2937	S	S	0.39	1.2545	1.1021	2.36
			2.3482	-1.7501	-0.0791		-1.6517								
D	4.28		0.1996	0.0017	0.0251	35.6039	-0.0667	1.0401	0.2932	US	US	0.24			
			1.2988	0.6012	0.2998		-0.7216								
E	3.41	3.41	-0.0069	-0.2771	-0.0002	38.6873	-0.1062	0.3938	0.8011	US	S	0.27	0.2771	0.9121	1.19
			-2.4501	-3.1859	-0.0026		-2.0673								
F	1.83	1.83	0.1362	-1.1106	-0.2559	32.4852	-0.0369	1.1231	0.7759	S	S	0.18	1.1106	0.3240	1.43
			1.9835	-1.9844	-2.5980		-2.3996								
G	2.89		0.4215	0.0121	-0.6206	32.9891	-0.0115	0.7423	0.3016	US	S	0.26			
			2.1329	1.6648	-1.9357		-0.1258								
H	2.90	2.90	0.3549	-0.9019	-0.3271	37.0692	-0.1315	1.2156	0.4245	S	S	0.15	0.9019	0.7768	1.68
			2.3385	-2.4104	-1.7564		-1.7150								
I	1.62	1.62	0.6395	-0.5576	-0.8090	35.9004	-0.1217	0.8044	0.6070	S	S	0.24	0.5576	0.7823	1.34
			2.7528	-1.8647	-2.4856		-2.1335								
J	5.14		0.1615	-0.0038	0.4587	43.3468	-0.1846	0.0318	0.1955	S	US	0.17			
			2.5685	-1.4025	0.1433		-2.0509								
K	4.12	4.12	0.4412	-0.8539	-0.0182	31.3594	-0.1178	1.3594	0.9565	S	S	0.21	0.8539	0.4917	1.35
			3.1847	-1.9033	-0.1556		-2.1845								
L	4.48	4.48	0.4889	-0.7505	0.3213	59.6947	-0.2918	0.6549	0.8021	S	S	0.48	0.7505	0.6229	1.37
			4.0316	-2.1072	1.9356		-8.8365								
M	1.76		0.7877	-0.0139	-0.9239	36.0634	-0.0170	1.8434	21.3971	S	US	0.25			
			3.3526	-1.5966	-2.7232		-0.1852								
N	0.40	0.40	-0.0759	-0.6257	-0.1311	35.7451	-0.3215	0.6193	0.1026	S	S	0.24	0.6257	0.8103	1.44
			-0.7405	-2.9555	-0.6817		-1.6881								
O	4.04		0.2051	-0.0054	0.1433	43.9012	-0.0113	0.0065	9.2659	US	US	0.26			
			2.9743	-0.6458	1.5779		-0.1238								
P	2.88	2.88	0.1509	-0.4581	0.1159	37.3926	-0.4416	1.2512	10.8888	S	S	0.18	0.4581	1.0009	1.46
			2.0019	-2.3784	1.1947		-2.0173								
Q	5.21		0.2802	-0.0084	0.4225	40.3038	-0.0325	0.2538	7.4846	S	S	0.24			
			3.5089	-2.2208	2.6044		-0.3536								
R	2.96	2.96	-0.1812	-0.7126	0.4303	38.1612	-0.2513	0.1722	2.3532	US	S	0.17	0.7126	0.5224	1.24
			-2.2609	-2.2139	2.4955		-2.0007								

S	3.22		0.3080	-0.7111	-0.0459	37.3707	-0.0469	0.1509	4.6568	US	US	0.20			
			2.9893	-2.8982	-0.4897		-0.1509								
T	2.96		0.3815	-0.0053	-0.0878	39.1550	-0.0284	0.8540	18.8474	S	S	0.30			
			4.0032	-1.9843	-1.2090		-0.3098								
U	3.71		0.1882	0.6608	-0.1002	88.9481	-0.0199	0.0046	5.1376	S	US	0.17			
			1.7384	0.2445	-0.8432		-0.2172								
V	3.44	3.44	0.4865	-1.0021	-0.3718	35.3032	-0.5633	0.4332	2.5989	S	S	0.21	1.0021	0.5120	1.51
			2.6447	-2.9482	-1.8175		-3.0357								
W	3.55		0.3476	0.0091	-0.4187	40.0209	-0.0225	0.2433	19.0698	US	US	0.17			
			2.6604	2.3213	-2.5013		-0.2468								
X	1.08		0.1307	0.0202	-0.3667	28.7519	-0.0016	0.1559	2.4411	S	S	0.16			
			0.4268	1.0620	-0.6992		-0.0182								
Y	4.49	4.49	0.0554	-1.2018	0.2251	80.8107	-0.1043	1.0388	4.9966	S	S	0.61	1.2018	0.6079	1.81
			1.9702	-1.7313	1.7039		-1.9981								
Z	6.18		0.2578	-0.0057	0.1399	57.7310	-0.0162	0.0051	3.5425	S	US	0.18			
			3.1976	-2.6203	1.8452		-0.1764								
A1	6.43	6.43	0.3044	-1.0030	0.1472	37.1646	-0.5113	2.4243	3.6482	US	S	0.43	1.0030	0.7145	1.72
			3.0958	-1.8432	1.9522		-2.0039								
B1	4.43	4.43	0.5729	-0.7143	-0.0932	29.6492	-0.4101	1.1656	16.4831	S	S	0.21	0.7143	1.0364	1.75
			3.6113	-2.3030	1.8405		-2.1103								
C1	3.50	3.50	0.1562	-1.0088	0.2723	39.2642	-0.2051	0.4664	23.9893	S	S	0.23	1.0088	0.3237	1.33
			2.1899	-1.7429	1.4427		-2.0556								
D1	3.02		0.1655	-0.0003	-0.1421	31.7107	-0.1161	0.0482	7.1575	S	US	0.16			
			1.2630	-0.5682	-0.7634		-0.8834								
E1														2.0139	2.01
F1														2.0032	2.00
G1														1.0091	1.01
H1														2.0041	2.00
I1															
J1														1.2125	1.21
K1															
Total	100.00	52.96	….	….	….	….	….	….	….	….	….	….	….	….	….

Table B4: **The Results of the Fitted Model to Australian Exports to Korea**

Exports to Korea													Absolute Value of Import Elasticity	Absolute Value of Export Elasticity	Summation of Elasticities
Item	Contribution	Significant	Ln(RGDP)	Ln(REXP)	Constant	F-Test	ECM(t-1)	LM	RESET	CUSUM	CUSUMSQ	Adj-R^2			
A	1.22	1.22	0.4859	-1.0025	-5.4264	35.4580	-0.1999	0.4759	0.0479	US	S	0.22	1.3206	1.0025	2.32
			3.6648	-1.6501	-3.6126		-1.8296								
B	0.52		0.6331	-0.0063	-7.0124	8.6200	-0.0452	0.5679	3.5488	S	S	0.18	0	0	
			2.3504	-0.5947	-0.4433		-0.4533								
C	3.25	3.25	0.3855	-1.1021	-3.9839	44.0865	-0.4465	2.3358	0.6157	S	S	0.16	1.2545	1.1021	2.36
			3.4294	-6.6083	-3.3728		-2.1978								
D	2.65		0.1856	-0.0099	-2.0624	35.8597	-0.0392	1.8075	28.3927	S	US	0.13	0	0.0099	
			0.7541	-1.9568	-0.7435		-0.4273								
E	2.97	2.97	0.1658	-0.9121	-1.9520	34.2265	-0.8092	0.0289	11.4550	S	S	0.11	0.2771	0.9121	1.19
			0.7257	-1.8323	-0.7507		-3.1009								
F	2.67	2.67	0.0772	-0.3240	-0.6097	33.7949	-0.2157	0.1243	0.1087	S	S	0.11	1.1106	0.3240	1.43
			0.9909	-1.8211	-0.7060		-2.0625								
G	2.47		1.0447	-0.0153	-11.5140	43.2194	-0.1945	1.0533	4.7350	US	S	0.19	0	0	
			4.7049	-3.3668	-4.7015		-2.2105								
H	0.40	0.40	2.5085	-0.7768	-28.3604	25.8113	-0.1080	2.0097	0.0367	US	S	0.30	0.9019	0.7768	1.68
			5.6242	-1.9385	-5.6378		-2.1048								
I	2.28	2.28	1.0608	-0.7823	-11.4468	47.3843	-0.0424	1.6660	2.0952	S	S	0.21	0.5576	0.7823	1.34
			4.7613	-1.9567	-4.7426		-2.0020								
J	1.54		0.8278	0.0051	-9.3454	34.0293	-0.0152	0.3052	0.0161	S	US	0.27	0	0	
			2.2383	0.6670	-2.2412		-1.8821								
K	2.02	2.02	0.3748	-0.4917	-4.1416	38.6766	-0.0585	0.0585	1.0507	S	S	0.11	0.8539	0.4917	1.35
			2.5984	-2.5643	-2.2346		-2.0014								
L	2.75	2.75	0.4875	-0.6229	-5.1309	33.8613	-0.0542	0.5675	2.0518	S	S	0.12	0.7505	0.6229	1.37
			2.7489	-1.6656	-2.6696		-1.9054								
M	1.59		0.5903	-0.0208	-6.2672	36.0546	-0.2106	1.7804	1.7804	US	US	0.16			
			3.7223	-3.1429	-3.6379		-3.1112								
N	0.28	0.28	0.0585	-0.8103	-0.5173	27.2432	-0.1503	1.8496	1.8496	S	S	0.10	0.6257	0.8103	1.44
			0.4600	-1.6891	-0.3576		-2.8852								
O	2.28		0.4227	-0.1277	-4.4259	32.8658	-0.2215	0.1867	0.3722	S	S	0.14	0	0	
			1.4659	-2.2038	-1.4437		-1.9654								
P	3.85	3.85	-0.0002	1.0009	0.2549	27.0211	-0.0403	1.4489	13.9916	US	S	0.12	0.4581	1.0009	1.46
			-0.0026	0.3371	0.2622		-2.3849								
Q	3.30		0.2175	-0.0012	-2.1341	37.1129	-0.0053	0.0104	0.8042	S	S	0.14			

			2.2107	-0.4307	-2.0519		-0.0588								
R	2.31	2.31	1.6097	-0.5224	-18.2079	18.6597	-0.1069	2.3484	0.2318	S	S	0.17	0.7126	0.5224	1.24
			3.8688	-2.5732	-3.8745		-1.8362								
S															
T	3.09		1.4321	-0.6264	-15.3008	6.2247	-0.4774	1.7359	7.5961	S	US	0.23			
			4.0351	-3.4801	-4.0337		-2.0114								
U	3.68		0.9116	-0.0045	-9.8089	34.2484	-0.2039	7.9136	7.4286	US	US	0.24			
			3.5768	-2.4368	-3.5794		-2.2021								
V	3.30	3.30	1.5136	-0.5120	-16.4736	45.5124	-0.0694	1.9612	11.9385	S	S	0.21	1.0021	0.5120	1.51
			4.5262	-3.0034	-4.5129		-1.8475								
W	1.87		0.4221	0.2127	-4.7020	30.1462	-0.1124	1.2932	2.3510	S	S	0.26			
			1.9812	1.5105	-1.9503		-1.8426								
X	2.84		0.1786	-0.0015	-1.9908	11.0647	-0.8369	1.0532	0.6523	S	US	0.27			
			0.1408	-0.0821	-0.1488		-0.4885								
Y	3.51	3.51	0.2870	-0.6079	-2.7914	29.7614	-0.0233	0.0959	0.4773	US	S	0.29	1.2018	0.6079	1.81
			1.8671	-1.7257	-1.6462		-1.7201								
Z	1.40		-0.1878	-0.6315	2.8331	3.7023	0.1497	3.2946	0.0465	S	S	0.31			
			-0.4535	-1.3356	0.5966		0.6572								
A1	5.88	5.88	2.0520	-0.7145	-21.9524	48.0603	-0.0579	1.4882	0.5283	S	S	0.24	1.0030	0.7145	1.72
			5.3427	-3.7196	-5.3018		-1.7859								
B1	4.71	4.71	0.5959	-1.0364	-6.2613	40.3326	-0.5473	3.0747	1.1997	S	S	0.30	0.7143	1.0364	1.75
			2.8321	-1.8155	-2.7899		-2.2888								
C1	4.99	4.99	0.0037	0.3237	-0.6031	25.1795	-0.3449	0.5199	1.9167	S	S	0.21	1.0088	0.3237	1.33
			1.5525	1.8825	-0.8342		-3.0018								
D1	3.31		-0.0171	-0.0171	-4.0596	34.7677	-0.0319	0.5833	1.4879	US	US	0.16			
			-2.2078	-2.2078	-2.3402		-2.3484								
E1	3.54	3.54	-0.0139	-2.0139	-0.6186	37.1582	-0.1973	0.0169	0.0899	S	S	0.11			
			-2.8113	-2.8113	-2.5377		-2.0810								
F1	4.02	4.02	-0.0032	-2.0032	-2.5451	8.0528	-0.4990	2.8939	2.1003	US	S	0.28	0	2.0032	2.00
			-1.6991	-1.6991	-1.7681		-2.4137								
G1	3.48	3.48	-0.0011	-1.0011	-10.2171	41.0281	-1.7642	1.3251	0.3350	S	S	0.18	0	1.0091	1.01
			-0.3827	-2.2227	-2.7312		-1.6582								
H1	3.28	3.28	-0.0041	-2.0041	-5.1564	40.2091	-0.7981	0.8965	2.3341	S	S	0.24	0	2.0041	2.00
			-1.2881	-1.8881	-2.9258		-3.0897								
I1	3.61		-0.0088	-0.0088	-16.0478	5.5998	-0.6103	19.8714	1.5912	S	US	0.36			

			-2.6805	-2.6805	-4.3333		-1.8428								
J1	3.90	3.90	0.0125	1.2125	-6.9143	13.3909	-0.3639	2.0184	2.6824	S	S	0.15	0	1.2125	1.21
			1.5071	1.6571	-2.6757		-4.1337								
K1	1.24		0.0105	0.0105	2.2036	30.6007	-0.0106	0.0007	3.3325	S	S	0.19			
			1.1215	1.1215	0.9191		-0.1111								
Total	100.00	64.61	….	….	….	….	….	….	….	….	….	….	….	….	….

Table A5: **The Results of the Fitted Model to Australian Imports from Thailand**

Item	Contribution in total imports	Contribution by Significant items	Imports from Thailand										Absolute Value of Import Elasticity	Absolute Value of Export Elasticity	Summation of Elasticities
			Ln(RGDP)	Ln(RIMP)	Constant	F-Test	ECM(t-1)	LM	RESET	CUSUM	CUSUMSQ	Adj-R^2			
A	1.12	1.12	0.0435	-0.8852	-0.4638	0.6986	-0.9192	3.2383	1.3883	S	S	0.20	0.8852	0.2448	1.13
			0.3278	-2.0329	-0.3022		-2.6413								
B	0.35		-0.1990	-0.0118	2.4377	7.8625	-0.1630	8.8384	10.8836	US	US	0.23	0.0118	0.0046	
			-1.2412	-0.0565	1.3196		-1.5889								
C	4.63	4.63	-0.1990	-0.9118	2.4377	90.7871	-0.0585	2.9073	1.0664	S	S	0.26	0.9118	0.1354	1.05
			-1.2412	-1.7565	1.3196		-2.0855								
D	2.04	2.04	0.4789	-0.1872	-5.1870	45.2212	-0.0546	3.2833	0.0574	US	S	0.21	0.1872	0.9182	1.11
			3.3024	-1.8767	-3.2251		-2.5880								
E	3.04	3.04	-0.0860	-0.9788	1.5503	35.5627	-0.5110	0.1751	2.2956	S	S	0.17	0.9788	0.0571	1.04
			-1.1935	-1.8723	1.7398		-4.1209								
F	2.44		0.6196	-0.3484	-6.7956	42.9134	-0.0400	0.0298	2.1019	US	US	0.18	0.3484	0.093	
			2.9935	-2.2310	-2.9329		-0.4279								
G	3.12	3.12	0.0375	-0.6592	-0.1398	25.2924	-0.2882	2.5314	1.2119	S	S	0.12	0.6592	0.5486	1.21
			0.5123	-1.9006	-0.1812		-2.2812								
H	3.51		0.5745	-0.1298	-5.8325	41.1615	0.0037	4.1061	18.6018	US	S	0.26	0.1298	0.0937	
			3.4184	-2.4629	-3.3561		0.0353								
I	2.9		0.0222	-0.0382	0.3943	34.5376	-0.0139	0.6630	17.2871	S	US	0.18	0.0382	0.1408	
			0.3179	-0.4317	0.4669		-0.1519								
J	4.35	4.35	0.1338	-1.2035	-1.2842	32.6225	-0.2555	2.8303	1.7140	S	S	0.21	1.2035	0.0049	1.21
			1.1165	-2.1439	-1.0451		-1.9864								
K													0	1.4496	1.45
L	3.53	3.53	0.6254	-0.1294	-6.3089	53.7148	-0.1042	0.4197	0.9572	S	S	0.23	0.1294	0.8778	1.01
			3.8557	-1.8045	-3.7658		-3.1032								
M	2.17		0.4631	0.1616	-4.7494	37.3170	-0.0281	0.3767	0.9559	US	US	0.17	0.1616	0.1571	
			3.4172	1.5963	-3.2835		-0.3079								
N	1.53		0.2210	-0.1190	-2.4783	38.9038	-0.0034	2.6741	8.4691	US	US	0.11	0.119	0.7295	

			2.5840	-1.5662	-2.6081		-0.0371								
O	3.24	3.24	0.8149	-0.4177	-8.9277	45.2202	-0.3352	0.0104	2.2289	S	S	0.19	0.4177	0.7217	1.14
			3.5578	-3.1458	-3.5364		-2.0574								
O1	3.32	3.32	0.4616	-0.0406	-4.4283	48.3853	-0.1506	1.2955	1.2501	S	S	0.34	0.0406	1.0242	1.06
			2.6331	-1.9192	-2.5663		-1.9362								
P1	3.32		0.4810	-0.3418	-5.3035	36.5473	-0.0139	0.0155	6.6063	US	US	0.10	0.3418	0.0121	
			2.5414	-2.4632	-2.5255		-0.1526								
P	2.76		-0.3235	0.1273	3.9644	20.2139	-0.0529	2.7665	26.6404	S	US	0.14	0.1273	0.044	
			-1.9255	0.6690	2.0975		-0.5062								
Q	4.07		0.1243	-0.0735	-1.3296	32.6433	-0.1097	######	1.7926	S	S	0.19	0.0735	0.2597	
			0.6668	-1.8264	-0.6751		-0.9216								
R	4.37		0.4765	-0.2642	-4.6263	42.1265	-0.1059	######	10.8457	S	S	0.25	0.2642	0.3065	
			4.1558	-4.3806	-4.0909		-0.9174								
S	4.30	4.3	1.6327	-0.1389	- 16.7282	85.3486	-0.7082	0.3348	1.1858	US	S	0.64	0.1389	0.1758	0.31
			11.0010	-1.9972	- 10.7066		-7.4909								
T	2.83		0.0992	0.0558	-1.0419	1.7564	-0.4526	1.8144	10.2682	S	S	0.11	0.0558	3.2217	
			0.4926	0.8291	-0.4686		-1.2772								
U	4.43	4.43	-0.8302	-0.3974	7.5931	0.0244	-2.4675	0.8966	1.6164	S	S	0.39	0.3974	0.2175	0.61
			-2.7112	-2.6367	2.7037		-5.1279								
V	2.45	2.45	-0.5849	0.3970	6.9816	35.6602	-0.0174	0.5919	1.5660	S	S	0.11	0.3970	0.7391	1.14
			-2.1324	1.7907	2.1567		-2.1886								
W	3.41		0.6725	0.0383	-7.0409	39.0609	-0.0147	0.0134	2.2596	S	US	0.15	0.0383	0.2858	
			3.4537	0.3478	-3.3511		-0.1609								
X	1.63	1.63	0.2189	-1.6920	-2.8002	8.1912	-0.1093	0.4501	2.0524	S	S	0.20	1.6920	0.2145	1.91
			0.6539	-3.3967	-0.7281		-2.1976								
Y	4.6		0.4107	-0.0057	-4.3001	34.7107	-0.0199	1.2826	5.9305	US	S	0.12	0.0057	0.0595	
			1.6333	-0.0255	-1.5726		-0.2088								
Z	3.51	3.51	0.4228	-0.0093	-4.4750	43.1206	-0.5102	2.1817	0.8155	S	S	0.11	0.0093	1.3589	1.37
			2.3466	-1.1868	-2.3238		-5.1125								
A1	3.76		0.3372	-0.0142	-3.6599	35.4780	0.0040	0.1414	0.0012	US	US	0.17	0.0142		
			1.6494	-0.1656	-1.6304		0.0436								
B1	3.76	3.76	0.9776	-1.4990	-9.3892	119.5820	-0.8464	1.1283	2.1892	S	S	0.13	1.4990	0	1.50
			7.7893	-3.9929	-6.8704		-9.3472								
C1	2.13		1.3785	0.3714	- 15.3493	32.1708	-0.0020	0.8280	2.3951	S	S	0.15	0.3714		
			2.6931	1.0078	-2.7047		-0.0217								
D1	3.40		0.3212	-0.0616	-3.3836	43.7092	-0.0575	0.8798	8.3463	US	US	0.22	0.0616		
			2.1195	-0.8142	-2.0559		-0.6118								
E1	3.82	3.82	1.4276	-1.1113	- 15.6945	44.5996	-0.1436	2.9602	1.8274	S	S	0.26	1.1113	0	1.11

			4.0312	-2.0835	-4.0180		-1.7901								
Total	100	52.29	….	….	….	….	….	….	….	….	….	….	….		

Table B5: **The Results of the Fitted Model to Australian Exports from Thailand**

Exports to Thailand													Absolute Value of Import Elasticity	Absolute Value of Export Elasticity	Summation of Elasticities
Item	Contribution	Significant	Ln(RGDP)	Ln(REXP)	Constant	F-Test	ECM(t-1)	LM	RESET	CUSUM	CUSUMSQ	Adj-R^2			
A	0.71	0.71	0.0032	-0.2448	0.1004	28.2285	-0.0629	0.4712	0.3773	S	S	0.12	0.8852	0.2448	1.13
			0.0215	-1.8636	0.3608		-1.7742								
B	5.79		0.1323	0.0046	-0.1461	36.2566	-0.0060	0.1556	11.7337	S	US	0.17	0.0118	0.0046	
			0.6090	0.0641	-0.4644		-0.0656								
C	2.38	2.38	0.0382	-0.1354	0.5355	33.6171	-0.0603	0.1458	0.3127	S	S	0.16	0.9118	0.1354	1.05
			0.3494	-1.8456	2.4884		-1.9934								
D	18.96	18.96	0.0589	-0.9182	0.2658	28.1765	-0.4498	1.5139	16.2026	S	S	0.19	0.1872	0.9182	1.11
			0.5916	-2.2552	1.9062		-1.7349								
E	0.38	0.38	0.3637	-0.0571	-0.5407	9.7775	-0.1333	0.3101	1.5881	S	S	0.16	0.9788	0.0571	1.04
			1.4231	-2.5455	-1.4268		-3.0366								
F	0.02		0.0242	0.0930	0.1063	28.0461	-0.0033	0.0195	0.5562	S	US	0.13	0.3484	0.093	
			0.1047	0.4247	0.2706		-0.0366								
G	1.30	1.30	1.2418	-0.5486	-1.6272	38.8773	-0.2454	0.1132	2.0622	S	S	0.22	0.6592	0.5486	1.21
			3.3168	-2.5898	-3.1483		-2.4811								
H	4.30		0.5067	0.0937	-0.6729	39.1680	-0.0321	0.0373	29.9194	S	US	0.18	0.1298	0.0937	
			1.5160	0.7522	-1.3855		-0.3434								
I	0.14		0.4439	-0.1408	-0.4686	32.2838	-0.0055	0.5943	0.9399	US	US	0.15	0.0382	0.1408	
			2.7002	-1.7447	-2.0586		-0.0607								
J	20.28	20.28	1.6217	-0.1049	-1.7730	39.4709	-0.1071	0.4648	0.0297	S	S	0.19	1.2035	0.0049	1.21
			4.7591	-1.7495	-4.3605		-2.0785								
K	9.89	9.89	0.8469	-1.4496	-0.9723	34.0444	-0.0145	0.8676	0.8546	S	S	0.14	0	1.4496	1.45
			3.3092	-3.3498	-2.9461		-0.1599								
L	0.53	0.53	-0.0542	-0.8778	0.6388	29.7793	-0.1114	0.0578	2.2534	US	S	0.09	0.1294	0.8778	1.01
			-0.3576	-1.9922	2.0211		-2.1253								
M	0.10		0.3637	0.1571	-0.2366	38.1427	-0.0569	0.5336	2.2663	US	S	0.21	0.1616	0.1571	
			1.5062	0.8773	-0.6437		-0.6054								
N	0.01		-0.2390	0.7295	0.8137	4.4461	0.0461	20.1106	0.0044	S	US	0.26	0.119	0.7295	
			-0.6834	2.3231	1.2773		0.4143								
O	1.23	1.23	0.5118	-0.7217	-0.5553	33.7955	-0.2471	0.5404	1.1799	S	US	0.16	0.4177	0.7217	1.14
			3.1943	-1.9632	-2.5526		-2.5001								
O1	0.40	0.40	0.8214	-1.0242	-1.3223	32.4290	-0.3145	0.4993	2.1817	S	S	0.16	0.0406	1.0242	1.06

			2.3027	-2.1329	-2.2666		-3.0491								
P1	0.33		0.3212	0.0121	-0.4658	0.0149	-0.0123	0.1623	0.0603	S	US	0.08	0.3418	0.0121	
			1.2291	0.0895	-1.1233		-0.1354								
P	0.82		0.1811	0.0440	-0.0149	33.4248	-0.0860	0.4242	2.5320	US	S	0.03	0.1273	0.044	
			1.3944	0.5537	-0.0942		-0.9206								
Q	4.65		1.0339	0.2597	-1.3898	33.0092	-0.0011	0.0237	0.8162	US	US	0.12	0.0735	0.2597	
			2.7218	1.4526	-2.5451		-0.0114								
R	0.79		0.7481	0.3065	-0.9529	32.3759	-0.0771	0.7710	1.0628	US	S	0.13	0.2642	0.3065	
			2.2739	1.5453	-2.1011		-1.9812								
S	1.22	1.22	0.5043	-0.1758	-0.6085	36.4883	-0.1416	1.0192	0.4438	US	S	0.17	0.1389	0.1758	0.31
			2.0600	-1.8634	-1.8521		-3.1271								
T	2.76		0.5929	3.2217	-0.7424	4.1478	-0.3996	5.9117	1.5412	S	US	0.16	0.0558	3.2217	
			1.8849	1.6500	-1.7515		-1.6694								
U	2.46	2.46	0.3723	-0.2175	-0.3299	38.0127	-0.1392	0.1633	3.8884	S	S	0.17	0.3974	0.2175	0.61
			1.4921	-1.7735	-1.0178		-1.6504								
V	0.41	0.41	0.1452	-0.7391	0.0757	26.2144	-0.0007	0.7293	2.3553	S	S	0.15	0.3970	0.7391	1.14
			0.4571	-2.6207	0.1312		0.0182								
W	0.87		0.3981	0.2858	-0.1523	28.7263	-0.0103	0.5771	0.1910	S	US	0.15	0.0383	0.2858	
			2.6637	2.4025	-0.7847		-0.1136								
X	13.01	13.01	0.2783	-0.2145	-0.0216	35.8874	-0.1248	0.4472	1.6653	S	S	0.15	1.6920	0.2145	1.91
			1.3532	-1.9372	-0.0915		-2.2718								
Y			0.3966	0.0595	-0.4487	34.0808	-0.0054	0.2299	23.6485	US	S	0.14	0.0057	0.0595	
			2.1752	0.7557	-1.9287		-0.0588								
Z	6.25	6.25	-0.3655	-1.3589	0.9061	34.0105	-0.6265	2.1768	0.2891	S	US	0.16	0.0093	1.3589	1.37
			-1.3599	-1.9527	1.6815		-3.2809								
A1	…	…	…	…	…	…	…	…	…	…	…	…	0.0142		
	…	…	…	…	…	…	…	…	…	…	…	…			
B1	…	…	…	…	…	…	…	…	…	…	…	…	1.4990	0	1.50
	…	…	…	…	…	…	…	…	…	…	…	…			
C1	…	…	…	…	…	…	…	…	…	…	…	…	0.3714	0	
	…	…	…	…	…	…	…	…	…	…	…	…			
D1	…	…	…	…	…	…	…	…	…	…	…	…	0.0616	0	
	…	…	…	…	…	…	…	…	…	…	…	…			
E1	…	…	…	…	…	…	…	…	…	…	…	…	1.1113	0	1.11
	…	…	….	….	….	….	….	….	….	….	….	….			
Total	99.29	79.41	….	….	….	….	….	….	….	….	….	….			

CHAPTER 3

ORCUTT HYPOTHESIS AND AUSTRALIAN TRADE BALANCE: A CASE STUDY OF AGRO-FOREST AND FISH PRODUCTS

ABSTRACT

Orcutt (1950) argues that trade flows among countries respond relatively faster to change in the nominal exchange rate than to change in the relative prices. However, his proposition is still under investigated, perhaps due to lack of interest by the researchers and/or unavailability of required data for research. In this article, we have examined the validity of this less investigated hypothesis for Australian AFF imports and exports with its five major trading partners namely USA, Japan, China, Thailand and Korea for the quarterly data over the period of 1988-2020. We have found overwhelming support in favor of his claim for the AFF products trade between Australia and its largest trading partners. The result shows the overwhelming dominance of exchange rates over relative prices in the agricultural trade flow of Australia. Policy implications of this finding are very important which emphasise that if Australia intends to improve AFF trade balance, instead of domestic price, nominal exchange rate manipulation would be a relatively better option.

Keywords: Orcutt Hypothesis, Trade, Exchange Rate, Australia.
JEL Classification: F12, F14

3.2. INTRODUCTION

Improving trade balance is possible by either fiscal (imposing tariff or direct subsidy) or monetary (interest rate concession or devaluing exchange rate) or a mixture of both policies. Public finance text book discourses point out that an X % tariff together with an X % subsidy is identical to an X% nominal devaluation/depreciation of a country's exchange rate. Unfortunately, due to the unavailability of necessary and relevant data researches in this proposition did not get progress.

In 1950, Orcutt provides a hypothesis without any empirical evidence that changes of nominal exchange rate affect trade flows more rapidly than changes of relative price. Following this hypothesis, central banks in many countries frequently changes nominal exchange rate during fixed exchange rate regimes prior to 1970. Even after Bretton-Woods conference in 1971 when flexible exchange rate regimes came into effect, the same tendency continued by using various market based monetary instruments particularly in developing world central banks.

In recent years the Australian price level exchange rates have shown a substantial level of volatility (Figure 01 & 02 in Appendix I) which may have vast implications on the countries trade flow. Since by this time much progress has been taken place in the arena of economic thoughts on international trade flows regarding the ramification of exchange rate and price level, the researcher has no hindrance to econometric tool and modelling for doing research in this topic. However, literature on this has not grown sufficiently as commodity-wise data unavailability hinders conducting such research. But the Australian government office of foreign affair and trade has kept monthly commodity-wise export and import level of quantity and price data for a substantial period from 1988 .This provides more than 30 years of data which allows the impact to be gauged by time series techniques. A preliminary awareness can be created by looking at the correlation coefficients and bi-variate relationship between bilateral trade balance of Australian agricultural commodities for the major five partners with inflation and real exchange rates.

Table 1: Australian bilateral trade balance correlation with own inflation and real exchange rate

	Trade Balance with				
	China	Japan	Korea	Thailand	The USA
Australian Inflation Rate	0.393979	0.317883	0.081328	0.272758	0.147311
Australian Real Exchange Rate	-0.168532	-0.400220	-0.267081	-0.246019	-0.302471

To this end, table 1 shows the correlation coefficients of Australian trade balance with its own inflation and bilateral real exchange rates. Figures 3 and 4 (Appendix VI) postulate the bi-variate relationship between bilateral trade balances of the same five countries with own inflation and bilateral real exchange rates. All correlation coefficients and bi-variate relationships of trade balance and real exchange rate are negative in these cases which is theoretically correct. However, the same are positive with inflation rates. Theoretically, this is an illogical outcome as it means that when the inflation rate increases, Australian agricultural commodities exports should be increased and import should be decreased. This is probably impact of price level on trade balance is offset by other factors such as income, real exchange rate, Australian people taste towards foreign products, etc. This initial result also indicates that the relative influence of the real exchange rate on Australian agricultural trade balance is possibly higher than the impact of its own price level.

Based on the unusual relationships among trade balance, exchange rate and price levels a basic question is raised regarding whether the change in the exchange rate contributes more than to the change of price level in the net external position of a country's particular sector such as agricultural, fish and forest products. In this study we have tried to determine the answer of this basic empirical question. Either exchange rate or price may have a faster favourable impact in this sector.

Wilson and Tackacs (1977) and three decades later again Bahmani-Oskooee and Kara (2008) have taken the initiative to fill this vacuum somewhat by analyzing the impact of exchange rate on trade balance. However, the agricultural sector is omitted from his analysis. Therefore, the objective of this paper is to examine the validity of Orcutt's (1950) hypothesis - a famous theoretical phenomenon that still remains under the cloud of ambiguity. Our intent is to investigate whether the impact of exchange rate and or price level have the quick impact on the net external trade balance of Australian AFF products with its top five trading partners: USA, Japan, China, Korea and Thailand. Earlier studies for different countries and regions focused mainly on industrial or manufacturing products but not on non-durable AFF products (Omisakin et. al (2010), Bahmani-Oskooee and Ebadi (2015 (a) & (b)), Bahmani-Oskooee and Hosny (2015(I) & (II)), Bahmani-Oskooee and Baek (2015), Bahmani-Oskooee and Durmaz(2017), Khan and Ali (2020)). Due to their non-durable characteristic, high dependence on nature, long gestation period for production, and the difference in inventory preserving techniques, the response of exchange rate and price changing on AFF products may differ from the response of the durable manufacturing products. Further, the impact may differ from other countries' AFF products for land abundant Australia - the most basic input of agricultural output. For this facet of AFF products this research is also a topical innovation and an attempt to fill up long held gaps in research.

Table 2: Contribution to AFF Trade by major 5 partners for the period 1988-2020.

Trading Partner of Australia	Percentage of Total AFF Imports	Percentage of Total AFF Exports
USA	11.23	8.31
Japan	10.15	13.01
China	8.16	20.50
Korea	7.25	7.22
Thailand	6.13	5.82

Source: Department of Foreign Affairs and Trade, Australia

Table 2 shows the trade view of Australia with its five major trading partners. These five countries have constituted between 43 and 55 percent of Australian AFF imports and exports respectively in 2020. Since Australia is a country with abundant land resources and AFF production requires intensive use of land resources, Australia has much scope to enlarge its contribution by AFF in its total trade share. By considering the above backdrop, this article takes the initiative to test the validity of the Orcutt (1950) hypothesis between Australia versus its major five AFF product trading partners.

To that end, we present the literature review in Section II, outline of the data, models and econometric techniques in Section III, Section IV explains the summary and analysis of the results, and conclusion and policy implications are reported in the Section V. References and Appendix are in the subsequent sections.

3.3. LITERATURE REVIEW

The study by Orcutt (1950) has inferred that trade flow is the function of country's domestic relative price and exchange rate. However, he has shown that trade flow response is not uniform to them and responds with a faster speed to the changes in exchange rate than to the changes in relative prices. Against such claims he has argued that this difference in response to the exchange rate and the relative price is reasoned with five lags which are recognition lag, decision lag, delivery lag, replacement lag, and production lag. He has further pointed out that such lag effects are also effective somewhat for price changes too. However, businesses perceive exchange rate changes in a shorter period than changes in prices levels which lingers the price impact more than exchange rate lags.

After the advent of Orcutt's (1950) hypothesis, it has not come in sight of the researchers immediately. At that time, researchers were busy to prove whether exchange rate is really a significant determinant of trade flows. Thus, firstly Kreinin (1967) obtained the evidence of both price and exchange rate as important determinants in trade flows between countries. This result was supported by the findings of Houthakker and Magee (1969), and Junz and Rhomberg (1973). None of them, however, has compared the relative length of time, both for exchange rate and relative price, it would take to enforce their impacts on trade flows.

Subsequently, Wilson and Tackacs (1977) have perhaps firstly agreed with this hypothesis that the trade balance is affected in a relatively shorter period by the changes in exchange rate than to the variation in relative prices.

Chambers and Just (1978) investigated the relative impact of the price and exchange rate for the US agricultural grain trade flows for the period of 1955-1973 by quarterly time series data. They have concluded that much of the problem of measuring exchange rate and individual commodity prices stemmed from a lack of price indices for certain commodities, and that impacts of exchange rates were relatively larger than impact of prices.

Bahmani-Oskooee (1986) and Tegene (1989, 1991) have given empirical evidence of contradiction in justification of Orcutt's view. This was further supported by findings of Marquez (1999) showing conflicting proof. Thus, they all conclude against the proposition of this hypothesis.

Alse and Bahmani-Oskooee (1995) point out that as devaluation increases the import prices and decreases the price of exports abroad, its impact will be visible if the country has no supply constraints for exports and demand constraints for imports. However, according to Bergin and Feenstra (2009) the devaluation is useful only when the price elasticity of demand and supply is respectively greater and smaller than one.

Later, Bahmani-Oskooee and Niroomand's (1998) investigation show that the devaluation is less effective for trade flows of the developed countries than compared to the developing countries.

Bahmani-Oskooee and Kara (2003) have involved in co-integration bound testing and error-correction approach for 9 industrial countries data sets and have used the criteria of the significance lag length of relative prices and exchange rate. By this way, they have found out that the results are country-specific and there is no general pattern and conclusion in this regard. The same results have been found again for 12 developing countries later by Bahmani-Oskooee and Kara (2008).

Omisakin et. al. (2010) have evaluated the relative responsiveness of trade flows to changes in real effective exchange rate and price level among the selected six African countries by the aggregate yearly trade data of 1980 to 2007. Their results reveal that both export and import have the long-run relationships with exchange rate and relative prices for the selected countries. However, their results have rather undermined and contradicted the validity of the Orcutt (1950) hypothesis as result indicates that export flow responds quicker to relative prices than it does to exchange rate.

Bahmani-Oskooee and Ebadi (2015(a)) have tested the Orcutt (1950) hypothesis using the significant lag length on both the exchange rate and relative prices for 8 industrial countries. Orcutt's hypothesis was supported in the import demand model of Germany and Japan and in the export demand model of the USA. More precisely, out of totally 16 cases only three cases showed the impulse response of imports and exports to the nominal exchange rate have died out faster than the same response to relative prices.

Bahmani-Oskooee, and Ebadi (2015 (b)) have again checked the validity of this hypothesis for six developing countries using the data of trade flows by Generalized Impulse Response (GIR) function and SD shock to the nominal exchange rate and to the relative prices. They have found out that the data sample of the study does not much support this hypothesis. Findings for developing countries by this study are similar to those found for developed countries in previous studies Bahmani-Oskooee, and Ebadi (2015 (1)).

Bahmani-Oskooee and Hosny (2015(I)) have examined the Orcutt's (1950) hypothesis for the commodity level quarterly data from Egypt and the USA for 59 industries. Orcutt's (1950) hypothesis is supported in case of one third of the industries where imports and exports reacted to exchange rate changes faster than relative price changes. They have concluded that exchange rate is not an important driving force of the trade balance.

Again, Bahmani-Oskooee and Hosny (2015(II)) have investigated the Orcutt (1950) hypothesis for 36 industries trading between Egypt and the USA. Using industry level data they have got the support for the hypothesis in the case of about 50 percent of industries.

Bahmani-Oskooee and Baek (2015) have inspected the industry level monthly data from 1991 to 2012 for Korean exports and imports with the USA. The hypothesis is supported in four Korean importing industries and two Korean exporting industries only. They have reached in the decision that while nominal bilateral Won-Dollar rate is a main long-run determinant of Korean imports, the US income is the main long-run determinant of Korean exports to the United States. They argue that depending on availability of data, future research should continue by using disaggregated industry or commodity level data to further explore this issue.

Bahmani-Oskooee and Durmaz (2016) have tested the Orcutt (1950) hypothesis using commodity level monthly data from 54 industries using the trade between Turkey and the US over the period of 1994 to 2014. Their findings are very clear that the Orcutt (1950) hypothesis is supported in only 16 industries. Moreover, 13 Industries results contradicted the notion of this hypothesis. The remaining 25 industries have given inconclusive results where lags are same for exchange rate and relative prices of export and imports.

Rahman *et. al*. (2018) investigated the validity of the Orcutt hypothesis among the selected developed and developing countries. Data coverage is given for 10 countries where five of each of the countries belong to developed and developing groups. With Australia is also one of them. Their findings show that Orcutt (1950) hypothesis is supported only by South African and the USA exports, and imports of the USA and Japan only. Therefore, they have recommended that exchange rate is not so much effective for the correction and improvement of the trade balance of developing countries.

Khan, and Ali (2020) have attempted to demystify the data from Pakistan trade balance with bilateral and disaggregated trade balance using the bound testing and error correction approach for its 8 major trading partners consisting of both developing and developed country groups. Their findings are relatively impressive and have confirmed about the evidence of the Orcutt (1950) hypothesis in five cases by constructing and estimating the import demand equation. Conversely, they have got the evidence in only two cases of the export demand functions.

We have reviewed all the studies of world repository related to Orcutt (1950) hypothesis which have come existence in the last seventy years. According to our investigation this hypothesis is still under researched and thus, there is a large gap in this issue analysis particularly in the case of developed country agricultural sectors. So, there is an overdue literature gap in this highly important issue. It is not clear why research in this issue has not progressed. Overall, we have identified research on Orcutt (1950) hypothesis has following flaws:

1. Research is undertaken with only industrial commodities data not with agricultural product data.
2. Research is conducted on trade between developed and developing country data and not so much with develop – develop country data.
3. The utilised research techniques do not address time series properties of the data.
4. Research has focused on bilateral data for the countries with fixed and flexible exchange rates, and only minimally on the data of perfect flexible – flexible exchange rate regimes.
5. Research is completed for the bilateral data of the countries with independent and without independent central banks where exchange rate is not market representative.
6. Research for the bilateral trading partners where exchange rates are fundamentally flawed and different than rates which appear in the regularly proclaimed exchange rate data due to trade promotional tariff benefit, duty drawback facilities to the traders, trade expanding cash incentive to exporters, exports with input subsidies, latent policies for import protectionism, and where central banks crudely intervene in the FX market rather than with data from free trade and floating exchange rates.
7. Prior researches have not explained why their research have provided mixed results. Researchers may have worked with the data where the impact of exchange rates can be off-set by the impacts of other factors such as income level, commodity quality and consumer tastes, etc. This can be true when the trading company of a developing country trades with

a partner from a developed or high income country. If the trade takes place between two countries of the same development status the scenery and stories can be different.

Our research addresses not only the above gaps in existing literature but also contribute to the following key areas:

1. This research gives a specific focus on agro based data
2. This is a research with develop – develop country data.

3.4. THE MODEL, ECONOMETRIC TECHNIQUE AND DATA

The usual econometric technique for such estimation is defining some import and export demand functions best suited to the commodity level export and import of Australian AFF products. Later researchers try to test the proposed Orcutt (1950) hypothesis based on those fitted import and export demand functions. Following Bahmani-Oskooee and Kara (2008), Australian import demand from the partner country for commodity i would be as follows where specification is done in natural logarithm (ln) so that the coefficients reflect pure elasticity of the respective variables:

$$\text{Ln } IM^{1}{}_{i} = a + b \ln Y_{AUS.i} + c \text{ Ln } \left(\frac{PIMi}{PDAUS}\right) + d \ln E + e_{i} \quad (1)$$

Where IM_i is the imports of commodity i by Australia from the partner country, Here, import demand of commodity i by Australia is assumed to depend on Australian Real GDP (Y_{AUSi}), relative price of commodity i ($\frac{PIMi}{PDAUS}$), and nominal exchange rate (E) at time t. Y_{AUS} is Australian Real GDP, and if an increase in Australia's income increases Australia's imports of commodity i, we can expect an estimated value of b is positive. Conversely, if an increase in Australia's income is due to increase in the production of substitute goods of i, Australia's import of commodity i could decline, and in that case an estimate of b should be negative. The next determinant of import of commodity i is assumed relative price of commodity i where we calculate relative price as a ratio of import price (PMi) and domestic price (PDi) of commodity i. Further, it is assumed that an estimate of c should be negative. In a combined way, PIM_i/PD_{AUS} - the relative Import Price Index. Finally, nominal exchange rate, E, is another determinant of Australian import of commodity i where E is defined as number of Australian dollars per Yen/Won/Yuan/Baht/US Dollar. If depreciation of the Australian dollar reduces Australia's imports of commodity i, an estimate of d is expected to be negative.

Estimation of equation (1) gives us the long-run coefficient those are unable to help us to perceive the viability of Orcutt (1950) hypothesis. To obtain comparatively more stable estimated coefficients with dynamic adjustment of commodity i, to changes of income, relative price, and nominal exchange rate, Bahmani-Oskooee and Kara (2008) also recommend converting equation (1) into a dynamic adjustment model by incorporating the short-run dynamic adjustment mechanism. Econometricians usually re-specify equation (1) by converting it into an Error Correction Model (ECM) proposed by Peseran *et. al*. (2001). Thus, our dynamic specification stands as equation (2) below, keeping coherence with the suggestion of Peseran *et al.* (2001) and Bahmani-Oskooee and Hosny (2013). Our empirical estimation will be based on time series analysis using data for the period of 1988Q1- 2020Q4 where the non-linear ARDL estimation technique is employed.

$$\Delta lnIM_t^i = \alpha + \sum_{j=0}^{n} \beta_j \Delta lnY_{AUS,I-J} + \sum_{j-0}^{n} \gamma_j \Delta \ln\left(\frac{PIMi}{PD_{AUS}}\right))_{t-j} + \sum_{j=1}^{n} \Theta_j \; \Delta lnE_{t-j}^i + \sum_{j=1}^{n} \lambda_j \; \Delta lnIM_{t-j}^i + \sigma_1 lnY_{AUS,J-1} + \sigma_2 \ln\left(\frac{PIM}{PD_{AUS}}\right)_{T-1} + \sum_{j=1}^{n} \sigma_3 lnE_{t-1}^i + \sigma_4 lnIM_{t-1}^i + \varepsilon_t$$

(2)

Equation (2) is an error correction model (ECM) that simulate Peseran *et. al.* (2001) and duplicates Engle-Granger technique. The difference against the Engle-Granger (1987) theorem is the inclusion of lagged level error correction term i.e. e_{t-1} is substituted by the lagged level variables. This type of specification by Pesaran *et. al.* (2001) has a number of benefits over Engle-Granger (1987) type specifications. One mentionable benefit is that researchers need not to conduct pre-unit root test for a data series that has time series dimension during testing co-integration as the integrating properties of the variables are incorporated in the model itself. To be confirmed about the presence of co-integration, Peseran *et. al*. (2001) proposes a newly invented standard F-Test that establishes joint significance of the lagged level variables as an indication co-integration. For this technique of co-integration method, they have tabulated a newly invented F-Table with new critical values of upper and lower bounds. Here, upper and lower bound critical values are imposed assuming that all variables used in the model are I(1) and I(0) respectively. To get the evidence of co-integration, the calculated F-Statistic must be greater than the upper bound critical value. Peseran et. al. (2001) have shown that the upper bound critical value can be used even if the variables have mixed pattern of I(1) and I(0). However, there should not have any variable of I(2). Since most of the time, series macroeconomic variables are either I(1) or I(0), prominent researchers believe that there is no need for unit root testing before running the model. Another benefit of this method is that it is a single-step process in which both short and long-run effects are estimated just by one model estimation. For example, in our case (i.e. in model 2), long-run effects of all variables (i.e. determinants) on the level of Australian imports of commodity i are inferred by the estimates of $\sigma_1 - \sigma_3$ that are normalized on σ_4. The short-run effects are also attained by the estimated coefficients of first-differenced variables. In order to test the Orcutt (1950) hypothesis we need to rely only on short-run dynamic adjustments of above equation (2). So, to test this hypothesis in our stated set up we need to determine and compare the number of lags of the relative price [$\Delta \ln\left(\frac{PIMi}{PD_{AUS}}\right))_{t-j}$]and nominal exchange rate [ΔlnE_{t-j}^i]. Orcutt hypothesis should be evidenced if the lags of the nominal exchange rates are shorter than the lags of relative price.

Next, we need to conduct the same operation for bilateral exports of Australia with its five major partner countries (= USA, Japan, China, Korea, and Thailand). To formulate the long-run export demand function to partner countries X for Australian AFF commodity exports of i (EX_i) as a function of the country's X income (Y_X), relative price ($\frac{PEXi}{PDx}$) , and nominal exchange rate ($E_{x.i}$) as in (3):

$$\text{Ln } EX^1{}_i = a' + b' \ln Y_{x.i} + c' \text{ Ln } \left(\frac{PEXi}{PDx}\right) + d' \ln E_{x.i} + e'_i \qquad (3)$$

Again, the three variables income, relative price and bilateral nominal exchange rates are assumed as the main determinant of Australian AFF exports. Here, if the trading partner country's income or economic activity ($Y_{x)}$ increases, exports of Australian AFF products is expected to be increased.

Secondly, any increase in the relative price of Australian AFF products will harm its' exports to partner countries. Finally, a depreciation of Australian Dollar i.e. an increase in E will raise Australian exports of commodity i. Thus, we expect an estimate of b', c', and d' should be positive, negative and positive respectively. Further, testing Orcutt (1950) hypothesis related to Australian exports has no difference with testing procedure of imports. Now, the ECM model associated with equation (3) yields the following shape:

$$\Delta lnEX_t^i = \alpha' + \sum_{j=0}^{n} \beta'_j \Delta lnY_{X,I-J} + \sum_{j-0}^{n} \gamma'_j \Delta \ln\left(\frac{PEXi}{PD_X}\right)_{t-j} + \lambda' \sum_{j=0}^{n} \beta'_j \Delta lnE_{X,I-J} + \sum_{j=1}^{n} \Theta'_j \Delta lnEX_{t-j}^i + \sigma'_1 lnY_{X,J-1} + \sigma'_2 \ln\left(\frac{PEX}{PD_X}\right)_{T-1} + \sigma'_{3i} lnE_{X,J-1} + +\sigma'_4 lnEX_{t-1}^i + \varepsilon'_t \quad (4)$$

Once again, equation (4) is estimated, the short-run effects inferred by the estimates of coefficients related to first-differenced variables, and long-run effects are accompanied by the estimates of σ'_1 and σ'_3 normalized on σ'_4.

Orcutt (1950) hypothesis will be satisfied if both the imports and exports respond rapidly for nominal exchange rates compared to the relative prices of the respective AFF commodities. The data, variables and traded AFF commodities are reported in Appendix 1 and Appendix 2, respectively.

3.5. RESULTS, DISCUSSION, AND RESULTS SUMMARY

As noted earlier, in this research, the Bahmani-Oskooee and Hosny (2013) type of modified error-correction models shown in equation (2) and (4) for all five AFF products trading partners of Australia relying on the quarterly data for the period of 1988Q1-2020Q4 has been used. We have estimated all export and import demand functions, imposing a lag 4 in each model. To select the optimal number of lag we have resorted the Akaike Information Criterion (AIC). In this way, we believe that each reported result is econometrically an optimum model. Now that we have the coefficients of optimally estimated models, we can infer the validity of Orcutt (1950) hypothesis. To do so, we require only the short-run coefficients of the error correction model postulated in equation (2) and (4). Therefore, we have reported the first significant short-run coefficients of each export and import demand model and its respective lag only. Since we need only "first significant short-run and its lag value" for our purpose we do not need to report the higher lagged short-run coefficients. There is no requirement to report the long-run coefficients of the estimated models as they are not related to our present concern. However, those coefficients can be supplied on request. As the inference technique in each model is the same, we are providing a brief and general outline only.

Table 3: Bound of the ARDL F-test when sample size is 130 and degrees of freedom is 2

ARDL Bounds Test for the sample period 1988Q3-2020Q4 (observation = 132)

F-statistic with degrees of freedom k = 2 for each model of each country fair

Critical value Bounds Tabulated by Peseran

Significance	I(0) Bound	I(1) Bound
10%	2.63	2.35
5%	3.10	3.87
1%	4.13	5.00

Since it is an ARDL species of ECM, we need to have a significant F-statistic to be confirmed about the co-integration between dependent (first differenced of export or imports) and explanatory variables (income, exchange rate, and relative price). The distribution table this F-test statistic is tabulated by Peseran *et. al.* (2001) where the significance of this calculated F-statistic means that relationship between the dependent and explanatory variables is meaningful (Table 3) since they have long-run equilibrium or co-integrated relationship. After having proof of a co-integrated relationship, we can turn our focus on the relevant diagnostic tests. To this end we have reported five diagnostic test results to gauge the accuracy of the estimation process. We have estimated the error component term (ECT) commonly known as ECM_{t-1} with optimum value of lag. This is nothing but the speed of convergence to the long-run equilibrium. Conceptually, higher value of significant negative ECM_{t-1} confirms higher speed of convergence i.e., the higher the better. The Lagrange Multiplier (LM) notes whether the error term suffers from serial correlation. We have relied on the Breush-Godfrey Serial Correlation LM test for this purpose. It is distributed as $ƛ^2$ and in our case it has 2 (two) degrees of freedom with a critical value of 5.99 since our sample size is 132. Additionally, Ramsey RESET test is used to identify if any misspecification in the designed functions exists. The test statistic of RESET test is also distributed as $ƛ^2$ with degrees of freedom 1 (one) for all estimated models. Further, we have applied the widely used CUSUM and CUSUMS tests to define the stability of the models and their estimated coefficients where stability is described by “S” and the instability by “US”. Finally, we also want to report the measurement of goodness of fit of the estimated models. Since using the supernumerary and unnecessary variable also gives us inflated as well as overestimated R^2, we have reported only adjusted-R^2.

The results of the application of the above econometric techniques for the five major AFF trading partners of Australia is elaborately given below:

Table A1 and B1 of Appendix report the results of the import and export demand models respectively for Australian AFF trade with the USA. As our sample size is 132, if the t-statistic is 1.646 (10% degrees of freedom) or above we have considered the coefficients are significant. By a careful review of Table A1, it is seen that the lag level of the significant short-run coefficient of nominal exchange rate in import demand function is smaller than the significant short-run coefficient of relative price for 67.59% (19 out of 29) of AFF products imported to Australia from the USA. Similarly, Table B1 shows that the lag value of nominal exchange rate in the estimated short-run function of the AFF exports demand by the US economy from Australia is smaller than the significant short-run relative price coefficient is in case of 63.98% (19 out of 29) products.

In the Appendix V, results of Australian AFF imports and exports demand functions with Japan are reported in the Table A2 and B2 respectively. The nominal exchange rate coefficient has negative and significant with shorter lag for 18 products amounting to 68.67% of AFF products imports of Australia from Japan than relative prices. That is, Australia has more scope to reduce AFF import imports from Japan by manipulating the exchange rate than relative import prices with a view to improve the trade balance. Now, Table B2 for the estimates of the Australian exports demand by Japanese economy can be considered. Negative and significant elasticity with a smaller lag of nominal exchange rate to relative export prices are obtained by about 58.17% AFF exports by Australia to Japan. It indicates that Australia has an option to increase exports of AFF products to Japan by exchange rate management than to relative price manipulation.

Table A3 and B3 (Appendix V) report the results of the fitted imports and exports demand models respectively for Australian AFF products with China. By the visual inspection of Table A3 it is clear that the lag with lower temporal values by significant coefficient of nominal exchange rate than relative import prices is 93.75% of AFF product imports by Australia from China. It indicates that Australian AFF commodities exports to China supports the Orcutt (1950) hypothesis overwhelmingly. Next, Table B3 describes Australian AFF exports function to China. In this case we have got that the nominal exchange rate coefficients of 70.39% Australian exports to China is significant, negative and with shorter lag than relative price lag levels which means that Australian AFF exports to China is highly supportive the Orcutt (1950) hypothesis.

Our next focus is on Table A4 and B4 (Appendix V) to understand the status of Australian and Korean bilateral trade of AFF products. Table A4 shows that the nominal exchange rate for approximately 62.10% of AFF products has a shorter and more significant lag with negatively signed elasticities than significant relative import price, meaning that gestation period of impact by nominal exchange rate is lower than relative prices for Australian major share of imports from Korea. Next, by reviewing the Table B4 we can predict the Australian AFF products demanded by the Korean economy. The short-run nominal exchange rate is carrying a negative and significant coefficient with shorter lag levels compare to relative price coefficients for 68.29% of total Australian AFF exports to Korea. So, our fitted model for Korea indicates the efficacy of Orcutt (1950) hypothesis in the case of Australian trade.

Lastly, we look at Tables A5 and B5 (Appendix V) which do the same work for the AFF commodity level import and export demand model of Australia with Thailand. It is observed that in the case of Australian imports, elasticities of the nominal exchange rate with negative, significant and smaller lags than lag of relative price significant elasticities is for about 52.29% of AFF products imported by Australia from Thailand exist. So, almost half of the Australian AFF imports from Thailand have recorded the supports to Orcutt (1950) hypothesis. It means that the nominal exchange rate and relative price takes almost similar period to show a perceptible impact on AFF imports from Thailand. To analyze AFF exports to Thailand, we look at Table B5. In the case of AFF exports to Thailand, nominal exchange rate coefficients have a significant and shorter length of lag to relative export price elasticity which is about for 73.16% Australian exports. From Tables A5 and B5, it is observed that for 52.29% and 78.12% of Australian AFF imports and exports respectively with Thailand, the Orcutt (1950) hypothesis is satisfied.

The summary of the above discussed results is presented in Table 4 below so that decisions on the Orcutt (1950) hypothesis can be made easily.

Table 4: Australian AFF trade performance with major five partners

Trading Partner Name	Total Items Imported	Total Items Agrees the Hypothesis	Percentage Agrees to hypothesis	Total Items Exported	Total Items Agrees the Hypothesis	Percentage Agrees to hypothesis

The USA	29	19	67.59	29	19	63.98
Japan	28	18	68.67	29	17	58.17
China	11	10	93.75	7	5	70.39
Korea	29	18	62.10	36	22	68.29
Thailand	32	15	52.29	27	13	73.16

Source: Authors own compilation based on data provided by the government of Australia, DFAT Australia.

Table 4 shows briefly the results of our fitted model to draw inference about the Orcutt (1950) hypothesis and the effectiveness of Australian AFF trade balance with it's five major partners. It is clear and easy to infer that the majority of Australian AFF trade with the biggest partners confirms the efficacy of the Orcutt (1950) hypothesis which means that nominal exchange rates take a shorter period to validate the impact on foreign trade of AFF products than relative domestic prices. According to these findings, depreciation of the domestic currency either by market forces or by any other means would bring improvement of the Australian AFF TB in a relatively shorter period than a decrease of the relative prices. This finding has significant policy implications when TB needs to improve quickly. Moreover, the results suggest that in addition to ER depreciation through monetary and fiscal policies, some other relevant policies such as export promotion by applying tariff and taxation benefits for foreign traders of AFF products would support an increase to profit margins can also help assist in a swift recovery of falling AFF TB for the country.

In our results, F-statistics are significant in almost all cases meaning that confirmed co-integration exists among dependent and explanatory variables. These results are reinforced by the estimated ECM_{t-1} with an optimum lag. The speed of convergence is fairly large in most cases. The Breush-Godfrey Serial Correlation LM test result indicates that our model does not suffer from autocorrelation. Further, Ramsey RESET test is showing that the designed functions are free from misspecification. The stability tests also reveal that most functions and their estimated coefficients are stable over the fitted data period. We believe that estimated models and their coefficients are reliable.

3.6. CONCLUSION AND POLICY IMPLICATIONS

Economists have been working to invent different means to improve a countries trade balance as it is important for a feasible and functional trade relationship with other countries in the world. Positive trade balance always bolsters the sustainable trade balance of a country and although much research is not conducted, the validity of the Orcutt (1950) hypothesis can be a one way to improve the trade balance of a country without much distortion of the domestic price level. This can generate a convenient option for the central bank of a country in its' monetary policy formulation and implementation. The findings of this research show that this hypothesis is valid for the majority share of imports and exports of Australian AFF sectors for it's largest five partners.

We have got that there are two types of analysis in this topic. Some of them are using aggregate trade balance and others are based on commodity level data. Analyses are insufficient in either sides. Further, first types of researches have raised questions due to not addressing the requirements of time series properties and aggregation biasness of the used data. The second category of the researches have focused only on industrial commodities trade balances. None of them are involved in research considering agricultural sector data. To overcome the limitations of prior studies, we have focused on commodity-wise agricultural sector data. We have also involved to use the latest econometric knowledge in regard to time series nature of the data.

We have reviewed multiple studies of this topic and have found that a large gap exists in existing literature since Orcutt (1950) hypothesis. After reviewing available research in this topic our understanding is that Orcutt (1950) hypothesis is extremely under researched, though its policy implication is vital for both developed and developing economies. This provides the primary the reason this old but important issue is being explored. The reasons of staying out of focus of the eyeballs of the researchers of this topic is not known to us - it may be either aloofness of the researchers or unavailability of the individual commodity prices of the trading goods. Therefore, this is perhaps the first ever research on Orcutt (1950) hypothesis with a special focus on AFF trade balance for any country or region in the world and it is understood that no prior research exists in this topic. Thus, we believe this paper will fill in this literature gap that presently exists.

Findings of this research show that majority percent of AFF trade supports the Orcutt (1950) hypothesis which means that if Australia wants to improve AFF trade balance instead of domestic price level, manipulation of nominal exchange rate would be a relatively better option to undertake. We believe that the research has important policy implications for the country which has relatively a larger agriculture sector and for the countries with equally large agricultural sector that has relatively high international linkage such as USA, Australia and India than other sector of the economy. So, this research finding has important policy implications regardless of the development status of the country.

Now, Australian general policy is to follow a market based and liberalized trading policy with rest of the world. The exchange rate of Australia is also determined by a market based flexible exchange rate regime. Therefore, one may raise a question that can a research finding that says nominal exchange rate depreciation would help its trade balance have a policy implication? In this case our answer is that since the central bank of Australia is independent from the federal government, it may favourably manipulate the exchange rate using a suitable monetary policy should it wish to improve trade balances. The federal government may also use its encouraging fiscal policy to expedite the country's foreign trade.

Last but not least, findings of this research suggest resistance to the proposition of Burda and Gerlach (1992) which says that durable products should be relatively more sensitive to the changes of exchange rate than non-durable products. Since AFF commodities are mostly non-durable in nature and Orcutt (1950) hypothesis is supported by greater segments of exports and imports for each of the five biggest AFF trade partners of Australia, it is proven that this proposition is not valid for the data of this study. This is perhaps due to the modern techniques used by Australia in AFF products preservation that increases durability for AFF products in the supply chains for both home and abroad.

Our suggestion is that, to obtain fair and reliable research results, depending on the data availability in future research to verify the validity and implication of Orcutt (1950) hypothesis, analysis should continue only with the product level data by incorporating all exchange rate and trade distorting factors in the model.

3.7. REFERENCES

Alse, J. and Bahmani-Oskooee, M. (1995) Do devaluations improve or worsen the terms of trade? Journal of Economic Studies, Vol. 22, PP. 16–25

Bahmani-Oskooee, M. (1986) Determinants of international trade flows: the case of developing countries, Journal of Development Economics, Vol. 20, PP. 107–23.

Bahmani-Oskooee, M. and Baek, J (2015). The Marshall_Lerner Condition at commodity level: Evidence from Korean-US trade. Economic Bulletin, Vol. 35, Issue 2.

Bahmani-Oskooee, M., & Baek, J. (2015).Further evidence on Orcutt's hypothesis using Korean–US commodity data. Applied Economics Letters, 22(9), 717-724.

Bahmani-Oskooee, M., & Ebadi, E. (2015).Impulse response analysis and Orcutt's hypothesis in trade. Empirica, 42(3), 673-683.

Bahmani-Oskooee, M. and Durmaz, N. (2017). Evidence on Orcutt's hypothesis using Turkish–US commodity trade. The Journal of International Trade & Economic Development. 26(1), 25-44

Bahmani-Oskooee, M., & Hosny, A. S. (2015a).Commodity trade between EU and Egypt and Orcutt's hypothesis. Empirica, 42(1), 1-24.

Bahmani-Oskooee, M., & Hosny, A. S. (2015b). Orcutt's hypothesis revisited: evidence from commodity prices. International Journal of Public Policy, 11(4- 6), 152-168

Bahmani Oskooee, H and Hosny, A S (2015) "Orcutt's Hypothesis Revisited: Evidence from Commodity Prices", International Journal of Public Policy, Vol. 11 (2015), pp. 152-168

Bahmani-Oskooee, M. and Kara, O. (2003) Relative responsiveness of trade flows to a change in prices and exchange rate, International Review of Applied Economics, 17, 293–308.

Bahmani-Oskooee, M., & Kara, O. (2008). Relative responsiveness of trade flows to a change in prices and exchange rate in developing countries. Journal of Economic Development, 33(1), 147-163

Bahmani-Oskooee, M. and Niroomand, F. (1998). "Long-run Price Elasticities and the Marshall–Lerner Condition Revisited", *Economics Letters*, Vol. 61, pp 101–109.

Bergin, P. R. and R. C. Feenstra (2009) Pass-Through of Exchange Rates and Competition between Floaters and Fixers, Journal of Money, Credit and Banking, 41, 35–70

Burda, M. C. and Gerlach, S. (1992). 'Intertemporal Prices and the US Trade Balance', *American Economic Review*, Vol. 82, pp. 1234–1253.

Chambers R G and Just R E (1981) Effect of exchange rate changes in the US agriculture: A dynamic analysis, American Agricultural Economic Association 1981 Vol 21 (2) pp 65-82

Houthakker H, Magee S (1969). Income and price elasticities in world trade. Rev. Econ. Stat., 51(2): 111-125

Junz H, Rhomberg R (1973). Price competitiveness in export trade among industrial countries. Am. Econ. Rev., Papers Proc., 63: 412- 418

Junz, H. and Rhomberg, R. R. (1973) Price competitiveness in export trade among industrial countries, American Economic Review, Papers and Proceedings, 63, 412–18.

Khan, S U., and Ali, A. (2020) Testing the Orcutt hypothesis: evidence from Pakistan's bilateral trade flows, Pakistan Economic Review 3:2 (Winter 2020), pp.80-91

Kreinin M (1967) Price elasticities in international trade. Rev. Econ. Stat., 49(4): 510-516

Marquez J (1999). Long-period stable trade elasticities for Canada, Japan, and the United States. Rev. Int. Econ., 7: 102-116

Omisakin, O., Oyinlola, A., and Adeniy, O. (2010) Relative responsiveness of trade flows to changes in exchange rate and prices in selected ECOWAS countries: Does Orcutt hypothesis hold? Journal of Economics and International Finance Vol. 2(6), pp. 102-108, June 2010

Omisakin, O., Oyinlola, A., & Adeniyi, O. (2010). Relative responsiveness of trade flows to changes in exchange rate and prices in selected ECOWAS countries: Does Orcutt hypothesis hold?. Journal of Economics and International Finance, 2(6), 102.

Orcutt, G. H. (1950) Measurement of price elasticities in international trade, The Review of Economics and Statistics, 32, 117–132.

Pesaran, M. H., Shin, Y. and Smith, R. J. (2001) Bounds testing approaches to the analysis of level relationships, Journal of Applied Econometrics, 16, 289– 326

Rehman, K U, Azhar, M U R., Masood, S., Malek N M. (2018) An Empirical Investigation of Orcutt's Hypothesis: Evidence from Selected Developed and Developing Countries, International Journal of Research and Innovation in Social Science, Volume II, Issue VIII, (2018) pp. 6 -16

Tegene, A. (1989) On the effects of relative prices and effective exchange rates on trade flows of LDCs, Applied Economics, 21, 1447–63.

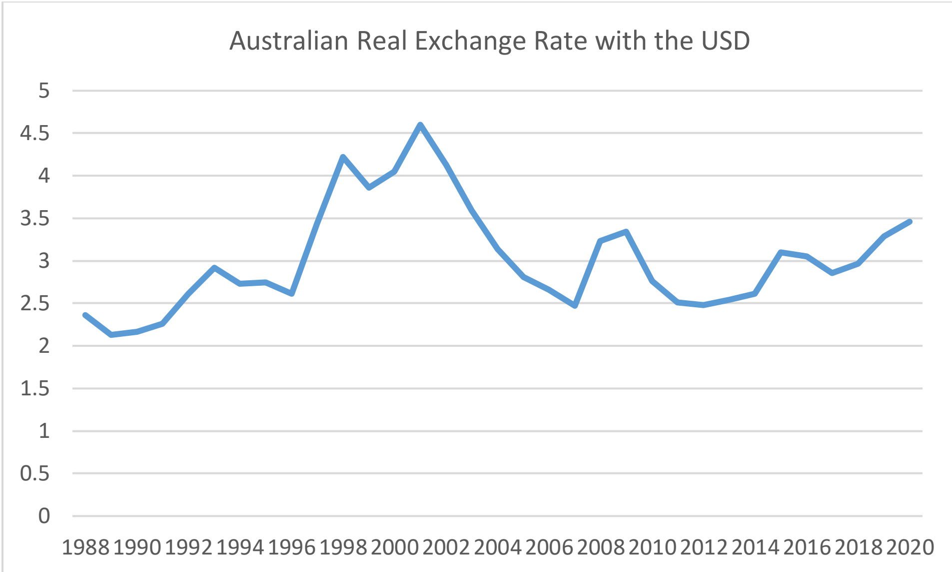
Tegene, A. (1991) Trade flows, relative prices, and effective exchange rates: a VAR on Ethiopian data, Applied Economics, 23, 1369–76.

Wilson, J. F. and Takacs, W. E. (1979) Differential responses to price and exchange rate influences in the foreign trade of selected industrial countries, The Review of Economics and Statistics, 61(2), 267–79

3.8.1. APPENDIX 1

Figure 01: **Yearly Inflation rate of Australia over the period of 1988-2020**

Figure 02: **Yearly Real Exchange Rate of Australia with the USD over the period of 1988-2020**



3.8.2. APPENDIX 2

3.8.2. *Data and Information and Sources*

Quarterly data over the 1988Q1 - 2020Q4 period are used to carry out the empirical analysis. Data used in this research is seasonally adjusted by Hodrick-Prescott (HP) filterization technique. The data categories and source are as follows:

3.8.2. *List of Variables*

IMi = For each Commodity i, IM is the volume of Australia Imports from the trading partner country X. It is defined as the ratio of the value of Australian Imports from the trading partner X over the respective import price index of commodity i.

EXi = For each commodity i, EX is the volume of Australian exports to the trading partner country X. It is defined as the ratio of Australian exports to the trading partner country X over the respective exports price index of commodity i.

Bilateral Imports and exports values are collected from the Department of Foreign Affairs and Trade of Australian Government. (Data period 1988Q1-2020Q4)

Y_{AUS} = Australian Real GDP. The data come from International financial Statistics (IFS), published by IMF.

Y_X = Real GDP of Australian Trading partner country X (=US, Japan, China, Korea, & Thailand). Data source: IFS.

PMi = For each commodity i, PM is import price index of Australia, collected from IFS

PD = Domestic Price Level in Australia, CPI data is used as proxy data for PD collected from IFS.

PXi = For each commodity i, PX is defined as export price index of Australia, collected from IFS.

P_{AUS} = The Price Level in the US. CPI data used as proxy for P^{AUS} collected from IFS.

3.8.2. APPENDIX 3: List of the indicators and respective AFF commodities Traded by Australia

Indicator	Name of the commodities	Indicator	Name of the Commodities
A	Live Animals	U	Food Industries, residuals, and Wastes Thereof
B	Meat and edible meat offal	V	Tobacco and manufactured tobacco substitutes
C	Fish and crustaceans, molluscs, and other aquatic, invertebrates	W	Salt
D	Diary Produce	X	Milk, milk powder, butter, cheese etc.
E	Animal originated products	Y	Root crops and plants
F	Trees and other plants, live	Z	Dry edible nuts and vegetables

G	Fresh vegetables and certain roots and tubers	A1	Round wood, swan wood, timber etc.
H	Fruit and nuts, edible	B1	Aquaculture, hatcheries and nurseries products
I	Coffee, tea, mate, and spices	C1	Fertilizers originated from natural products
J	Cereals	D1	Tanned, processed and raw hides
K	Products of milling Industry	E1	Non-fish sea extracts
L	Oil seeds and oleaginous fruits	F1	Organic fertilizer and active agents
M	Lac; gums, resins and other vegetable saps and extracts	G1	Residues and waste from the food industries; prepared animal fodder
N	Vegetable plaiting materials	H1	Products of animal origin, not elsewhere specified or included
O	Animal or vegetable fats and oils and their cleavage products	I1	Wool, fine or coarse animal hair, and animal hair yarn
P	Cocoa and Cocoa preparations	J1	Fur skins, leather etc
Q	Preparations of cereals, flour, starch or milk	K1	Feathers and downs prepared
R	Preparations of vegetables, fruit, nuts, or other parts of plants	L1	Furniture
S	Miscellaneous edible preparations	M1	Miscellaneous edible products
T	Beverages, spirits and vinegars	N1	Sugars and sugar confectionary

3.8.2. APPENDIX 4

Table 1: The **Results of the Fitted Model to Australian Imports and exports with the USA**

Panel A1			Import from the USA										First Significant Lag on Nominal Exchange Rate	First Significant Lag on Relative Price	Whether Orcutt (1950) Hypothesis is proved
Item	Contribution in total imports	Contribution by Significant items	$\Delta \ln Y_{AUS}$	$\Delta Ln(E)$	$\Delta Ln(PIM/PD_{AUS})$	F-Test	ECM(t-1)	LM	RESET	CUSUM	CUSUMSQ	Adj-R^2			
A	3.36	3.36	-0.9598*	-0.6298*	-10.1266*	16.3757	-0.1228	0.5818	1.9164	S	S	0.21	1	3	Yes
			-3.7259	-2.0719	-3.8258		-1.7329								
B	3.30	3.30	-1.2029*	-0.4130*	-14.0342*	35.2595	-0.1831	0.5643	16.3728	S	S	0.10	1	2	Yes
			-2.5346	-1.8165	-2.6957		-1.7344								
C	3.36		-0.1497	0.0888	-1.2969	42.3983	-0.0409	2.6418	0.4206	S	US	0.13	1	1	No
			-1.2702	0.5650	-1.1349		-0.4445								
D	3.40	3.40	-0.2688	-0.6658*	-4.0967*	43.4960	-0.5183	0.0746	14.0175	S	S	0.11	2	3	Yes
			-1.599	-2.4289	-2.1726		-1.7714								
E	3.57		-0.1079	-0.0008	-0.9562	28.6470	-0.6597	2.9437	2.0795	US	S	0.18	3	1	No
			-1.0897	-0.0067	-1.0493		-0.9852								
F	1.87	1.87	-0.4593*	-0.6119*	-3.6103*	42.3843	-0.2014	0.9555	0.9555	US	S	0.22	2	4	Yes
			-3.0044	-2.2632	-2.4769		2.4617								
G	3.72	3.72	-0.1320*	-0.3172*	-0.7719*	27.6913	-0.1208	0.9397	19.1127	S	S	0.13	1	2	Yes
			-2.2184	-2.8010	-1.9154		-1.6779								
H	2.57	2.57	-0.7315*	-0.7868*	-8.5003*	43.6697	-0.2418	0.9703	10.4699	US	S	0.14	2	3	Yes
			-4.556	-4.4631	-4.6852		-1.8156								
I	2.87		-0.0331	-0.1561	-0.4221	34.4620	0.0551	24.5170	10.3569	S	US	0.20	3	2	No
			-0.3863	-1.2591	-0.5745		0.4896								
J	3.10	3.10	-0.3927	-0.1605	-3.7040	31.9244	-0.2113	0.2079	0.1428	S	S	0.28	3	4	Yes
			-2.1958*	-1.9520*	-2.0107*		-1.9439								
K	3.15		-0.3895*	-0.0736	-4.1238*	43.0849	-0.0169	2.3318	2.0304	US	US	0.09	4	2	No
			-2.6764	-0.5410	-2.7783		-0.1870								

L	3.93		0.0538	0.1162	-0.3394	33.0474	-0.0028	1.1287	2.1017	S	US	0.11	3	2	No
			0.7353	0.6523	-0.4627		-0.0312								
M	3.32	3.32	0.1247	-0.7749*	-1.1889*	32.6245	-0.1133	1.0919	0.7999	US	S	0.18	2	3	Yes
			1.0309	-1.7648	-1.9105		-1.7455								
N	2.87	2.87	-0.1069	-0.5454*	-0.4761*	30.1601	-0.2202	3.2678	17.2678	S	S	0.10	1	2	Yes
			-0.8896	-1.8649	-2.4096		-1.7424								
O	3.49		0.3466*	-0.2696	-3.8898*	44.0286	-0.1247	5.0593	0.4015	US	S	0.08	1	3	No
			2.7567	-1.5255	-2.7651		-0.9786								
O1	3.88	3.88	0.4165*	-0.2345*	-3.8532*	44.0922	-0.1477	0.9183	21.4847	S	S	0.09	3	4	Yes
			3.8457	-2.2381	-4.0163		-1.6858								
P1	3.58	3.58	0.1948*	-0.2442*	-2.2161*	28.4390	-0.2294	0.7013	12.2248	US	S	0.08	2	3	Yes
			1.7053	-1.8962	-1.9518		-1.6916								
P	3.36	3.36	-0.0686	-0.4826*	-0.0658*	39.1044	-0.0112	3.8966	16.7922	S	US	0.10	1	2	Yes
			-0.4786	-2.7339	-2.0473		-0.1228								
Q	3.69		0.0366	-0.3221*	-0.8932	33.1720	0.0502	7.0807	8.5126	S	S	0.23	2	2	No
			0.2668	-2.7351	-0.6947		0.4796								
R	3.99	3.99	0.3393*	-0.2034*	-3.7084*	42.4244	-0.1653	0.7463	1.0365	S	S	0.31	2	5	Yes
			2.4649	-1.7415	-2.7036		-1.7079								
S	4.26	4.26	0.4080*	-0.8743*	-4.1218*	33.8331	-0.2227	0.1211	29.2505	US	S	0.07	1	3	Yes
			1.7790	-1.9211	-1.9150		-2.2743								
T	4.34		0.4075*	-0.1671	-4.4058*	44.5184	0.1531	36.1372	10.4831	S	US	0.24	3	1	No
			2.3996	-1.3113	-2.3510		1.1178								
U	4.57	4.57	0.5973*	-0.4906*	-5.0289*	9.0765	-0.4368	0.8389	0.0151	S	S	0.22	2	3	Yes
			2.3873	-2.1268	-2.2699		-1.8395								
V	3.43	3.43	-0.3344*	-0.3761*	-4.9232*	40.8721	-0.6628	1.2509	0.8123	US	S	0.16	1	2	Yes
			-1.8934	-1.7655	-2.4145		-2.8306								
W	3.74		0.0528	0.0682	-0.0156	20.9924	-0.0421	8.2262	5.9769	S	S	0.17	3	2	No
			0.9024	0.4662	-0.0239		-0.3925								
X	3.77	3.77	0.7708*	-0.4738*	-8.9554*	35.9753	-0.2663	0.2525	1.7614	S	S	0.18	2	5	Yes
			3.2306	-1.7855	-3.4547		-1.7014								

Y	4.74	4.74	0.1608*	-0.1050*	-1.5274*	24.9533	-0.0799	6.0589	7.1748	S	S	0.17	1	NA	Yes
			1.7217	-0.7295	-1.7712		-0.0825								
Z	4.77	4.77	0.1482*	-0.8384*	-1.3945*	35.6958	-0.5633	0.3287	0.3287	US	S	0.27	1	3	Yes
	0		1.6988	-2.2237	-1.8194		-2.3367								
A1	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
Total	100.00	67.59	…	…	…	…	…	…	…	…	…	…	…	…	…

Panel B1			Export to USA										First Significant Lag on Nominal Exchange Rate	First Significant Lag on Relative Price	Whether Orcutt (1950) Hypothesis is proved
Item	Contribution	Significant	$\Delta \ln Y_x$	ΔLn(E)	Δln(PEXi/PDx)	F-Test	ECM(t-1)	LM	RESET	CUSUM	CUSUMSQ	Adj- R^2			
A	2.98	2.98	0.3384*	0.7389*	-2.6258*	30.8554	-0.1090	0.0252	0.5573	US	S	0.09	1	3	Yes
			1.6678	2.0013	-2.1221		-2.0103								
B	5.77	5.77	0.2209*	0.9215*	-2.5654*	30.1012	-0.7739	2.3643	1.1756	S	S	0.19	2	3	Yes
			2.2964	1.9915	-2.3967		-1.8619								
C	4.42		0.0273	0.0876	-0.0038	30.3521	-0.2152	15.4144	30.2153	S	S	0.20	4	2	No
			0.2883	0.6001	-0.2229		1.7464								
D	4.09	4.09	0.1451*	0.7415*	-1.0980*	20.5996	-0.4216	1.2999	3.5320	S	S	0.13	2	4	Yes
			1.7421	1.8409	-1.9212		-2.2228								
E	3.63		0.3184	0.0737	-3.7884*	34.5164	-0.0014	0.2273	0.3868	US	US	0.06	3	2	No
			1.6026	0.3887	-1.6545		-0.0158								
F	3.02	3.02	-0.1792*	0.5866*	-2.8984*	35.3663	-0.6504	1.3702	13.2954	S	S	0.27	1	2	Yes
			-2.4325	1.9421	-2.8702		-1.8418								
G	3.10	3.10	0.8723*	0.2691*	-1.4559*	39.5417	-0.0868	1.9711	1.8856	US	S	0.12	2	3	Yes
			2.6668	1.7619	-1.9678		-1.9521								
H	4.21	4.21	0.4148*	0.2934*	-4.2835*	24.7941	-0.4417	1.7409	14.1675	US	S	0.18	1	4	Yes
			2.5373	1.7883	-2.4819		-1.7721								
I	2.33		1.3001*	0.4981*	-5.4957*	39.0607	-0.0129	1.3715	4.1437	S	S	0.15	4	3	No
			4.1713	1.9634	-4.0954		-1.9812								
J	2.02	2.02	0.4942*	1.1702*	-8.4605*	29.1891	-0.8839	0.9066	0.6012	S	US	0.11	2	4	Yes
			1.8809	1.8820	-2.2713		-3.0434								
K	4.40		0.2012*	0.2286	-2.7746*	25.4669	0.0469	5.3218	4.5849	S	S	0.10	3	1	No
			1.7673	1.5231	-1.9435		0.4808								
L	3.92		0.1474	0.1688	-1.9018	35.9269	-0.0061	0.5510	1.3612	S	S	0.06	4	1	No
			0.8637	0.7795	-0.9957		-0.0676								
M	3.39	3.39	0.3503*	0.3707*	-3.4754*	36.4711	-0.3262	0.6276	10.8550	US	S	0.20	1	3	Yes

			1.9127	1.9596	-2.1737		-2.2868								
N	0.71	0.71	-0.5583	1.0501*	-5.4103*	27.7169	-0.4162	1.3287	0.4353	S	S	0.15	2	3	Yes
			-1.3398	1.7919	-1.9922		-1.6766								
O	3.43		1.3067*	0.2072	6.5179*	23.2931	0.0174	12.5075	27.3799	S	US	0.25	4	4	No
			4.4223	1.0660	-4.5397		0.1800								
O1	3.35	3.35	0.3715*	1.2101*	-4.7417*	44.2206	-0.2074	3.1144	0.6557	S	S	0.15	1	3	Yes
			3.2504	1.8251	-3.3176		2.1802								
P1	4.30	4.30	-0.1693	0.8264*	-2.3057*	36.2424	-0.2608	1.7994	0.0486	S	S	0.14	2	3	Yes
			-1.2923	1.9195	-1.8986		-2.1583								
P	2.35	2.35	1.1775*	0.4897*	-13.6656*	19.8659	-0.0229	4.8770	13.8689	S	US	0.28	1	2	Yes
			4.6412	1.9423	-4.6247		-0.2498								
Q	0												NA	NA	NA
R	3.79	3.79	0.5828*	0.8737*	-7.1413*	41.8912	-0.0914	2.6071	7.0169	S	S	0.19	2	3	Yes
			3.6292	1.8631	-3.6803		-2.3198								
S	3.66	3.66	0.4174*	0.2065*	-5.4825*	37.1193	-0.1433	0.5593	2.5051	US	S	0.09	1	4	Yes
			2.2747	1.9660	-2.3899		-3.0366								
T	5.06		0.1391	0.4278*	-0.9236	36.9875	-0.1769	30.5338	9.5261	S	S	0.18	4	1	No
			1.1980	3.7524	-0.6643		-1.2308								
U	3.57	3.57	1.3675*	1.1233*	-17.0383*	35.4665	-0.2532	1.8719	2.3262	S	US	0.13	1	3	Yes
			3.3582	2.3747	-3.3938		-2.2348								
V	1.34	1.34	2.2320*	1.9925*	-24.9899*	16.3557	-0.3787	1.0362	1.0362	S	S	0.19	1	2	Yes
			4.0998	3.8156	-4.0270		-1.9950								
W	3.84		0.1559	0.2044	-2.0280	40.3070	-0.0124	1.5231	13.4631	S	S	0.15	4	3	No
			1.0775	1.2395	-1.2234		-0.1360								
X	4.90	4.90	0.6394*	0.6305*	-1.1321*	33.8081	-0.9185	0.4345	-0.7714	S	S	0.11	2	3	Yes
			1.8513	1.7618	-1.8107		-3.2017								
Y	4.99		-0.0686	0.2129	-1.7030	37.3599	-0.0099	0.8612	14.3713	S	US	0.17	2	1	No
			-0.4095	0.7526	-0.7934		-0.1080								
Z	5.04	5.04	-0.2553	0.1932*	-3.6176*	34.8952	-0.3843	0.2584	33.5122	US	S	0.13	3	4	Yes
			-1.0244	1.7234	-1.9992		-2.1445								
A1	2.39	2.39	1.3706*	1.2142*	-17.5252*	8.8040	-0.1256	0.7844	0.7844	US	S	0.21	2	4	Yes
	0		4.1268	2.5406	-4.2449		-2.3545								
Total	100.00	63.98	….	….	….	….	….	….	….	….	….	….			…

Table 2: **The results of the Fitted Model to Australian Imports and exports with Japan**

Panel A2			Imports from Japan										First Significant Lag on Nominal Exchange Rate		
Item	Contribution in total imports	Contribution by Significant items	ΔlnY_{AUS}	$\Delta Ln(E)$	$\Delta Ln(PIM/PD_{AUS})$	F-Test	ECM(t-1)	LM	RESET	CUSUM	CUSUMSQ	Adj-R^2		First Significant Lag on Relative Price	Whether Orcutt (1950) Hypothesis is proved
A	4.42	4.42	1.967*	-2.2048*	-20.8539*	7.4503	-0.5028	1.4751	0.7576	S	S	0.31	1	3	Yes
			2.4513	-2.5579	-10.0239		-6.4138								
B	2.28	2.28	-1.4534	-2.2440*	-17.1473*	25.5439	-0.1795	0.2979	2.3185	S	S	0.24	1	4	Yes
			-1.4912	-2.0851	-8.5211		-1.8167								
C	3.77		0.0873	-4.9365*	-0.0781	30.6034	-0.3975	0.5348	10.6198	S	US	0.34	4	3	No
			0.7496	-2.9300	-0.0593		-3.6973								
D	2.14	2.14	0.1041	-11.4100*	-1.9321*	5.9842	-0.2343	1.4280	9.3766	S	US	0.18	2	4	Yes
			0.1720	-5.4849	-2.1441		-2.4672								
E	3.62	3.62	0.5304*	-0.8776*	-4.8789*	7.1713	-0.1661	1.2771	0.4824	S	S	0.22	2	4	Yes
			1.7441	-2.3039	-2.3377		-1.7347								
F	3.53	3.53	1.8136*	-2.7158*	-19.8350*	10.6951	-0.1911	1.8047	2.9997	US	s	0.20	2	3	Yes
			2.8799	-1.8475	-2.7636		-2.0985								
G	2.14	2.34	0.5593	-2.1710*	-12.4954*	26.4032	-0.0845	2.1625	10.6539	S	S	0.16	1	2	Yes
			0.2234	-1.9845	-5.9628		-1.8843								
H	2.41		0.7627	-0.4118	-9.0352	26.2828	-0.2547	0.0552	1.0604	US	US	0.23	4	1	No
			0.6347	-0.3205	-0.5158		-0.6268								
I	4.17	4.17	7.2575*	-1.2008*	-2.2619*	18.4778	-0.5757	2.1097	4.1369	S	S	0.38	2	3	Yes
			4.2908	-1.8850	-3.5126		-3.0663								
J	4.63		2.4159*	-1.2708*	-3.0943*	8.6600	-0.4008	2.6982	5.4635	S	S	0.22	4	2	No
			1.7056	-2.4631	-2.3601		-5.5307								
K	1.86	1.86	0.6634	-0.1279*	-7.4202*	19.0565	-0.0915	0.2605	0.8498	US	S	0.48	1	4	Yes
			0.7643	-2.2078	-1.9870		-1.9856								
L	1.06		0.3082	-0.2986	-3.4694	12.4412	-0.0256	3.4236	1.0030	S	US	0.14	3	2	No
			0.5277	-0.4797	-0.5159		-1.1832								
M	3.56	3.56	4.2918*	-1.2905*	-6.5225*	20.3703	-0.3537	45.9569	21.2147	US	S	0.26	1	4	No
			2.4408	-1.8724	-2.8251		-3.3188								
N	3.89	3.89	3.9160	-2.2443*	-0.7448*	25.2034	-0.0645	0.9852	0.3371	US	S	0.25	2	3	Yes
			0.9311	-2.5057	-3.3667		-3.5220								
O	4.47	4.47	2.2385	-2.2517*	-0.1583*	28.9018	-0.1261	0.7492	1.2139	S	S	0.18	2	4	Yes
			0.4934	-2.4482	-2.1195		-2.4017								
O1	3.73		0.6859*	-1.6860*	-10.4509*	42.3114	-0.2424	12.1326	37.8437	S	S	0.33	4	3	No

			4.4773	-3.8974	-4.3470		-2.5702								
S1	3.75		0.4848*	-1.5472*	-4.4333*	33.7588	-0.3429	11.8650	62.7327	US	S	0.29	2	1	No
			3.0943	-3.2489	-2.7116		-3.9148								
P	3.84		0.2529*	-1.2906*	-2.1754	28.2358	-0.2086	44.6287	9.7795	US	US	0.24	3	2	No
			1.8471	-1.8607	-1.3114		-2.1454								
Q	3.86	3.86	0.3937*	-0.7232*	-4.0485*	46.0537	-0.1278	2.2258	0.5617	S	S	0.29	1	2	Yes
			2.0741	-1.9709	-1.9577		-2.9658								
R	3.87		0.9202*	-1.5289*	-8.9915*	42.9599	-0.4638	18.8002	60.3773	S	US	0.32	3	2	No
			4.4193	-3.5513	-4.2562		-4.5357								
S	3.88	3.88	-0.3421*	-0.8538*	-0.6545*	33.6052	-0.3348	1.8046	11.2913	US	S	0.32	2	3	Yes
			-4.0356	-2.1309	-2.6413		-2.0150								
T	0.18		1.0935	-2.3262*	-3.9129	17.0799	-0.2614	5.1948	0.5917	S	US	0.28	3	1	No
			0.7937	-1.7688	-0.7431		-0.2851								
U	4.46	4.46	6.1498*	-3.1826*	-7.2730*	32.7137	-0.0697	0.8698	1.7416	US	S	0.41	2	4	Yes
			3.2772	-2.0734	-2.0754		-1.9970								
V	4.56	4.56	0.9887	-1.3127*	-11.8014*	24.0815	-0.1841	0.5392	0.3199	S	S	0.24	2	4	Yes
			0.9141	-2.0112	-2.9229		-1.9251								
W	6.65	6.65	2.3525*	-3.1818*	-4.1057*	10.6890	-0.5492	0.8129	0.6445	S	S	0.12	1	3	Yes
			1.9215	-2.2888	-3.7047		-2.8294								
X	4.29		0.7141*	-0.5894*	-6.5678*	33.4556	-0.2205	28.9055	17.3177	US	US	0.35	2	1	No
			3.4533	-1.7408	-3.1389		-2.4736								
Y	2.55	2.55	-0.0006	-0.9183*	-1.7074*	7.0238	-0.3271	0.0214	0.8629	S	S	0.16	2	4	Yes
			-0.0198	-2.0547	-2.1888		-2.1949								
C1	6.43	6.43	0.6888*	-1.5291*	-6.3566*	7.5316	-0.2464	2.0514	0.4029	S	S	0.25	1	3	Yes
	0		3.7780	-1.8046	-8.6623		-5.3472								
A1															
Total	100	68.67	…	…	…	…	…	…	…	…	…	…	…		

Panel B2			Exports to Japan										First Significant Lag on Nominal Exchange Rate	First Significant Lag on Relative Price	Whether Orcutt (1950) Hypothesis is proved
Item	Contribution	Significant	ΔlnY_x	$\Delta Ln(E)$	$\Delta ln(PEXi/PDx)$	F-Test	ECM(t-1)	LM	RESET	CUSUM	CUSUMSQ	Adj-R^2			
A	3.27	3.27	1.7619*	1.0922*	-1.3259*	8.4507	-0.4037	1.5086	2.1042	S	US	0.12	1	3	Yes
			1.7589	1.8725	-1.9308		-2.1611								
B	4.88	4.88	0.3318*	0.1585*	-0.2046*	24.6493	-0.2404	0.7019	2.0698	S	S	0.17	2	4	Yes
			1.8518	2.3992	-2.5321		-2.7484								
C	4.24		0.1836	0.3129*	-0.9034	33.9940	-0.2651	47.5613	13.1573	S	US	0.16	4	1	No
			0.9032	3.2884	-1.8736		-3.6117								
D	4.25	4.25	0.0044	1.0157*	-0.8682*	33.8377	-0.2449	0.4326	1.0297	S	S	0.19	2	3	Yes

			0.0773	2.6420	-1.7335		-3.6639								
E	3.41	3.41	0.0772	1.1095*	-1.2087*	30.6027	-0.1156	0.1748	0.5504	S	S	0.16	1	2	Yes
			0.3865	1.7627	-2.4832		-1.7064								
F	2.17	2.17	0.1682	0.5523*	-0.7244*	26.5986	-0.1306	1.5897	6.1883	US	S	0.13	2	4	Yes
			1.4192	2.3397	-1.9912		-2.3095								
G	3.15		-0.1525	0.1488	-0.4177	25.0838	0.1315	15.2052	8.8079	S	S	0.22	3	2	No
			-0.3169	1.3868	-1.2244		0.9158								
H	3.47		0.6456	0.0522	-1.0049	39.3930	-0.1545	0.3948	0.0004	US	US	0.18	2	1	No
			1.3874	0.7410	-1.3228		-0.1982								
I	2.16	2.16	-0.0108	2.1753*	-0.1771*	32.9180	-0.0838	1.3716	2.5599	S	S	0.15	2	4	Yes
			-0.0214	1.8892	-2.1832		-2.2456								
J	4.28		0.4253	0.1561*	-0.6227*	39.2799	-0.1613	0.3048	0.9242	S	US	0.19	2	2	No
			0.1588	1.9843	-1.9441		-3.0548								
K	3.72	3.72	0.2953*	1.1169*	-0.7340*	31.9187	-0.3206	0.8875	0.3762	S	S	0.14	1	3	Yes
			2.6212	1.7880	-1.8931		-2.2454								
L	4.15	4.35	0.6403*	0.1992*	-0.7266*	28.0172	-0.4442	0.0595	0.0595	S	US	0.09	1	2	Yes
			1.7245	2.4411	-2.2007		-2.0541								
M	1.48		1.8445*	0.3302	-3.3999*	35.5841	0.0085	0.1764	0.0145	S	S	0.21	1	1	No
			1.8780	1.4909	-1.7982		0.0881								
N	0.77	0.77	0.4300	0.3194*	-0.5176*	7.5338	-0.0957	0.1563	0.1563	S	S	0.26	2	3	Yes
			0.4909	4.1385	-2.3137		-2.6091								
O	3.25	3.25	0.4883*	0.8489*	-0.3669*	22.4790	-0.1518	0.9923	1.2234	S	US	0.16	1	3	Yes
			1.7712	2.6387	-1.7796		-2.2479								
O1	3.51		0.6164	0.0801	-1.2576	28.9947	0.0773	16.5642	6.9837	US	US	0.16	4	2	No
			0.8982	1.0102	-0.9795		0.6974								
S1	3.95		1.6651*	1.5163*	-0.0004	39.4935	-0.6346	0.3827	0.0920	S	S	0.08	2	1	No
			2.6870	1.7483	-0.0005		-1.8897								
P	3.38		2.3866*	0.3937*	3.0762*	60.7339	-0.4207	1.0399	14.2889	S	S	0.03	2	3	No
			5.3851	4.6829	-4.7762		-5.6440								
Q	3.42	3.42	0.8817*	0.3309*	-0.8469*	35.4040	-0.1294	0.5463	0.4335	S	S	0.12	2	3	Yes
			2.8635	3.6635	-1.8285		-1.9764								
R	3.47		0.5755*	0.8244*	-0.5173	23.0125	-0.4705	3.3521	0.3436	US	S	0.13	3	2	No
			1.7452	2.3177	-0.9486		-1.9181								
S	3.47	3.47	0.8864*	1.7637*	-2.5979*	30.4517	-0.3168	0.8964	0.7081	S	S	0.17	1	4	Yes
			2.0833	2.4112	-0.7748		-1.7247								
T	3.49		1.2636*	1.1959*	-1.6531*	32.6484	-0.3135	0.2271	0.3662	US	S	0.16	3	3	No
			3.4832	2.8509	-3.0968		-1.9246								
U	3.89	3.89	0.1963	1.1926*	-0.0975*	33.3367	-0.1129	0.8457	0.8315	S	S	0.17	2	3	Yes

			0.8009	2.0648	-2.2316		-2.4508								
V	1.87	1.87	-0.3117	0.1888*	-0.7664*	29.3337	-0.1106	0.1553	0.1731	US	US	0.15	1	2	Yes
			-0.3916	2.2353	-2.4869		-2.1163								
W	3.94	3.94	-0.4938*	1.2531*	-2.1103*	27.5939	-0.1247	0.7821	0.9715	S	S	0.15	3	4	Yes
			-1.8405	3.3366	-2.7678		-2.0626								
X	5.24		0.2409	0.0276	-0.1887	25.4089	-0.0329	30.9115	14.0887	S	S	0.15	4	3	No
			0.9988	0.2819	-0.4418		-0.2780								
Y	5.61	5.61	0.2977	0.1922*	-1.0787*	25.3944	-0.1467	1.7989	2.0832	S	S	0.14	1	3	Yes
			1.0310	2.1189	-2.1771		-2.4397								
Z	3.74	3.74	1.6196*	0.6196*	-1.5156*	40.5473	-0.2122	0.6656	0.6247	US	S	0.16	2	4	Yes
			1.8065	1.7065	-1.9286		-2.2531								
A1	2.37		-0.7029	0.7029	-2.1572*	33.1666	-0.1756	0.7293	0.7293	S	US	0.17	3	1	No
	0		-1.0306	1.0306	-1.8455		-1.8450								
Total	100.00	58.17											…		

Table 3: **The Results of the Fitted Model to Australian Imports and exports with China**

Panel A3			Imports from China										First Significant Lag on Nominal Exchange Rate	First Significant Lag on Relative Price	Whether Orcutt (1950) Hypothesis is proved
Item	Contribution in total imports	Contribution by Significant items	ΔlnY_{AUS}	$\Delta Ln(E)$	$\Delta Ln(PIM/PD_{AUS})$	F-Test	ECM(t-1)	LM	RESET	CUSUM	CUSUMSQ	Adj-R^2			
C	11.37	11.37	0.4883*	-2.2366*	-5.1835*	36.9799	-0.1100	0.3893	1.6240	S	S	0.43	1	2	Yes
			2.1544	-2.4291	-2.1402		-2.0234								
D	7.53	7.53	0.6786*	-0.1157*	-7.4684*	35.5378	-0.4600	0.1482	0.4481	S	S	0.27	2	4	Yes
			2.4897	-2.9737	-2.4709		-2.4512								
H	10.80	10.80	0.2307*	-2.2707*	-0.1419*	45.3968	-0.0893	2.0285	2.5589	US	S	0.36	3	4	Yes
			1.7521	-1.6835	-1.6564		-2.0897								
U	6.87	6.87	1.1095*	-0.8357*	-5.7143*	34.0100	-0.0677	0.8909	10.9702	S	S	0.11	2	3	Yes
			2.7131	-2.9637	-2.7223		-1.9842								
L1	0	0											NA	NA	NA
M1	0	0											NA	NA	NA
N1	0	0											NA	NA	NA

O	8.89	8.89	0.3578*	-0.0530*	-1.1236*	47.3080	-0.1040	0.0016	1.5483	S	US	0.14	1	3	Yes
			2.4124	-1.8850	-2.3585		-2.3022								
E	8.84	8.84	0.2423*	-2.3527*	-2.4541*	42.5149	-0.1771	0.0305	0.7115	S	S	0.16	2	3	Yes
			2.9144	-2.6705	-1.9818		-3.1160								
J	6.25		0.4212*	-0.5695	-6.0260*	36.0855	-0.0950	8.7967	0.1289	S	S	0.28	2	2	No
			2.3699	-1.3746	-1.4550		-2.3645								
P	8.02	8.02	1.1854*	-1.3257*	-12.9627*	38.2603	-0.2620	-0.2451	4.3985	US	S	0.18	1	2	Yes
			3.8692	-1.8449	-3.8086		-2.8603								
I	9.89	9.89	0.1746*	-1.0232*	-1.8509*	44.8170	-0.0492	-0.2765	0.0074	S	S	0.19	2	4	Yes
			2.4105	-2.2605	-2.3647		-1.6674								
B	10.73	10.73	1.1207*	-1.1832*	-11.9245*	47.0207	-0.2451	-0.1522	1.0349	US	S	0.21	1	3	Yes
			4.4089	-4.3187	-4.3604		-2.8963								
L	10.81	10.81	0.2972*	-1.1548*	-2.8268*	47.2021	-0.2765	-0.1805	1.6918	US	US	0.25	2	3	Yes
			2.5784	-1.9115	-2.4639		-2.4512								
Total	100.00	93.75													
Panel B3			Exports to China										First Significant Lag on Nominal Exchange Rate	First Significant Lag on Relative Price	Whether Orcutt (1950) Hypothesis is proved
Item	Contribution	Significant	ΔlnY_x	ΔLn(E)	Δln(PEXi/PDx)	F-Test	ECM(t-1)	LM	RESET	CUSUM	CUSUMSQ	$Adj\text{-}R^2$			
C	19.14	19.14	0.0058*	0.0184*	-0.1489*	33.5983	-0.1791	0.0007	0.0138	S	S	0.43	2	4	Yes
			1.7616	1.8459	-2.2189		-1.9751								
D	19.15	19.15	0.0065*	1.0501*	-0.1619*	33.8938	-0.4386	2.1969	2.1351	US	S	0.27	1	4	Yes
			1.7047	1.7216	-1.9367		2.0106								
H	15.01	15.01	0.0068	0.1852*	-1.1565*	34.0162	-0.0398	0.2060	0.0950	S	S	0.36	1	2	Yes
			1.5550	2.5357	-2.3521		-1.7556								
U	16.16	16.16	0.0099*	0.1841*	-0.4506*	36.5127	-0.1135	0.0061	0.3345	US	S	0.11	3	4	Yes
			2.4163	1.8072	-2.9499		-3.0862								
L1	11.01	…	-0.0029	0.9368*	-1.0334	32.4109	-0.1462	1.0151	0.0021	S	US	0.12	2	1	No
		…	-0.5794	2.8769	-0.3794		-3.3396								
M1	3.93	3.93	0.0005	0.1632*	-1.0975*	27.4214	-0.1924	4.1701	1.1294	US	US	0.17	2	3	Yes
		…	0.0698	1.8953	-2.4221		-1.5736								
N1	15.60	…	0.1749*	0.3667*	-4.2006*	41.6608	-0.1257	0.4778	9.9281	S	S	0.19	3	2	No
	…	…	2.6774	3.1381	-5.1274		-3.0392	…	…	…	…	…			…
O	…	…	…	…	…	…	…	…	…	…	…	…			
	…	…	…	…	…	…	…	…	…	…	…	…			
E	…	…	…	…	…	…	…	…	…	…	…	…			
	…	…	…	…	…	…	…	…	…	…	…	…			

J	...	...	...	...	...	...	...	...	...	...	...	...			
	...	...	...	...	...	...	...	...	...	...	...	...			
P	...	...	...	...	...	...	...	...	...	...	...	...			
	...	...	...	...	...	...	...	...	...	...	...	...			
I	...	...	...	...	...	...	...	...	...	...	...	...			
	...	...	...	...	...	...	...	...	...	...	...	...			
B	...	...	...	...	...	...	...	...	...	...	...	...			
	...	...	...	...	...	...	...	...	...	...	...	...			
L	...	...	...	...	...	...	...	...	...	...	...	...			
	...	...	...	...	...	...	...	...	...	...	...	...			
Total	100	70.39													…

Table 4: **The Results of the Fitted Model to Australian Imports and Exports with Korea**

Panel A4			Imports from Korea										First Significant Lag on Nominal Exchange Rate	First Significant Lag on Relative Price	Whether Orcutt (1950) Hypothesis is proved
Items	imports	Significant items	$\Delta \ln Y_{AUS}$	$\Delta Ln(E)$	$\Delta Ln(PIM/PD_{AUS})$	F-Test	ECM(t-1)	LM	RESET	CUSUM	CUSUMSQ	Adj-R^2			
A	3.03	3.03	-0.0458	-1.3206*	-0.4496*	39.9886	-0.0443	1.1759	1.6844	S	S	0.28	1	2	Yes
			-0.6600	-1.7761	-2.4802		-2.1520								
B															
C	3.04	3.04	0.1327*	-1.2545*	-1.0109*	33.7398	-0.0480	0.6129	0.2937	S	S	0.39	2	3	Yes
			2.3482	-1.7501	-2.0791		-1.6517								
D	4.28		0.1996	0.0017	-0.0251	35.6039	-0.0667	1.0401	0.2932	US	US	0.24	3	4	No
			1.2988	0.6012	-0.2998		-0.7216								
E	3.41	3.41	-0.0069*	-0.2771*	-3.0002*	38.6873	-0.1062	0.3938	0.8011	US	S	0.27	1	4	Yes
			-2.4501	-3.1859	-1.9926		-2.0673								
F	1.83	1.83	0.1362*	-1.1106*	-0.2559*	32.4852	-0.0369	1.1231	0.7759	S	S	0.18	2	3	Yes
			1.9835	-1.9844	-2.5980		-2.3996								
G	2.89		0.4215*	0.0121*	-0.6206*	32.9891	-0.0115	0.7423	0.3016	US	S	0.26	2	1	No
			2.1329	1.6648	-1.9357		-0.1258								
H	2.90	2.90	0.3549*	-0.9019*	-0.3271*	37.0692	-0.1315	1.2156	0.4245	S	S	0.15	3	4	Yes
			2.3385	-2.4104	-1.7964		-1.7150								
I	1.62	1.62	0.6395*	-0.5576*	-0.8090*	35.9004	-0.1217	0.8044	0.6070	S	S	0.24	1	2	Yes
			2.7528	-1.8647	-2.4856		-2.1335								

J	5.14		0.1615*	-0.0038	-0.4587	43.3468	-0.1846	0.0318	0.1955	S	US	0.17	3	2	No
			2.5685	-1.4025	-0.1433		-2.0509								
K	4.12	4.12	0.4412*	-0.8539*	-1.0182*	31.3594	-0.1178	1.3594	0.9565	S	S	0.21	3	4	Yes
			3.1847	-1.9033	-2.1556		-2.1845								
L	4.48	4.48	0.4889*	-0.7505*	-0.3213*	59.6947	-0.2918	0.6549	0.8021	S	S	0.48	1	2	Yes
			4.0316	-2.1072	-1.9356		-8.8365								
M	1.76		0.7877*	-0.0139	-0.9239*	36.0634	-0.0170	1.8434	21.3971	S	US	0.25	4	2	No
			3.3526	-1.5966	-2.7232		-0.1852								
N	0.40	0.40	-0.0759	-0.6257*	-1.1311*	35.7451	-0.3215	0.6193	0.1026	S	S	0.24	2	4	Yes
			-0.7405	-2.9555	-2.6817		-1.6881								
O	4.04		0.2051*	-0.0054	-0.1433	43.9012	-0.0113	0.0065	9.2659	US	US	0.26	3	2	No
			2.9743	-0.6458	-1.5779		-0.1238								
P	2.88	2.88	0.1509*	-0.4581*	-0.1159*	37.3926	-0.4416	1.2512	10.8888	S	S	0.18	1	3	Yes
			2.0019	-2.3784	-2.1947		-2.0173								
Q	5.21		0.2802*	-0.0084*	-0.4225*	40.3038	-0.0325	0.2538	7.4846	S	S	0.24	4	1	No
			3.5089	-2.2208	-2.6044		-0.3536								
R	2.96	2.96	-0.1812*	-0.7126*	-0.4303*	38.1612	-0.2513	0.1722	2.3532	US	S	0.17	2	4	Yes
			-2.2609	-2.2139	-2.4955		-2.0007								
S	3.22		0.3080*	-0.7111*	--0.0459*	37.3707	-0.0469	0.1509	4.6568	US	US	0.20	1	1	No
			2.9893	-2.8982	-0.4897		-0.1509								
T	2.96	2.96	0.3815*	-0.0053*	-0.0878*	39.1550	-0.0284	0.8540	18.8474	S	S	0.30	1	3	Yes
			4.0032	-1.9843	-2.2090		-0.3098								
U	3.71		0.1882*	0.6608	-0.1002	88.9481	-0.0199	0.0046	5.1376	S	US	0.17	2	1	No
			1.7384	0.2445	-0.8432		-0.2172								
V	3.44	3.44	0.4865*	-1.0021*	-0.3718*	35.3032	-0.5633	0.4332	2.5989	S	S	0.21	2	3	Yes
			2.6447	-2.9482	-2.8175		-3.0357								
W	3.55		0.3476*	0.0091*	-0.4187*	40.0209	-0.0225	0.2433	19.0698	US	US	0.17	4	1	No
			2.6604	2.3213	-2.5013		-0.2468								
X	1.08		0.1307	0.0202	-0.3667	28.7519	-0.0016	0.1559	2.4411	S	S	0.16	3	2	No
			0.4268	1.0620	-0.6992		-0.0182								
Y	4.49	4.49	0.0554*	-1.2018*	-1.2251*	80.8107	-0.1043	1.0388	4.9966	S	S	0.61	1	2	Yes
			1.9702	-1.7313	-2.7039		-1.9981								
Z	6.18	6.18	0.2578*	-0.0057*	-0.1399*	57.7310	-0.0162	0.0051	3.5425	S	US	0.18	2	3	Yes
			3.1976	-2.6203	-1.8452		-0.1764								
A1	6.43	6.43	0.3044*	-1.0030*	-0.1472*	37.1646	-0.5113	2.4243	3.6482	US	S	0.43	2	3	Yes
			3.0958	-1.8432	-1.9522		-2.0039								
B1	4.43	4.43	0.5729*	-0.7143*	-0.0932*	29.6492	-0.4101	1.1656	16.4831	S	S	0.21	1	4	Yes
			3.6113	-2.3030	-1.8405		-2.1103								
C1	3.50	3.50	0.1562*	-1.0088*	-0.2723*	39.2642	-0.2051	0.4664	23.9893	S	S	0.23	2	4	Yes

			2.1899	-1.7429	-2.4427		-2.0556								
D1	3.02		0.1655	-0.0003	-0.1421	31.7107	-0.1161	0.0482	7.1575	S	US	0.16	4	3	No
			1.2630	-0.5682	-0.7634		-0.8834								
E1															
F1															
G1															
H1															
I1															
J1															
K1															
Total	100.00	62.1													

Panel B4			Exports to Korea										First Significant Lag on Nominal Exchange Rate	First Significant Lag on Relative Price	Whether Orcutt (1950) Hypothesis is proved
Item	Contribution	Significant	ΔlnY_x	ΔLn(E)	Δln(PEXi/PDx)	F-Test	ECM(t-1)	LM	RESET	CUSUM	CUSUMSQ	Adj-R^2			
A	1.22	1.22	0.4859*	1.0025*	-5.4264*	35.4580	-0.1999	0.4759	0.0479	US	S	0.22	1	3	Yes
			3.6648	1.9801	-3.6126		-1.8296								
B	0.52		0.6331*	0.0063	-7.0124	8.6200	-0.0452	0.5679	3.5488	S	S	0.18	4	3	No
			2.3504	0.5947	-0.4433		-0.4533								
C	3.25	3.25	0.3855*	1.1021*	-3.9839*	44.0865	-0.4465	2.3358	0.6157	S	S	0.16	2	4	Yes
			3.4294	6.6083	-3.3728		-2.1978								
D	2.65		0.1856	0.0099*	-2.0624	35.8597	-0.0392	1.8075	28.3927	S	US	0.13	2	1	No
			0.7541	1.9568	-0.7435		-0.4273								
E	2.97	2.97	0.1658	0.9121*	-1.9520*	34.2265	-0.8092	0.0289	11.4550	S	S	0.11	3	4	Yes
			0.7257	1.8323	-2.7507		-3.1009								
F	2.67	2.67	0.0772	0.3240*	- 0.6097*	33.7949	-0.2157	0.1243	0.1087	S	S	0.11	1	3	Yes
			0.9909	1.8211	-2.7060		-2.0625								
G	2.47		1.0447*	0.0153*	-11.5140*	43.2194	-0.1945	1.0533	4.7350	US	S	0.19	3	2	No
			4.7049	3.3668	-4.7015		-2.2105								
H	0.40	0.40	2.5085*	0.7768*	-28.3604*	25.8113	-0.1080	2.0097	0.0367	US	S	0.30	2	3	Yes
			5.6242	1.9885	-5.6378		-2.1048								
I	2.28	2.28	1.0608*	0.7823*	-11.4468*	47.3843	-0.0424	1.6660	2.0952	S	S	0.21	1	2	Yes

			4.7613	1.9567	-4.7426		-2.0020								
J	1.54		0.8278*	0.0051	9.3454*	34.0293	-0.0152	0.3052	0.0161	S	US	0.27	4	3	No
			2.2383	0.6670	-2.2412		-1.8821								
K	2.02	2.02	0.3748*	0.4917*	-4.1416*	38.6766	-0.0585	0.0585	1.0507	S	S	0.11	2	3	Yes
			2.5984	2.5643	-2.2346		-2.0014								
L	2.75	2.75	0.4875*	0.6229*	-5.1309*	33.8613	-0.0542	0.5675	2.0518	S	S	0.12	3	4	Yes
			2.7489	1.9656	-2.6696		-1.9054								
M	1.59		0.5903*	-0.0208*	-6.2672*	36.0546	-0.2106	1.7804	1.7804	US	US	0.16	2	1	No
			3.7223	3.1429	-3.6379		-3.1112								
N	0.28	0.28	0.0585	0.8103*	-0.5173*	27.2432	-0.1503	1.8496	1.8496	S	S	0.10	1	3	Yes
			0.4600	1.8891	-2.3576		-2.8852								
O	2.28		0.4227	0.1277*	-4.4259	32.8658	-0.2215	0.1867	0.3722	S	S	0.14	3	2	No
			1.4659	2.2038	-1.4437		-1.9654								
P	3.85	3.85	-0.0002	1.0009*	-1.2549*	27.0211	-0.0403	1.4489	13.9916	US	S	0.12	2	4	Yes
			-0.0026	2.3371	-2.2622		-2.3849								
Q	3.30		0.2175*	0.0012	-2.1341*	37.1129	-0.0053	0.0104	0.8042	S	S	0.14	2	1	No
			2.2107	0.4307	-2.0519		-0.0588								
R	2.31	2.31	1.6097*	0.5224*	-18.2079*	18.6597	-0.1069	2.3484	0.2318	S	S	0.17	2	3	Yes
			3.8688	2.5732	-13.8745		-1.8362								
S	0	0											NA	NA	NA
	0	0											NA	NA	NA
T	3.09		1.4321*	0.6264*	-15.3008*	6.2247	-0.4774	1.7359	7.5961	S	US	0.23	2	1	No
			4.0351	3.4801	-4.0337		-2.0114								
U	3.68	3.68	0.9116*	0.0045*	-9.8089*	34.2484	-0.2039	7.9136	7.4286	US	US	0.24	2	3	Yes
			3.5768	2.4368	-3.5794		-2.2021								
V	3.30	3.30	1.5136*	0.5120*	-16.4736*	45.5124	-0.0694	1.9612	11.9385	S	S	0.21	1	2	Yes
			4.5262	3.0034	-4.5129		-1.8475								
W	1.87		0.4221*	0.2127	-4.7020*	30.1462	-0.1124	1.2932	2.3510	S	S	0.26	4	2	No
			1.9812	1.5105	-1.9503		-1.8426								
X	2.84		0.1786	0.0015	-1.9908	11.0647	-0.8369	1.0532	0.6523	S	US	0.27	4	3	No
			0.1408	0.0821	0.1488		-0.4885								
Y	3.51	3.51	0.2870*	0.6079*	-2.7914*	29.7614	-0.0233	0.0959	0.4773	US	S	0.29	1	2	Yes
			1.8671	1.7257	-1.9662		-1.7201								
Z	1.40		-0.1878	0.6315	-2.8331	3.7023	0.1497	3.2946	0.0465	S	S	0.31	3	1	No
			-0.4535	1.3356	-0.5966		0.6572								
A1	5.88	5.88	2.0520*	0.7145*	-21.9524*	48.0603	-0.0579	1.4882	0.5283	S	S	0.24	1	4	Yes
			5.3427	3.7196	-5.3018		-1.7859								
B1	4.71	4.71	0.5959*	1.0364*	-6.2613*	40.3326	-0.5473	3.0747	1.1997	S	S	0.30	2	3	Yes
			2.8321	1.8155	-2.7899		-2.2888								

C1	4.99	4.99	0.0037	0.3237*	-0.6031*	25.1795	-0.3449	0.5199	1.9167	S	S	0.21	3	4	Yes
			1.5525	1.8825	-1.8342		-3.0018								
D1	3.31		-0.0171*	0.0171*	-4.0596*	34.7677	-0.0319	0.5833	1.4879	US	US	0.16	2	2	No
			-2.2078	2.2078	2.3402		-2.3484								
E1	3.54	3.54	-0.0139*	2.0139*	-0.6186*	37.1582	-0.1973	0.0169	0.0899	S	S	0.11	3	2	No
			-2.8113	2.8113	-2.5377		-2.0810								
F1	4.02	4.02	-0.0032*	2.0032*	2.5451*	8.0528	-0.4990	2.8939	2.1003	US	S	0.28	1	2	Yes
			-1.6991	1.9891	-1.8681		-2.4137								
G1	3.48	3.48	-0.0011	1.0011*	-10.2171*	41.0281	-1.7642	1.3251	0.3350	S	S	0.18	2	3	Yes
			-0.3827	2.2227	-2.7312		-1.6582								
H1	3.28	3.28	-0.0041	2.0041*	-5.1564*	40.2091	-0.7981	0.8965	2.3341	S	S	0.24	2	4	Yes
			-1.2881	1.8881	-2.9258		-3.0897								
I1	3.61		-0.0088*	0.0088*	-16.0478*	5.5998	-0.6103	19.8714	1.5912	S	US	0.36	4	1	No
			-2.6805	2.6805	4.3333		-1.8428								
J1	3.90	3.90	0.0125	1.2125*	-6.9143*	13.3909	-0.3639	2.0184	2.6824	S	S	0.15	1	4	Yes
			1.5071	1.7571	-2.6757		-4.1337								
K1	1.24		0.0105	0.0105	-2.2036	30.6007	-0.0106	0.0007	3.3325	S	S	0.19	3	2	No
			1.1215	1.1215	-0.9191		-0.1111								
Total	100.00	68.29													

Table 5: **The Results of the Fitted Model to Australian Imports and exports with Thailand**

Panel A5			Imports from Thailand										First Significant Lag on Nominal Exchange Rate	First Significant Lag on Relative Price	Whether Orcutt (1950) Hypothesis is proved
Items	imports	Significant items	$\Delta \ln Y_{AUS}$	ΔLn(E)	$\Delta Ln(PIM/PD_{AUS})$	F-Test	ECM(t-1)	LM	RESET	CUSUM	CUSUMSQ	Adj-R^2			
A	1.12	1.12	0.0435	-0.8852*	-0.4638*	0.6986	-0.9192	3.2383	1.3883	S	S	0.20	3	4	Yes
			0.3278	-2.0329	-2.3022		-2.6413								
B	0.35		-0.1990	-0.0118	-2.4377	7.8625	-0.1630	8.8384	10.8836	US	US	0.23	1	1	No
			-1.2412	-0.0565	-1.3196		-1.5889								
C	4.63	4.63	-0.1990	-0.9118*	-2.4377*	90.7871	-0.0585	2.9073	1.0664	S	S	0.26	1	4	Yes
			-1.2412	-1.7765	-2.3196		-2.0855								
D	2.04	2.04	0.4789*	-0.1872*	-5.1870*	45.2212	-0.0546	3.2833	0.0574	US	S	0.21	2	3	Yes
			3.3024	-1.8767	-3.2251		-2.5880								
E	3.04	3.04	-0.0860	-0.9788*	-1.5503*	35.5627	-0.5110	0.1751	2.2956	S	S	0.17	1	3	Yes
			-1.1935	-1.8723	-1.9998		-4.1209								

F	2.44		0.6196*	-0.3484*	-6.7956*	42.9134	-0.0400	0.0298	2.1019	US	US	0.18	4	3	No
			2.9935	-2.2310	-2.9329		-0.4279								
G	3.12	3.12	0.0375	-0.6592*	-0.1398*	25.2924	-0.2882	2.5314	1.2119	S	S	0.12	1	2	Yes
			0.5123	-1.9006	-1.8812		-2.2812								
H	3.51		0.5745*	-0.1298*	-5.8325*	41.1615	0.0037	4.1061	18.6018	US	S	0.26	2	2	No
			3.4184	-2.4629	-3.3561		0.0353								
I	2.9		0.0222	-0.0382	-0.3943	34.5376	-0.0139	0.6630	17.2871	S	US	0.18	3	2	No
			0.3179	-0.4317	-0.4669		-0.1519								
J	4.35	4.35	0.1338	-1.2035*	-1.2842*	32.6225	-0.2555	2.8303	1.7140	S	S	0.21	1	2	Yes
			1.1165	-2.1439	-2.0451		-1.9864								
K	0	0												NA	NA
L	3.53	3.53	0.6254*	-0.1294*	-6.3089*	53.7148	-0.1042	0.4197	0.9572	S	S	0.23	3	4	Yes
			3.8557	-1.8045	-3.7658		-3.1032								
M	2.17		0.4631*	0.1616	-4.7494*	37.3170	-0.0281	0.3767	0.9559	US	US	0.17	2	1	No
			3.4172	1.5963	-3.2835		-0.3079								
N	1.53		0.2210*	-0.1190	-2.4783*	38.9038	-0.0034	2.6741	8.4691	US	US	0.11	4	3	No
			2.5840	-1.5662	-2.6081		-0.0371								
O	3.24	3.24	0.8149*	-0.4177*	-8.9277*	45.2202	-0.3352	0.0104	2.2289	S	S	0.19	2	3	Yes
			3.5578	-3.1458	-3.5364		-2.0574								
O1	3.32	3.32	0.4616*	-0.0406*	-4.4283*	48.3853	-0.1506	1.2955	1.2501	S	S	0.34	1	2	Yes
			2.6331	-1.9912	-2.5663		-1.9362								
P1	3.32		0.4810*	-0.3418*	-5.3035*	36.5473	-0.0139	0.0155	6.6063	US	US	0.10	2	2	No
			2.5414	-2.4632	-2.5255		-0.1526								
P	2.76		-0.3235*	0.1273	-3.9644*	20.2139	-0.0529	2.7665	26.6404	S	US	0.14	4	1	No
			-1.9255	0.6690	-2.0975		-0.5062								
Q	4.07		0.1243	-0.0735*	-1.3296	32.6433	-0.1097	######	1.7926	S	S	0.19	3	2	No
			0.6668	-1.8264	-0.6751		-0.9216								
R	4.37		0.4765*	-0.2642*	-4.6263*	42.1265	-0.1059	######	10.8457	S	S	0.25	4	1	No
			4.1558	-4.3806	-4.0909		-0.9174								
S	4.30	4.3	1.6327*	-0.1389	-16.7282*	85.3486	-0.7082	0.3348	1.1858	US	S	0.64	3	4	Yes
			11.0010	-1.9972	-10.7066		-7.4909								
T	2.83		0.0992	0.0558	-1.0419	1.7564	-0.4526	1.8144	10.2682	S	S	0.11	4	3	No

			0.4926	0.8291	-0.4686		-1.2772								
U	4.43	4.43	-0.8302*	-0.3974*	-7.5931*	0.0244	-2.4675	0.8966	1.6164	S	S	0.39	1	3	Yes
			-2.7112	-2.6367	-2.7037		-5.1279								
V	2.45	2.45	-0.5849*	-0.3970*	-6.9816*	35.6602	-0.0174	0.5919	1.5660	S	S	0.11	2	3	Yes
			-2.1324	-1.7907	-2.1567		-2.1886								
W	3.41		0.6725*	0.0383	-7.0409*	39.0609	-0.0147	0.0134	2.2596	S	US	0.15	4	1	No
			3.4537	0.3478	-3.3511		-0.1609								
X	1.63	1.63	0.2189	-1.6920*	-2.8002*	8.1912	-0.1093	0.4501	2.0524	S	S	0.20	1	2	Yes
			0.6539	-3.3967	-1.7281		-2.1976								
Y	4.6		0.4107	-0.0057	-4.3001	34.7107	-0.0199	1.2826	5.9305	US	S	0.12	3	2	No
			1.6333	-0.0255	-1.5726		-0.2088								
Z	3.51	3.51	0.4228*	-0.0093*	-4.4750*	43.1206	-0.5102	2.1817	0.8155	S	S	0.11	3	4	Yes
			2.3466	-1.8868	-2.3238		-5.1125								
A1	3.76		0.3372	-0.0142	-3.6599	35.4780	0.0040	0.1414	0.0012	US	US	0.17	3	1	No
			1.6494	-0.1656	-1.6304		0.0436								
B1	3.76	3.76	0.9776*	-1.4990*	-9.3892*	119.5820	-0.8464	1.1283	2.1892	S	S	0.13	1	2	Yes
			7.7893	-3.9929	-6.8704		-9.3472								
C1	2.13		1.3785*	0.3714	-15.3493*	32.1708	-0.0020	0.8280	2.3951	S	S	0.15	3	1	No
			2.6931	1.0078	-2.7047		-0.0217								
D1	3.40		0.3212*	-0.0616	-3.3836*	43.7092	-0.0575	0.8798	8.3463	US	US	0.22	4	1	No
			2.1195	-0.8142	-2.0559		-0.6118								
E1	3.82	3.82	1.4276*	-1.1113*	-15.6945*	44.5996	-0.1436	2.9602	1.8274	S	S	0.26	1	4	Yes
			4.0312	-2.0835	-4.0180		-1.7901								
Total	100	52.29	….	….	….	….	….	….	….	….	….	….			

Panel B5			Exports to Thailand										First Significant Lag on Nominal Exchange Rate	First Significant Lag on Relative Price	Whether Orcutt (1950) Hypothesis is proved
Item	Contribution	Significant	ΔlnY_x	$\Delta Ln(E)$	$\Delta ln(PEXi/PDx)$	F-Test	ECM(t-1)	LM	RESET	CUSUM	CUSUMSQ	Adj-R^2			
A	0.71	0.71	0.0032	0.2448*	-0.1004*	28.2285	-0.0629	0.4712	0.3773	S	S	0.12	1	3	Yes
			0.0215	1.8636	-2.3608		-1.7742								
B	5.79		0.1323	0.0046	-0.1461	36.2566	-0.0060	0.1556	11.7337	S	US	0.17	4	2	No
			0.6090	0.0641	- 0.4644		-0.0656								
C	2.38	2.38	0.0382	0.1354*	-0.5355*	33.6171	-0.0603	0.1458	0.3127	S	S	0.16	2	4	Yes
			0.3494	1.8456	-2.4884		-1.9934								

D	18.96	18.96	0.0589	0.9182*	-0.2658*	28.1765	-0.4498	1.5139	16.2026	S	S	0.19	3	4	Yes
			0.5916	2.2552	-1.9062		-1.7349								
E	0.38	0.38	0.3637	0.0571*	-1.5407*	9.7775	-0.1333	0.3101	1.5881	S	S	0.16	2	4	Yes
			1.4231	2.5455	-2.4268		-3.0366								
F	0.02		0.0242	0.0930	-0.1063	28.0461	-0.0033	0.0195	0.5562	S	US	0.13	3	2	No
			0.1047	0.4247	-0.2706		-0.0366								
G	1.30	1.30	1.2418*	0.5486*	-1.6272*	38.8773	-0.2454	0.1132	2.0622	S	S	0.22	1	3	Yes
			3.3168	2.5898	-3.1483		-2.4811								
H	4.30		0.5067	0.0937	-0.6729	39.1680	-0.0321	0.0373	29.9194	S	US	0.18	4	1	No
			1.5160	0.7522	-1.3855		-0.3434								
I	0.14		0.4439*	0.1408*	-0.4686*	32.2838	-0.0055	0.5943	0.9399	US	US	0.15	2	1	No
			2.7002	1.7447	-2.0586		-0.0607								
J	20.28	20.28	1.6217*	0.1049*	- 1.7730*	39.4709	-0.1071	0.4648	0.0297	S	S	0.19	1	2	Yes
			4.7591	1.7495	-4.3605		-2.0785								
K	9.89	9.89	0.8469*	1.4496*	-0.9723*	34.0444	-0.0145	0.8676	0.8546	S	S	0.14	2	3	Yes
			3.3092	3.3498	-2.9461		-0.1599								
L	0.53	0.53	-0.0542	0.8778*	-0.6388*	29.7793	-0.1114	0.0578	2.2534	US	S	0.09	1	4	Yes
			-0.3576	1.9922	-2.0211		-2.1253								
M	0.10		0.3637	0.1571	-0.2366	38.1427	-0.0569	0.5336	2.2663	US	S	0.21	2	1	No
			1.5062	0.8773	-0.6437		-0.6054								
N	0.01		-0.2390	0.7295*	-0.8137	4.4461	0.0461	20.1106	0.0044	S	US	0.26	3	2	No
			-0.6834	2.3231	-1.2773		0.4143								
O	1.23	1.23	0.5118*	0.7217*	-0.5553*	33.7955	-0.2471	0.5404	1.1799	S	US	0.16	2	3	Yes
			3.1943	1.9632	-2.5526		-2.5001								
O1	0.40	0.40	0.8214*	1.0242*	- 1.3223*	32.4290	-0.3145	0.4993	2.1817	S	S	0.16	1	2	Yes
			2.3027	2.1329	-2.2666		-3.0491								
P1	0.33		0.3212	0.0121	-0.4658	0.0149	-0.0123	0.1623	0.0603	S	US	0.08	4	2	No
			1.2291	0.0895	-1.1233		-0.1354								
P	0.82		0.1811	0.0440	-0.0149	33.4248	-0.0860	0.4242	2.5320	US	S	0.03	3	2	No
			1.3944	0.5537	-0.0942		-0.9206								
Q	4.65		1.0339*	0.2597	-1.3898*	33.0092	-0.0011	0.0237	0.8162	US	US	0.12	2	2	No
			2.7218	1.4526	-2.5451		-0.0114								
R	0.79		0.7481*	0.3065	0.9529*	32.3759	-0.0771	0.7710	1.0628	US	S	0.13	3	1	No
			2.2739	1.5453	-2.1011		-1.9812								
S	1.22	1.22	0.5043*	0.1758*	- 0.6085*	36.4883	-0.1416	1.0192	0.4438	US	S	0.17	2	4	Yes
			2.0600	1.8634	-1.8521		-3.1271								
T	2.76		0.5929*	3.2217*	-0.7424*	4.1478	-0.3996	5.9117	1.5412	S	US	0.16	4	1	No
			1.8849	1.6500	-1.7515		-1.6694								

U	2.46	2.46	0.3723	0.2175*	-0.3299*	38.0127	-0.1392	0.1633	3.8884	S	S	0.17	2	3	Yes
			1.4921	1.7735	-1.9178		-1.6504								
V	0.41	0.41	0.1452	0.7391*	-0.1757*	26.2144	-0.0007	0.7293	2.3553	S	S	0.15	1	2	Yes
			0.4571	2.6207	-2.1312		0.0182								
W	0.87		0.3981*	0.2858*	-0.1523	28.7263	-0.0103	0.5771	0.1910	S	US	0.15	3	3	No
			2.6637	2.4025	-0.7847		-0.1136								
X	13.01	13.01	0.2783	0.2145*	-0.0216*	35.8874	-0.1248	0.4472	1.6653	S	S	0.15	3	4	Yes
			1.3532	1.9372	-1.8915		-2.2718								
Y			0.3966*	0.0595	-0.4487*	34.0808	-0.0054	0.2299	23.6485	US	S	0.14	2	1	No
			2.1752	0.7557	-1.9287		-0.0588								
Z	6.25		-0.3655*	1.3589*	-0.9061*	34.0105	-0.6265	2.1768	0.2891	S	US	0.16	3	3	No
			-1.3599	1.9527	-1.6815		-3.2809								
A1	…	…	…	…	…	…	…	…	…	…	…	…			
	…	…	…	…	…	…	…	…	…	…	…	…			
B1	…	…	…	…	…	…	…	…	…	…	…	…			
	…	…	…	…	…	…	…	…	…	…	…	…			
C1	…	…	…	…	…	…	…	…	…	…	…	…			
	…	…	…	…	…	…	…	…	…	…	…	…			
D1	…	…	…	…	…	…	…	…	…	…	…	…			
	…	…	…	…	…	…	…	…	…	…	…	…			
E1	…	…	…	…	…	…	…	…	…	…	…	…			
	…	…	….	….	….	….	….	….	….	….	….	….			
Total	99.29	73.16	….	….	….	….	….	….	….	….	….	….			

3.8.2. APPENDIX 5

Figure 03: Bi-variate Relationship of Australian Inflation Rate and Agricultural Trade Balance with the concerned five countries

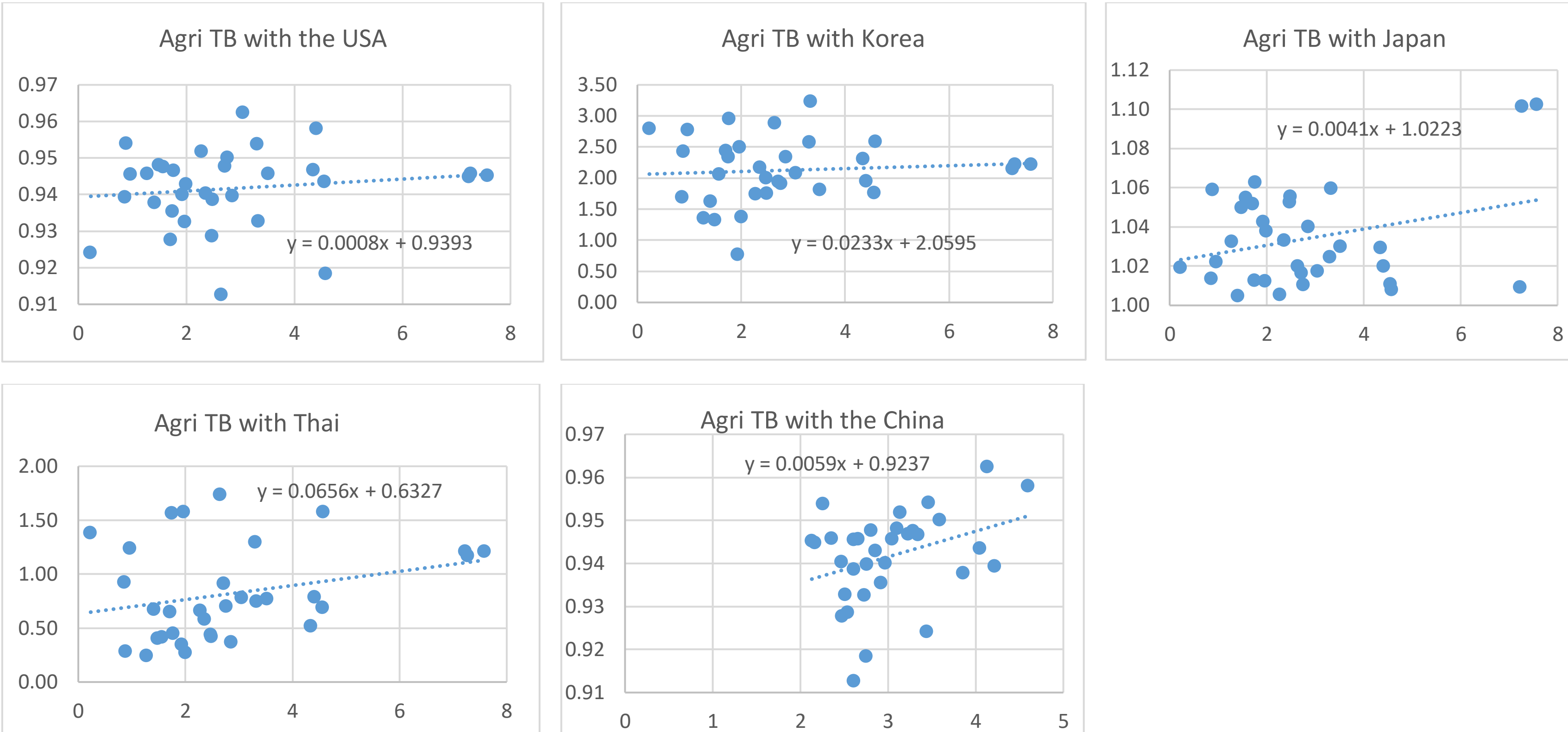
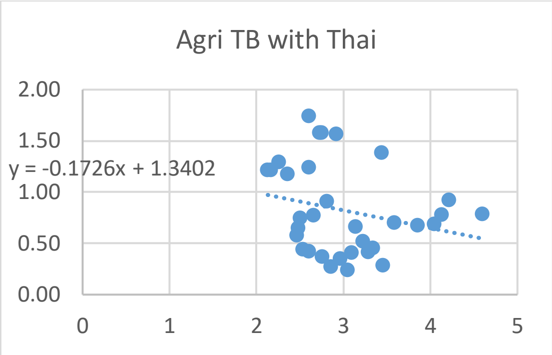
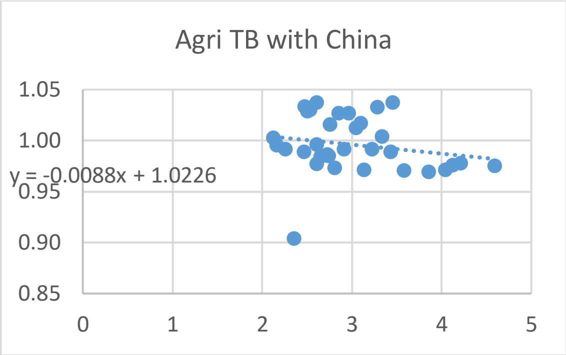
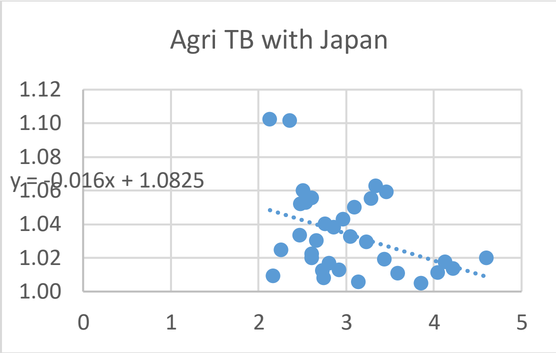
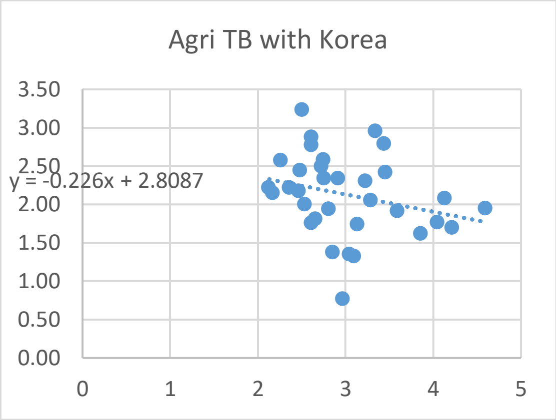


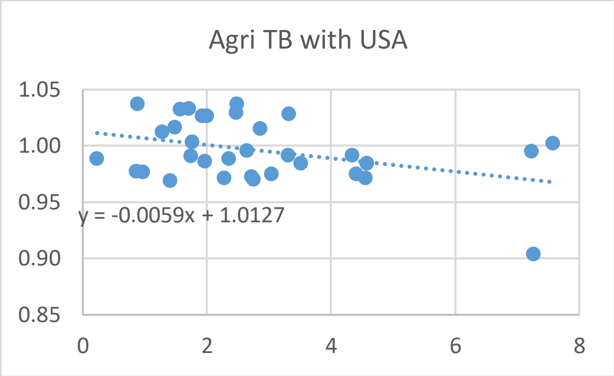
Figure 04 Bi-variate Relationship of Australian Real Exchange Rate and Agricultural Trade Balance with the concerned five countries


Agri TB with Thai
2.00
1.50
1.00
0.50
0.00
y = -0.1726x + 1.3402
0
1
2
3
4
5


Agri TB with China
1.05
1.00
0.95
0.90
0.85
y = -0.0088x + 1.0226
0
1
2
3
4
5


Agri TB with Japan
1.12
1.10
1.08
1.06
1.04
1.02
1.00
y = -0.016x + 1.0825
0
1
2
3
4
5


Agri TB with Korea
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
y = -0.226x + 2.8087
0
1
2
3
4
5


Agri TB with USA
1.05
1.00
0.95
0.90
0.85
y = -0.0059x + 1.0127
0
2
4
6
8

CHAPTER 4

ENVIRONMENTAL CONSEQUENCE OF AUSTRALIAN AGRICULTURAL TRADE: AN ASYMMETRIC ANALYSIS

ABSTRACT

Links between environmental degradation and agricultural trade balance (ATB) is still an under explored research area. This paper, therefore, investigates the issue for Australia using the quarterly data of 1988 - 2021 under the aegis of the environmental Kuznets curve (EKC) hypothesis framework. In this regard when a linear model is applied, support for short-run impacts is revealed. However, this model is unable to explore the asymmetry of the relationship. Therefore, a nonlinear model is applied to address this difficulty. The later model has supported both short- and long-run asymmetry adjustment by the ATB on Australian pollution. The findings reveal that improvement of the ATB is harmful for Australian environment, and agro import related economic activities are environmentally more efficient than agro export related activities. However, to improve the environmental conditions, agricultural commodity import substitution is not a good policy option for Australia. The findings also validate the EKC hypothesis, and additionally when environmental pollution is concerned, national income is as important as the ATB in case of Australia.

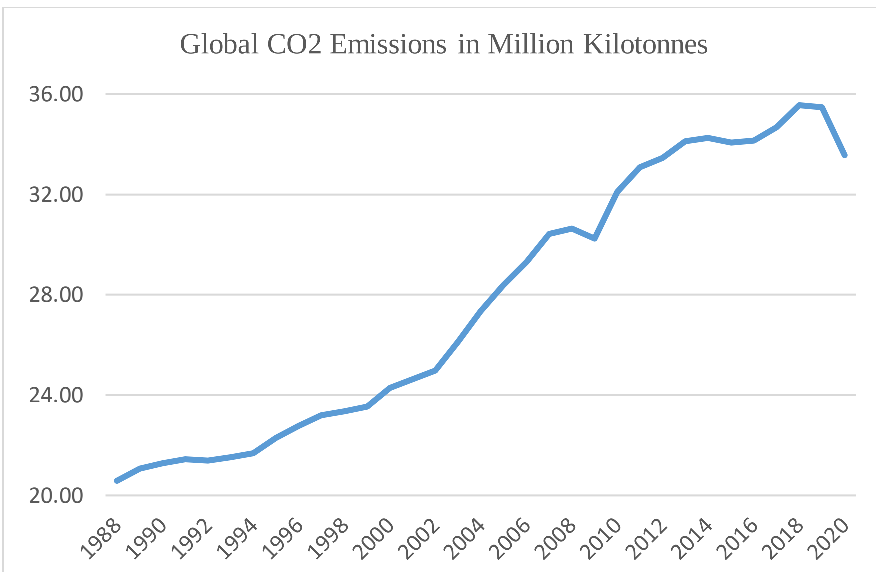
Keywords: Carbon emissions, Environmental pollution; Agro Trade Balance; Asymmetric Analysis, and Australia.

JEL Classification: F18, Q17, Q27, Q54, and Q56

4.2. INTRODUCTION

Environmental damage is considered as a serious collateral consequence of economic activities around the world. Ever increasing international trade is considered as one of the prime examples of such activities. Recent trends show that Australia is one of the worst victimized countries in the world by environmental pollution and consequent climate change. Frequent bush fires, floods, drought, ecological and biodiversity damages in both land and ocean areas are the principal issues among them. Ultimate impact of such damage falls upon the agricultural production and trading activities of the country. Therefore, the impact of trading activities on environmental pollution is an important research issue among academicians, environmentalists, researchers and policy makers. However, a careful review of existing literature reveals that though some studies on the trade-environment link exist, research regarding the environmental effect of the sectorial trade balance is very scarce in general and the agricultural trade balance (ATB) (ratio between agricultural export and import) in particular. This paucity of research leads us to investigate the environmental effect of Australian agricultural trade that has a vast contribution on the world agricultural commodity supply chain.

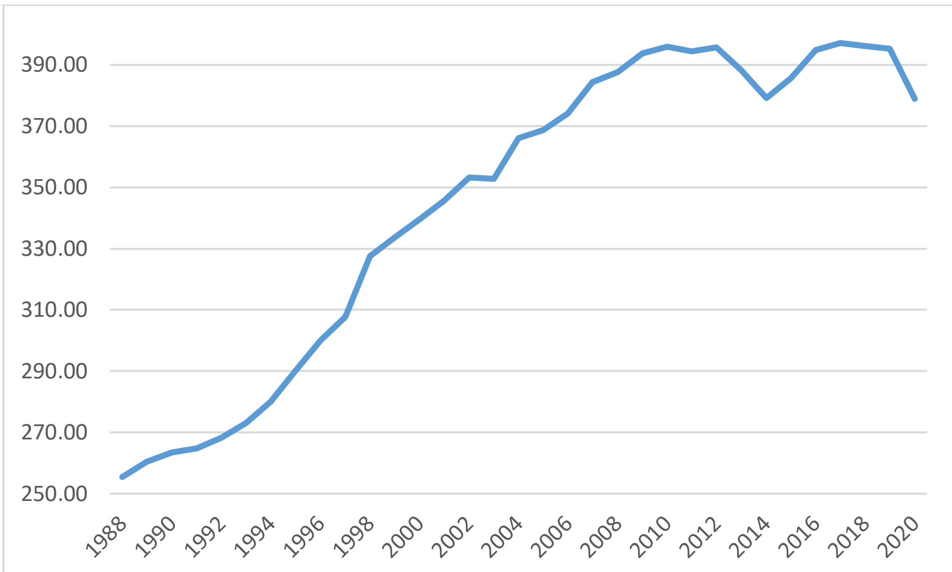
Figure 1: Global CO2 Emissions in Million Kilotons



Source: World Development Indicator (World Bank)

As it is mentioned above that in recent years, climate change related events in Australia are frequently making headlines in the international news outlets. Exponential increase of GHGs emission around the globe (Figure 1) and consequent climate change is believed the main cause of such occurrences. Sources of GHGs emissions are multiple and highly diversified. Trading activities and their linked services are considered as one of the major source of GHGs emission (Ansari, *et. al.* (2020)). Figure 2 shows that keeping coherence with the global trend, Australian CO_2 emissions level is also increasing day by day even though the country is trying to increase the climate friendly renewable energy use in its economic activities (Figure 3). However, this figure also postulates that intensity of renewable energy use by Australian economy is still less than 10 percent of its total energy needs. Thus, it is clear that the production process and technology of Australian GDP is still GHGs emission intensive. Since real GDP of Australia is in increasing trend (Figure 4), CO_2 emission is also going up. Agricultural trade is considered as one of the important sources of GHGs emission for any country. Australian ATB has been going up for many years (Figure 5). It means that Australian agricultural exports are increasing in a more speed than the increase of imports. Is there any impact of this ever increasing ATB on its environment? If there, what is the nature of that impact? This study contemplates to examine the impact of Australian ATB on its environmental pollution.

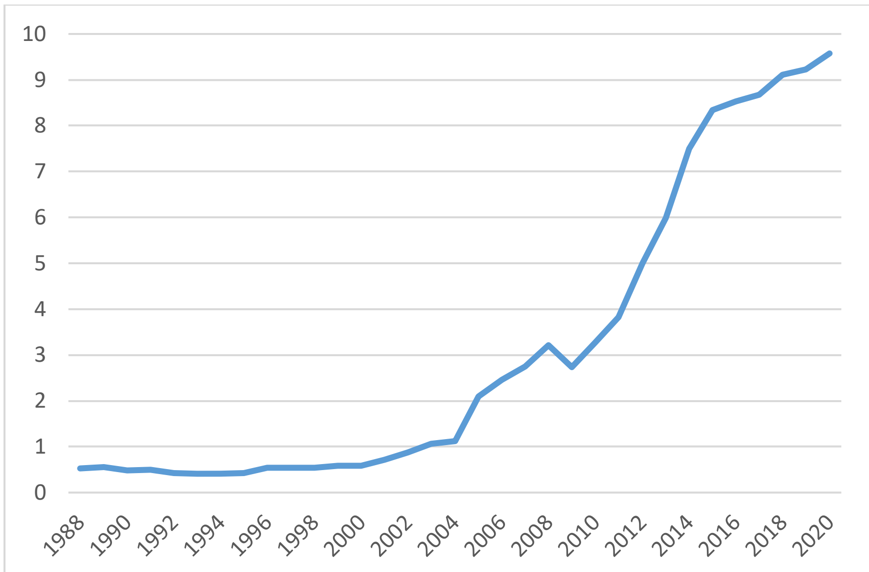
Figure 2: CO2 Emissions by Australia in Thousand Kilotons



Source: World Development Indicator (World Bank)

It has been shown in past numerous studies that expansion of international trade can have a noticeable negative impact on the environmental conditions of a country (Kumaran *et. al.*, 2012; Solarin *et al.*,2017; Raza and Shah, 2018). Here the arguments are that international trade can create negative externalities for the environment. Such externalities are originated from the unintended trans-boundary pollution, massive deforestation, setting up of new production plants and production relocation disregarding the environmental consequences, increasing the setting of backward and upwardly linked industrial plants in regard to targeted trading activities, and increasing domestic and international transportation of the concerned trading goods. Existing literature suggests that each country has own consequences which can be different for an individual country (Managi *et. al.*, 2008). The concerned country of this paper Australia has no exception as well. Some studies suggest that trade harms the Australian environment (Dellink *et. al.* 2017) but others show that the environmental impact of trade is insignificant in the case of Australia (Ansari, *et. al.* 2019). Australia exports 80 percent of its agricultural products, but agro export based land utilization has caused a grave environmental degradation, including salinisation because of land clearing and over irrigation, over usage of water, forest logging and massive land clearing, soaring greenhouse gas emissions, soil acidification, and high speed biodiversity loss and water contamination due to increased dependence on pesticides and fertilizer use (Cebon, 2003). In contrast, Frankel (2009) points out that empirical researches of multi-country data generally show no harmful effects of trade on the environment. Clearly the issue is inconclusive and country specific. Only a few number of studies postulate that a country‘s environmental condition might be benefited by intense agricultural trade (Karp, 2011), and a few other researchers have concluded that agricultural trade has no significant influence on environment or have manifested the effects on the environment actually might be ambiguous (Kankesue *et. al.* 2012).

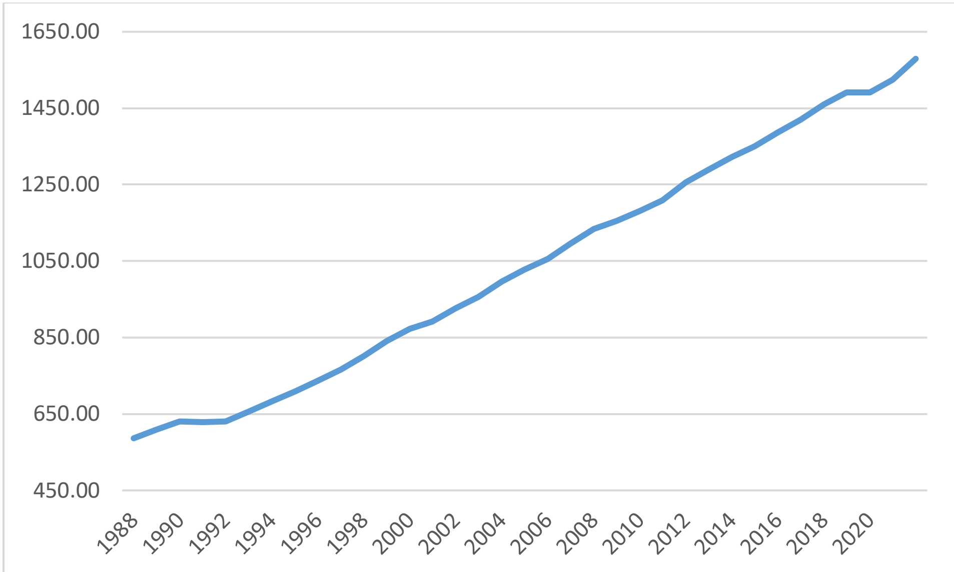
Figure 3: Renewable Energy Consumption as a % of total Energy Consumption in Australia



Source: World Development Indicator (World Bank)

A number of studies about the environmental consequences of international trade in Australia also exist. However, though country's agricultural trade contribution is about one fifth of its the total international trade, concentration of the literature on agricultural trade is very rare. A few studies focused on this issue and revealed the mixed results both in short-run and long-run. Such ambiguity may be raised due to the diversity of data and model specifications, and methodologies used in the study. Rahman and Mamun (2016) and Uddin, *et. al.* (2016) have assessed the data to check the impact of Australian trade on the environment that has reached in the conclusion that trade has a negative impact on Australian environment. However, Elton (2015) found that Australian trade has no influence on environmental degradation. We have inspected almost all available literature on Australia and found the flaws and lacunas in those studies that can be noted as: (i). data length is short and annual, thus the data did not leave enough degrees of freedom (Rahman, *et. al.* 2022); (ii) data suffers from the aggregation bias and results do not beget any clear decision (Rahman *et. al.* (2021); Rahman, *et. al.* 2022); (iii) no sector-segregated data is applied in any research; (iv) results are mixed and ambiguous, and thus misleading (Uddin, *et. al.* (2016) and Elton (2015)); (v) results and research technique have a high correlation; (vi) proper and updated econometric techniques were not used; (vii) asymmetric analysis is completely absent in the literature; and, (viii) no concentration is found on agricultural trade although agricultural trade contributes a big part in Australian foreign trade.

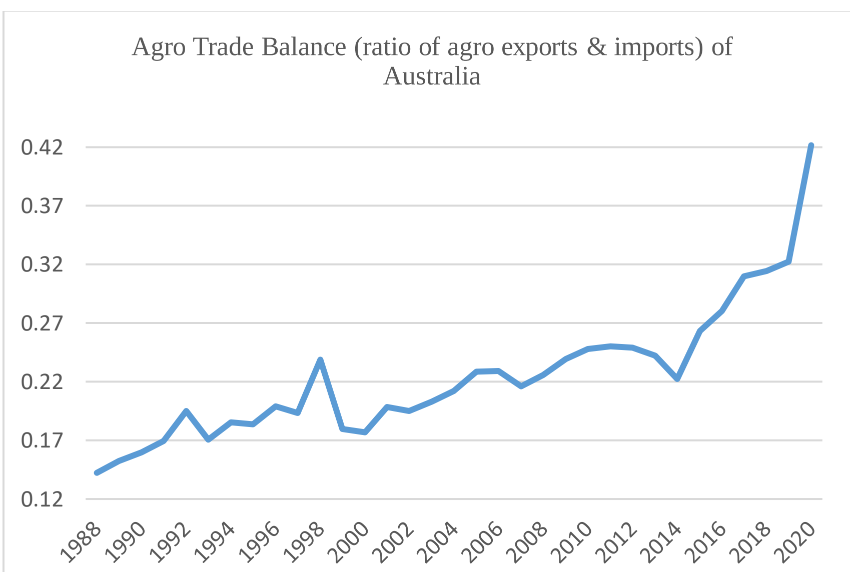
Figure 4: Australian Real GDP in Billion USD (base year 2015)



Source: World Development Indicator (World Bank)

Statistical reports postulate the utter dependence of Australian agriculture on foreign trade. The country exported about 72 and 61 percent of its agro products in 2020 and 2021, respectively (ABARES and DFAT, March 2022). Therefore, Australian agriculture is basically an export-oriented sector which is a very uncommon characteristic of this sector around the world. To recognize the relative importance of this sector in Australian trade, we plot the percentage share of total output exported for some of the major agricultural products in 2020 in the figure 6. As it is seen, major portions of the national annual outputs are exported almost for all of the listed agricultural items which indicates that Australian agriculture sector is basically a trade dependent sector. Such a sheer dependence in foreign market also urgently appeals to investigate the environmental consequence by the Australian agricultural trading activities.

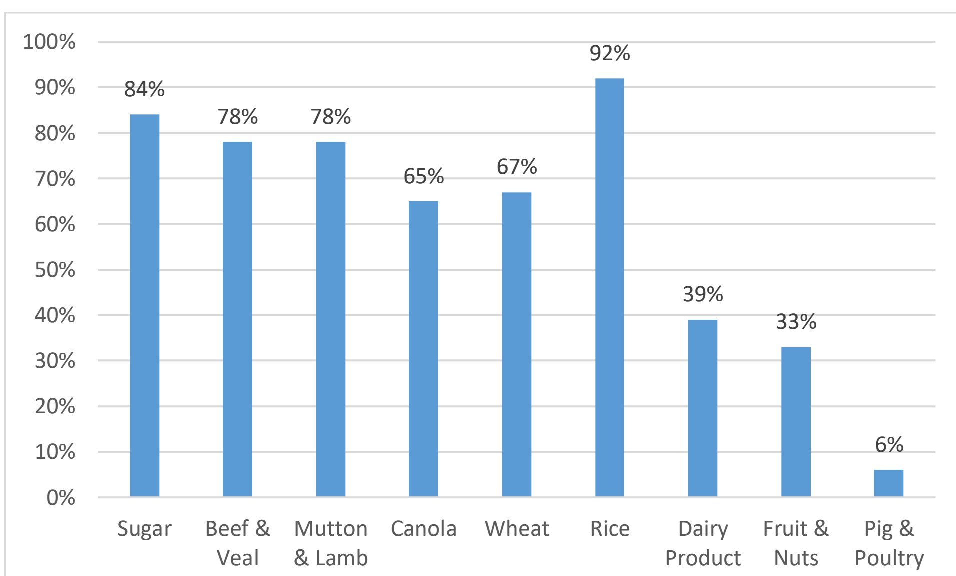
Figure 5: Agricultural Trade Balance (ratio of agro exports & imports) of Australia



Source: World Development Indicator (World Bank)

Despite the importance of the agro prone trade and business, the number of empirical researches exploring the nexus among agriculture-trade-environment is surprisingly very limited in the case of Australia. Not only it is the case in this country, but the issue also suffers from the lack of evidential and empirical knowledge in the rest of the world. One of the common features of the earlier studies is that they assume that the impact of trade on environment is always symmetric. They further assume that - each sector like primary mineral, manufacturing, service and agricultural goods – have the same directional impact on environmental pollution which may not be true in reality. This assumption is also arisen by the methodological constraints they have relied for investigations. Formulating and implementing environmental and trading policy based on such research outcome may lead abortive results. Understanding this gravity of both methodological and empirical knowledge gaps, this paper aims to provide a concrete outcome about the environmental impacts by ATB based on the recently (almost one decade ago) developed estimation techniques in time series econometrics with most recent data. Hence this study is unique, and it is expected that the results, from updated data and estimation techniques would have much policy implications for Australian as well as global environmental stakeholders. Our research results will have more reliance than available studies as we are using only agricultural sector data rather than aggregate trade data. Reducing or eliminating the malevolent aggregation bias by using individual sector trade balance data will incur originality of this research against the conventional aggregate data-based literature.

Figure 6: Share of total agro items exports out of total national production



Source: ABARES and Ministry of Agriculture, Forestry and Fishery of Australia. (https://www.awe.gov.au/abares/products/insights/snapshot-of-australian-agriculture-2022#around-72-of-agricultural-output-is-exported)

Since this is the first research of its kind, the results of this research are expected to be both asymmetric and symmetric. If the result is asymmetric, it will mean that environmental adjustment impact by ATB is not similar in short and long-runs. Further, the impact can be different when the trade balance improves and deteriorates either in short- or long-runs. If the result is symmetric, the conclusion would be that the impact is uniform regardless of improvement and deterioration of Australian ATB. Policy implications for the second case should be easier than first case. However, in the earlier case it would be bit difficult since in that case time, direction and magnitude of the ramification will have complex dynamics. So, our target in this study is to define whether the Australian ATB has a symmetric or an asymmetric influence on CO_2 emissions so that gravity of the complexity can be clear to the environmental policy making and implementing authorities. Accordingly research question of this study is that whether the impact of ATB on environmental pollution of Australia is symmetric or asymmetric.

The reminder of the paper is arranged as follows: Section II contemplates to review the existing literature to identify the concurrent research gaps; Section III explains data, models and econometric methods. Empirical research findings and associated analyses are narrated in Section IV, and finally, Section V notes the eventual observations and remarks for policy implications.

4.3.LITERATURE REVIEW

Trade and environmental pollution is widely explored in the research (Marije, *et. al.* 2023, Rahman *et. al.* 2022, Rahman *et. al.* 2021). Likewise, Michieka *et al.* (2013) analyzed the association between the exports and pollution for China. Further, Knight and Schor (2014), Khan *et al.* (2020), and Xia, *et. al.* (2023) have postulated that exports and imports amplify the growth of carbon intensive output productions and thus generates extra carbon emissions. Similarly, Wahab *et. al.* (2020) have also shown that both imports and exports have substantially positive impact on CO_2 emissions.

Besides some researchers have focused on whether the trade balance has any impact on the environment. The findings of Fawzia *et. al.* (2012) expressed the evidence of a co-integration relationship and short-run impacts of the trade balance on CO_2 emissions. Almost same result for long-run is revealed by Ben Jebli and Ben Youssef (2017), Ben Jebli *et. al.* (2016), and Chen *et. al.* (2019). An extensive literature has also come out in regard to trade openness and environmental pollution nexus. Dou *et. al*. (2021), Alfred, *et. al*. (2019), Salman *et. al.* (2019), Fredrick (2018), Al-Mulali and Ozturk (2015), Yang and Zhao (2014), Shahbaz *et al.* (2013), and Tamazian *et al.* (2009) have found strong correspondence between trade openness and CO_2 emissions for their sample based on different countries. Their findings are also supported by Halicioglu, (2009), Athula, (2011), Aziz *et al.*, (2013), Akin (2014), Farhani *et al.*, (2014), Zakarya *et al.*, (2015), Khuong, (2017), Karedla *et. al*. (2021), and Appiah *et. al.* (2022). Even causal linkage between carbon emissions and trade openness is discovered by Yang and Zhao (2014); Al-Mulali *et al.* (2015); Farhani and Ozturk (2015); Mihai (2018), Sarkodie, *et. al.* (2019), and Yao (2021), A vast number of studies have revealed the dynamic linkage between trade openness and CO_2 emissions too (Zhang *et al.* (2017), Mutascu (2018), Zamil *et al.* (2019), Mutascu and Sokic (2020), and Musah *et al.* (2021)).

The relationship between agricultural activities and CO_2 release has been studied and has found diverse outcomes. A group of studies such as Özilgen and Sorgüven, (2011); Santiago-De la Rosa *et al.*, (2017); Chen *et. al.* (2018), Waheed *et al.*, (2018) and Koondhar *et. al*. (2021), and Kandel, *et. al.* (2023) have shown the positive relationship between CO_2 emissions and agricultural output levels. Additionally, Alamdarlo, (2016) has conducted a study and has given evidence that CO_2 discharge has a one to one association with the agriculture sector and its linked services and industries. The findings from these researches have further shown that agricultural activities (pre-harvest, harvest and post-harvest activities) have impacts on CO_2 emissions differently. The result of this study is reinforced by the findings of Francisco, *et. al.* (2023), Farhani *et. al.* (2014), Gagnon *et al.*, (2016), and Dogan, (2016).

We were capable to discover only one paper on the topic like agro export and environmental pollution - the nearest topic to the issue discussed in this paper. That paper has postulated a positive relationship between agricultural exports and the environmental pollution level of Pakistan (Zaid *et. al.* 2021).

From the discussion above it is clear that Michieka *et al.* (2013) and (Zaid *et. al.* 2021) have assessed the impact of exports on environment and have reached in a decision that exports deteriorate environmental standard. Likewise, Knight and Schor (2014), Khan *et al.* (2020), and Wahab *et. al.* (2020) have explored the issue and have got that both exports and imports have positive impact on environmental pollution. Further, Fawzia *et. al.* (2012), Jebli *et. al.* (2016), Ben Jebli and Ben Youssef (2017), and Chen *et. al.* (2019) have detected long-run positive impact of trade balance on environmental pollution level.

Overall, the past literature suggests high linkage of international trade level, trade balance, trade openness, exports and imports individually and separately with environmental pollution. Further, empirical literature also shows extensive evidence of association between environmental pollution (carbon emissions) and agricultural output level. However, according to our exploration, none of the paper has investigated the impact of the trade balance of the individual sector of the economy (like manufacturing, or industrial, or service, or agricultural, etc.) on environmental pollution. All papers have relied on aggregate trade data.

That is, existing studies evaluate the impact of aggregate trade, ignoring the potential differences of this impact by trade balance of individual sector of economy. They did not put attention in the specific sectors like agriculture, manufacturing, service or their further segregated subsectors. Thus, whether the change of individual sector trade balance have any impact on environment such as agricultural trade balance (ATB) is a fundamental and basic empirical question which still remains unresolved. The ATB individually may either degrade or improve or has no impact at all on environment. Therefore, the objective of this research is to empirically examine the impact of ATB of Australia on its environmental pollution. Thus evidently, earlier studies for different countries and regions focused only on aggregate trade balance but not specifically in non-durable agro-based products trade balance. Due to their non-durable characteristic, production process's higher dependence on nature, long gestation period for the production turnout, and difference in inventory preservation techniques, the response of ATB may differ from the response of the trade balances of highly durable manufacturing or industrial products. For this facet of agro-based products, this paper also makes a topical innovation and an attempt to fill up a long vacuum of empirical research that was totally ignored in past researches. Additionally, to the best of our knowledge, no past research has explored the asymmetric analysis between the ATB or non-ATB and environmental pollution for any country ever. So, asymmetric analysis between the relationship of environment and ATB is also still remained uninvestigated. Clearly, this brief review of existing literature, there are multiple and long research gaps yet to be filled up. In short, we have found the following research gaps in the existing literature those can be reiterated: (i) no research on asymmetric analysis between environmental pollution (CO_2 emissions) and ATB; (ii) no research on agricultural trade and pollution level except agro exports and pollution in Pakistan; (iii) no research in case of Australia. From this identification of research lacuna, it is clear that the issue is suffering from number of empirical knowledge and evidence gaps on conceptual, theoretical, analytical, and methodological perspectives. Therefore, this research intends to fill up these overdue literature gaps. Such large and prolonged research gaps are also providing the evidence of the originality and urgency of this research.

4.4. DATA, MODELS AND ECONOMETRIC METHODS

To carry out the empirical analysis, the data period covered by this study is 1988Q1-2021Q4. There is no missing data in any of the selected series. We were needed to rely on three sources for the required data. Australian agricultural Trade Balance (ATB) data with the rest of the world are collected from the Department of Foreign Affairs and Trade (DFAT), Government of Australia. The ATB is defined as Australian imports from the rest of the world over her exports to the rest of the world which can be mathematically shown as (M_t/X_t)[1]. Since ATB is a ratio it has no unit. Data on the Australian Real GDP (Y_t) series (with base year 2010 and unit in US$) is collected from International Financial Statistics (IFS) of the International Monetary Fund (IMF, March 2022). Finally annual Australian carbon (CO_2) emissions (E_t) data are retrieved from the World Development Indicators (WDI) by World Bank (April, 2022), The unit of this data is in metric tons.

4.4.1. Crafting the model: The theoretical foundation for our empirical model is based on environmental Kuznets Curve (EKC) hypothesis, which shows an inverted u-shaped relationship between economic growth and environmental degradation; environmental degradation increases with the increase of economic growth at the initial level of development of a country. After certain level of development when the country can afford green technology, environmental quality improves with the increase of economic growth. We rely on Shin *et. al*. (2014) which also partially depends on Pesaran *et. al* (2001) model to make the inferences. This model is used in number of empirical investigation for asymmetry analysis especially in the trade related issues. So, we decide to use this advancement of knowledge in Environmental Economics asymmetric analysis may be for the first time and hope that this will open a new window for the analysis of environmental issue in the days to come. Our specification in this regard is as follows:

$$LnE_t = \alpha + \beta\ LnY_t + \gamma\ LnY^2{}_t + \delta\ LnATB_t + €_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (1)$$

where Ln means natural logarithm and E_t is Australian pollution, measured by the carbon emissions at the year t. Y_t is the Australian GDP at the year t. Finally, ATB_t is the Australian agricultural trade balance with rest of the world at year t where the ATB is defined as the ratio of Australian agricultural imports from the rest of the world over her agricultural exports to the rest of the world at year t. It is a novel model formulated by the admixture of the notions of the models by Shin *et. al.* (2014), and Kashem and Rahman (2020) model where pollution is a function of national income and trade ratio. To define ATB we use the ratio of imports over exports by following Bahmani-Oskooee (1991); an increase in the ratio means deterioration of the trade balance and vice versa. In using the term GDP-squared, (Y^2) is followed by the Kashem and Rahman (2020) model since they have considered that the relationship between emissions and

[1] Improvement of ATB means a decrease of the ratio M_t/X_t and vice versa.

GDP is quadratic means that as per EKC hypothesis pollution may increase in the initial period of increase of the income and may decrease after some time. If the GDP-squared variable gives a significant negative sign, the EKC hypothesis will be supported otherwise not. Here the target variable is ATB as our intention is to infer the impact of ATB on the Australian pollution level. Australian real GDP (or Y_t) is the control variable in the model. National income or real GDP is an inevitable variable for CO_2 emission function since economists believe that there is a one to one association between national income and CO_2 emissions over the history. Since the model is in logarithmic form we will get the estimates of impact by the change of the explanatory variable directly as elasticity. Since in the above equation Y_t is the Australian real GDP and an increase in real GDP is expected to increase Australian carbon emissions, an estimate of β is expected to be positive. In contrast, since we assume that the relationship is perhaps quadratic, an estimate of δ is expected to be negative. Finally, since some findings have concluded that relationship between emissions level and trade balance is positive [Rahman and Vu (2020), and Rahman (2017)] and some others have said negative (Mahmud *et. al*. 2020), the sign of δ can be positive or negative.

4.4.2. Incorporating the Long- and Short-run Dynamics in the Model: Now that we have a well specified model, our next task in this regard should be incorporating the short-run dynamic adjustment process into our model which is just an error-correction type short-run dynamic adjustment process along with probable long-run effects or relationships, and the model can be specified by equation (2) as follows:

$$\Delta LnE_t = \alpha_\tau + \sum_{j=1}^{n} \beta_{t-j}\, \Delta LnE_{t-j} + \sum_{j=0}^{n} \gamma_{t-j}\, \Delta LnY_{t-j} + \sum_{j=0}^{n} \delta_{t-j}\, \Delta LnY^2{}_{t-j} + \sum_{j=0}^{n} \lambda_{t-j}\, \Delta LnATB_{t-j} + \theta_1 \,\mathrm{Ln}\, E_{t-1} + \theta_2 \,\mathrm{Ln}\, Y_{t-1} + \theta_3 \,\mathrm{Ln}\, Y^2{}_{t-1} + \theta_4 \,\mathrm{Ln}\, ATB_{t-1} + \upsilon_t \;\ldots\ldots(2)$$

The above equation (2), is clearly a traditional error-correction model where the typical short-run effects of each explanatory variable on the environmental pollution (total carbon emissions) are inferred by the respective estimated coefficients related to the variables in first-differenced form and, similarly, the usual long-run impacts are gauged by the significance status of estimates of θ_1, θ_2, θ_3 and θ_4 which are also ultimately normalized on θ_1. However, to make these normalized estimated coefficients to be consequential and meaningful, it is needed to be confirmed about the co-integration or the long-run equilibrium relationships. The decision making mechanism of this fresh method is originally come from Pesaran *et. al.* (2001), who have recommended the application of their newly invented F-test for which they also have tabulated a set of novel critical values. According to Pesaran *et. al.* (2001), since the critical value is calculated considering the degree of integration of the variables, a researcher does not need to conduct the standard unit root test too, and thus, there is no problem if the incorporated variables in the model are an admixture of I(0) and I(1) - the very common characteristics of the time series data.

4.4.3. Demerits of the above model: One of the fundamental conditions of equation (2) to be applied is that changes in any of the independent variable of equation must have a symmetric effect on the dependent variable - the carbon emissions level in our present case. Now concentrating on the ATB (our target variable), the symmetry assumption unequivocally indicates that an increase of the ATB has the same effect on carbon emissions level as a decrease of the ATB in size but of course not in sign. However, it can be argued to the contrary that since in most of the time, business community ignores the socioeconomic consequence of the environmental pollution in doing their business activities, and as government and environmental bargaining groups reaction could be different in these two different periods, emission levels could be different in case of increase as compared to decrease of agricultural trade balance (ATB).

4.4.4. Capturing the asymmetries: Therefore, tackling such two opposite scenarios of traders' and related vested groups attitude we have resorted to the asymmetry model suggested by Shin *et. al.* (2014). To do that we have to modify the above model (2) into a totally new and different type of specification which could be applied to evaluate the asymmetric effects of ATB changes on CO_2 level emissions as follows:

$$\Delta LnE_t = a_\tau + \sum_{j=1}^{n} b_j\, \Delta LnE_{t-j} + \sum_{j=0}^{n} c_j\, \Delta LnY_{t-j} + \sum_{j=0}^{n} d_j\, \Delta LnY^2{}_{t-j} + \sum_{j=0}^{n} e_j\, \Delta PS_{t-j} + \sum_{j=0}^{n} f_j\, \Delta NG_{t-j} + \omega_1 \text{ Ln } E_{t-1} + \omega_2 \text{ Ln } Y_{t-1} + \omega_3 \text{ Ln } Y^2{}_{t-1} + \omega_4 PS_{t-1} + \omega_5 NG_{t-1} + \psi_t \;.......(3)$$

4.4.5. Econometric manipulation: As can be perceived, turning equation (2) into (3), the LnATB variable is substituted by a couple of new variables named as, PS and NG as a surrogate of Positive and Negative changes of ATB respectively. Here, clearly PS indicates the summation of only all the positive changes in LnATB and, obviously, reflects the deterioration of agricultural trade balance. Likewise, the variable NG reveals the summation of remaining all the negative changes in LnATB only and, naturally, shows an improvement of the agricultural trade balances.[2] As incorporation of such couple of segregated and partial sum variables include the non-linear adjustment process of ATB into an usual error-correction model, this type of specification, like (3) above, is known as a non-linear ARDL model, while the linear ARDL model like (2) assumes symmetric effects only. Therefore, the above equation (3) can capture if the explanatory variable(s) intrinsically perform any asymmetric effect on dependent variable of the model.

4.4.6. Techniques of Asymmetry Detection: Shin *et al.* (2014) have shown that by estimating equation (3), the OLS technique could be applied for the assessment of asymmetric co-integration and many other asymmetric effects (if any) analysis. We attempt here to use this model to assess the influence of ATB on the environmental pollution (i.e., carbon emissions) level of Australia. We want to follow the way to move forward as below:

To capture the joint significance of the adopted lag variables, the similar F-test would be used as a technique of asymmetry co-integration. It is worth to mention here that Shin *et. al.* (2014) proposed to treat the new found PS and NG variables like "a single" variable so that the critical values of their novel F-test can be kept at the same level while we would switch to (3) from (2), even though the model (3) has incorporated one additional variable in it.

4.4.7. Decision Making Process: For model (3) almost an identical type of test is considered for searching the long-run equilibrium or co-integration in case of the linear ARDL model (2). In the case of this alternative test, which is also known as an error-correction test (ECM_{t-1}), also known as the long-run estimates model (3) where LnATB is substituted by newly created PS and NG variables, are brought to formulate the so-called error-term which is connoted as ECM. By substituting the lag variables from equation (3) using the ECM_{t-1}, the newly specified model can also be estimated at the optimum values of lagged variable as before. Now a significant negative value of the coefficient of ECM_{t-1} should be just a substituted value for establishing the much expected co-integration. Here, simply as usual the traditional F-test, which is applied to evaluate

[2] Notes that to formulate the two new PS and NG variables, at first we counted ΔATB which has both positive and negative directions. After that PS_t at time t is defined as an aggregate summation of all observations in ΔATB_t where negative changes are substituted by zero(s). Then, similarly the NG_t is formulated by the same way where positive values of ΔATB_t are substituted by zero(s).

the significance of this newly estimated coefficients follow a fresh and unique type of F-distribution that is invented and later proposed by Pesaran *et. al.* (2001), and subsequently formulated a new table for the extreme bounds (i.e. upper and lower) or in other words “critical values”.

4.4.8. Nomenclature of Asymmetry: If in case of each lag j, an estimate of e_j is significantly different than estimate of f_j it should be an indication of the short-run asymmetric effects of the Australian ATB on the Australian carbon emission level; but according to Shin *et. al.* (2014) if $\sum \hat{e}_t \neq \sum \hat{f}_t$ this will be considered as a symptom of the short-run aggregate or so-called “***cumulative asymmetry***”. In this case, they have suggested the application of the traditional Wald test to check the significance of this inequity. In contrast, if the optimum number of lag value of ΔPS is not the same of the optimum number of lag values of ΔNS, that should be an indication of short-run ‘***asymmetry in coordination’***. *Lastly*, if it can be established that $\hat{\theta}_3/\hat{\theta}_0$ = - $\hat{\theta}_4/\hat{\theta}_0$, i.e., elaborately, estimated value related to the PS is significantly different from the estimated value related to the NG, it will be a confirmed symptom of the ‘***asymmetry in the long-run’***. As before, also in this case, the conventional Wald test can be applied to econometrically verify such inequality.

Table 1: Results of Linear ARDL (L-ARDL) and Non-linear ARDL (NL-ARDL) Models

Panel I: Estimates of Short Run Model		
	L - ARDL	**NL - ARDL**
	Coefficient	**Coefficient**
ΔlnYA,t	0.37 (0.89)	0.46 (1.08)
ΔlnYA,t-1	0.33 (0.52)	0.29 (0.48)
ΔlnYA,t-2	1.55 (2.53)**	1.36 (2.26)**
ΔlnYA,t-3	1.13 (2.00)**	1.22 (2.09)**
ΔlnYA,t-4	0.74 (1.70)*	0.98 (2.27) **
ΔlnY2,t	1.76 (0.35)	3.94(0.66)
ΔlnY2,t-1	-3.56(2.17)*	-3.22(2.05)*
ΔlnY2,t-2	0.43(0.29)	1.11(0.80)
ΔlnY2,t-3	0.78(0.54)	0.55(0.40)
ΔlnY2,t-4	3.47(2.29)*	-0.53(0.41)
ΔlnATBt	1.82(0.94)	
ΔlnATBt-1	-2.87(3.25)**	
ΔlnATBt-2	0.63(0.82)	
ΔlnATBt-3	0.67(0.82)	
ΔlnATBt-4	-1.25(1.64)*	
ΔPSt		-23.48(2.63)**
ΔPSt-1		-18.78(2.54)**
ΔPSt-2		-14.34(2.61)**
ΔPSt-3		-7.73 (1.81)*
ΔPSt-4		-2.98(1.97)
ΔNGt		5.12(0.83)
ΔNGt-1		4.06(0.89)
ΔNGt-2		1.15(1.21)
ΔNGt-3		3.59(1.79)*
ΔNGt-4		3.43(2.38)*
Panel II: Estimates of Long-Run Model		
ln Yt	0.93 (1.78)*	1.12 (2.24)**
ln Y^2 t	-2.24 (2.86) **	3.03(3.81) ***
lnATBt	0.71 (1.22)	
PS		2.86(1.53)
NG		-5.94(2.81) **
Constant	22.21 (3.34)**	27.95(3.95)**
Panel III: Statistics of Diagnostic tests		
F	24.00**	20.25**
LM	0.54	1.23
RESET	1.33	0.87
Adjusted R^2	0.54	0.56
CS (CS2)	S(S)	S(UNS)
WALD - Short		6.32**
WALD - Long		8.19**

Necessary Notes for the empirical results:

a) Figures within the first bracket are corresponding values of the t-statistic regardless their signs. ***, ** and * means, 1%, 5% and 10% level of significance,respectively.
b) In case co-integration test the critical value of the upper bounds are 3.77 and 4.35 at 10 % and 5% level of significance respectively.
c) Since k = 3, for significant ECM_{t-1} the critical values are -3.47 and -3.82 at 10 % and 5% level of significance respectively.
d) Lagrange multiplier (LM) test for autocorrelation is indicated by LM. It follows the Chi-squared (χ2) distribution. In our present case it is for degrees of freedom 2. At 5% level of significance its critical value is 9.48.
e) In case of specification the Ramsey RESET test is done with 1 degrees of freedom. In our case the critical values are 3.84 and 2.70 at 5% and 10% level of significance are respectively.
f) The critical values for Wald Test with degrees of freedom 1 at 5 % and 10% level of significance are 3.84 and 2.70 respectively.
g) Here, test statistics of all LM, RESET and Wald tests are following Chi-squared (χ^2) distribution. Only co-integration test of ECM_{t-1} is following the F-distribution invented by Pesaran et al (2001).

4.5. EMPIRICAL RESULTS AND ANALYSIS

We have estimated both of the proposed model in the last section of Australian carbon emissions for the ATB with the rest of the world with a view to investigate the consequence of ATB on environmental pollution. Environmental pollution is measured by the Quarterly CO_2 emissions of Australia for the period 1988Q1-2021Q4 to conduct the empirical investigations. To determine the optimal lag levels of the model, we relied on Akaike Information Criteria (AIC) and accordingly the maximum of ‘4’ lags are imposed on each of the first-differenced variables. We have considered critical values up to 10 percent level of significance to count statistical significance of both coefficient and diagnostic statistic which are presented in the Table 1 above. Further notification is that estimation of the linear and non-linear ARDL models are described as L-ARDL and NL-ARDL respectively.

The estimates of short-run coefficients of the L-ARDL model are reported in Panel I. The results indicate that ATB carries multiple significant coefficients in the L-ARDL model. Likewise, in case of the NL-ARDL model it seems that either ΔPS or ΔNG carry more than one significant coefficients with theoretically expected signs meaning that a deterioration of the ATB improves the environment and improvement of the ATB degradates Australian pollution. The result performs in line with the theoretical expectation as well as supports our hypothesis that improving of ATB (i.e. increase of exports is more than the increase of imports) is environmentally harmful for Australia. This finding supports the findings of Michieka *et al.* (2013), Knight and Schor (2014), Alamdarlo, (2016), Rahman and Mamun (2016), Uddin, *et. al.* (2016), Khan *et al.* (2020), Wahab *et. al.* (2020), and Zaid *et. al.* (2021). However, this finding contrasts with that of Elton (2015).

Additionally, to examine the support in the short-run effects of ATB on Australian CO_2 emissions level, the non-linear models also support short-run adjustment asymmetry in the models since in the case of ΔPS it takes a different significant lag order than ΔNG with theoretically expected signs. Moreover, the magnitude of the estimates of short-run coefficient related to ΔPS and ΔNG is different in numerical values almost in all cases of the same lag level (i.e., absolute numerical value of the estimates of ΔPS is higher than the estimates of ΔNG). This is in turn supports the asymmetric effects in the short-run by ATB on carbon emissions. This portion of results accords with results of Fawzia *et. al.* (2012).

Further, in the NL-ARDL model, ΔPS is significant in case of shorter and more number of lags than ΔNG and, similarly, the coefficients of ΔPS are relatively larger than the coefficients of ΔNG. It means that ramification of ΔPS is immediate, higher in magnitude, and longer in time than ΔNG meaning that when ATB deteriorates, CO_2 emissions do not fall in a similar speed and quantity. However, when ATB improves, CO_2 emissions increase relatively in a lower level and takes relatively larger time for influence to be effective into validation. Moreover, since, in case of ΔPS and ΔNG, lag effects are different in terms of time and magnitude, the impact of ATB on CO_2 emission is asymmetric.

Likewise, the sum of coefficients associated with ΔPS are significantly different than the sum related to ΔNG, as in these cases of the Wald test statistic reported as the Wald-Short in Panel III are significant. So, each direction of assessment confirms that short-run impact of ATB on Australian CO_2 emissions is asymmetric. Now, the question is, "does this short-run asymmetric effect sustain also in the long-run?"

The long-run coefficients are reported in the Panel II of Table 1. Estimates of the L-ARDL model exhibit that Australian ATB with the rest of the world has an insignificant coefficient with negative sign meaning that a deterioration or improvement of ATB will have no long-run impact on Australian carbon emissions level. However, when we shift to the corresponding NL-ARDL model, we see that PS has an insignificant long-run coefficient but NG is significant. It means that Australian ATB improvement has an adverse long-run impact on environmental pollution but deterioration of ATB has no beneficial impact on the environmental condition. This could be due to the fact that Australian carbon emissions may have no association with Australian agricultural trading goods production, packaging, marketing and consumption activities when ATB falls. It means that ATB has an asymmetric impact on the Australian environmental condition. This result is further supported by the Wald test since this test reveals that the Wald-Long in Panel III is significant. It means that like the short-run coefficient, the long-run coefficient of PS and NG are statistically different to each other. So, evidently the impact is asymmetric both in short- and long-runs.

Clearly, the results are model-specific. If we were to rely only on the L-ARDL model, we would have reached in the conclusion that the ATB improvement with the rest of the world has no long-run impacts on the Australian carbon emissions. However, subsequent NL-ARDL predicts that while ATB improvement has negative effect on emissions level, ATB deterioration has no positive impact on the Australian pollution level. So, first part of the result reveal by the NL-ARDL model supports the decision reached by Jebli *et. al.* (2016), Ben Jebli & Ben Youssef (2017), and Chen *et. al.* (2019). However, the second part contrasts with the findings of these three researches. Moreover, from the NL-ARDL model, we get an asymmetric impact by ATB on Australian pollution both in short- and long-runs. Based on this finding we can reach the following conclusions:

i. Australian income, ATB, and CO_2 emissions are co-integrated.
ii. It is true that ATB is harmful for the Australian environment but deterioration of ATB does not ensure significant improvement of CO_2 emissions.

iii. Both the linear and non-linear ARDL model for environmental pollution confirms that national income is as harmful as the ATB in the case of Australia in both short- and long-run.
iv. If the government wants to improve the Australian environment, decrease of agro commodity imports or agro commodity import substitution strategy is not a good policy choice.
v. Perhaps agro import related economic activities are environmentally more efficient than agro export related activities in Australia.
vi. Since the coefficient of the income-squared is significant with negative values, the EKC notion is valid for Australia.

Our findings both support and disagree with the prior findings by other researchers. For example, the research outcome regarding ATB supports the findings of Fawzia *et. al.* (2012), Jebli *et. al.* (2016) and Chen *et. al.* (2019). The findings related to GDP are similar to the findings of Michieka *et. al.* (2013), Wahab *et. al.* (2020), and Rahman *et. al.* (2021). Finally, the hypothesis related to EKC supports the findings of Faridul *et. al.* (2013), and Lean and Smyth (2010). However, this finding contradicts the results of Romero-Ávila (2008), and Apergis and Payne (2009).

All the long-run estimates reviewed above are econometrically valid since co-integration among the variables incorporated in the models is supported by the F-test, as its statistic is significant with a negative sign (Panel III). To reach in a confirmed conclusion, we have also conducted and subsequently have reported some more required diagnostic tests in the Panel III. The Lagrange Multiplier (LM) test is conducted and the test statistic is also reported. As the test statistic is insignificant in our (L-ARDL & NL-ARDL) models, we can claim that the error term is free from autocorrelation. To test whether the proposed models are wrongly specified, we have completed the Ramsey RESET test. So, as per the results reported, we can infer that perhaps models are correctly specified too. Another important diagnostic test is investigation of the models' stability throughout the sample period. To enquire the stability of the short- and long-run estimates, we have relied upon CUSUM and CUSUMSQ tests. The results of the test are given in the Panel III. Here, 'S' and 'UNS' indicate that the estimates are 'stable' and 'unstable', respectively. It is observed that both L-ARDL and NL-ARDL estimates are 'stable' by CUSUM though anomaly is there by the result of CUSUMSQ test. Finally, the value of adjusted-R^2 indicates the robustness of the goodness of fit of the models i.e., used explanatory variables explain the most variations of the carbon emissions of Australia.

4.6. CONCLUSIONS

The nexus between carbon emissions and trade balance has now entered into a new phase since the world is increasingly interconnecting day by day through trading activities. However, it is yet to be investigated the nexus of environment and agricultural trade balance comprehensively. Moreover, asymmetric analysis of this relationship has been totally ignored by the past researches. Thus, there is a big research gap on this issue across the literature. In this paper, we attempt to fill up this research gap. With this intention, we have selected to explore the Australian environment pollution and ATB linkage as this country's agricultural sector is one of the highest export oriented in the world with an intensively mechanized production technique. Since the existing literature does not provide anything about asymmetric analysis of this linkage, our research is the first of this kind. An asymmetry analysis usually needs application of a non-linear model, and, thus, non-linear adjustment of the ATB on environmental pollution is assumed to be the main contribution of this study. Australia is a land abundant country and land is intensively used input in agriculture. The country has a substantial reliance on agro-based trade for keeping its aggregate trade balance healthy. Considering all these facts we believe Australia can be one of the best countries to select for such a case study. Hence, to conduct this study, we have used quarterly Australian data for the period of 1988 Q1 -2021 Q4. The research also has high policy implications for the other countries of the world those have high stake on agricultural trade.

When we have used the linear ARDL approach of Pesaran *et al.* (2001) for modeling Australian carbon emission level, we have found short-run support of the impact of ATB on carbon emissions of Australia with no significant long-run impact. However, when we have separated positive and negative changes of ATB and relied upon Shin *et. al*.'s (2014) asymmetric analysis by non-linear ARDL approach, support for the asymmetry is found both in short- and long-runs. In this way, estimates from the NL-ARDL model imply that time required to make the response to the carbon emissions is not same during the cases of improvement and deterioration of the ATB. It means that when ATB improves environmental pollution increases but fall of ATB does not ensure the decrease of pollution. It further means that the reasons for the decline in the ATB are unrelated to the causes of environmental pollution. So, in case of Australia ATB may fall due to nonproduction related causes like unfavorable movement of exchange rate, fall of international demand, discontinuity and disruption of supply chain, etc.

Precisely, the overall empirical findings of the research support the conventional theoretical guidelines of the environmental economics. The study shows that Australian income, agricultural trade balance, and CO_2 emissions have the long-run equilibrium relationships. The findings also reveal that ATB improvement is harmful for the Australian environment both in short- and long-runs However, since the deterioration of ATB has longer lagged effect on CO_2 emissions, it indicates a delayed improvement of environmental condition due to the fall of the ATB. Additionally, findings also postulate that agricultural import related economic activities are environmentally more efficient than export related activities, and i.e. since import increases as income or consumption power increases of a country, indirectly Environmental Kuznet Curve (EKC) hypothesis is also empirically supported in case of Australia by the findings of this study.

Therefore, the policy implication of this study is that if the government wants to improve the Australian environmental quality by agricultural commodity import substitution, the policy may not bring immediate positive results for the Australian environment. Thus, government should concentrate on extension of environment friendly technology for the agricultural production and trade related activities not the direct control of agricultural exports and imports.

This research has number of limitations too. It fails to estimate the true duration of impact of ATB changes on CO_2 emissions. The potential studies may concentrate on this point. Further, according to our perception if possible future research should be conducted by concentrating on Australian environmental pollution with the bilateral level disaggregated trading data, by further segregated trade flows by commodity level to define how each industry responds to asymmetric effects of agro and non-agro based trade balance changes. Such researches also will help in decomposition analysis of the pollutions levels by various trade commodities which will ultimately help the world to switch to the less polluting trading activities. Future researchers also can contemplate to investigate the asymmetric analyses of environmental pollution with respect to the use renewable energy, national income, population, urbanization etc. important polluting factors identified by the past researches.

4.7. REFERENCES

Alamdarlo, H.N., (2016). Water consumption, agriculture value added and carbon dioxide emission in Iran, environmental Kuznets curve hypothesis. International Journal of Environmental Science and Technology (Tehran), 13(8): 2079-2090.

Alfred, A. Haug, M. & Ucal, M. (2019). The role of trade and FDI for CO_2 emissions in Turkey: Nonlinear relationships. Energy Economics Volume 81, Pages 297-307

Akin, C. S. (2014). The Impact of Foreign Trade, Energy Consumption and Income on Co2 Emissions. International Journal of Energy Economics and Policy Vol. 4, No. 3, 2014, PP.465-475

Al-Mulali, U., & Ozturk, I., (2015). The effect of energy consumption, urbanization, trade openness, industrial output, and the political stability on the environmental degradation in the MENA (Middle East and north African) region. Energy, 84(1): 382-389.

Ansari, M. A., Haider, S. Khan, N. A. (2019). Does trade openness affects global carbon dioxide emissions: Evidence from the top CO_2 emitters. Management of Environmental Quality. Volume 31, Issue 1.

Athula, N. (2011). Does Trade Openness Promote Carbon Emissions? Empirical Evidence from Sri Lanka. The Empirical Economics Letters. Vol. 10, January - December, 2011.

Apergis, N. & Payne. J. E. (2009). CO2 Emissions, Energy Usage, and Output in Central America. Energy Policy, 37: 3282-3286.

Appiah, K. Worae, T. A., Yeboah, B., & Yeboah, M. (2022). The causal nexus between trade openness and environmental pollution in selected emerging economies. Ecological Indicators Vol. 138, May 2022, 108872.

Aziz, A.A., Mustapha, N.H.N., & Ismail, R. (2013). Factors affecting energy demand in developing countries: A dynamic panel analysis. International Jour. of Energy Economics and Policy, 3(4S): 1-6.

Al-Mulali U, Ozturk I, & Lean H H (2015). The influence of economic growth, urbanization, trade openness, financial development, and renewable energy on pollution in Europe. Nat Hazards 79: 621- 644.

Bhamani-Oskooee, M. (1991). Is There a Long-Run Relation between the Trade Balance and the Real Effective Exchange Rate of LDCs? Economic Letters, 36: 403-407.

Ben Jebli M, & Ben Youssef S., (2017). Renewable energy consumption and agriculture: evidence for co-integration and Granger causality for Tunisian economy. Int J Sustain Dev World Ecol 24:149-158.

Banerjee, A., Dolado, J., & Mestre, R. (1998). Error-correction mechanism tests for co-integration in a single-equation framework. Journal of Time Series Analysis 19: 615-25

Cebon, M. (2003). The Australia-US free trade agreement: An environmental impact assessment. Oz Prospect, Melbourne, VIC, Australia, http//www.ozprospect.org

Chen Y, Wang Z, & Zhong Z (2019). CO2 emissions, economic growth, renewable and non-renewable energy production and foreign trade in China. Renew Energy 131: PP 208-216.

Chen, J. Cheng S., & Song, M., (2018). Changes in energy-related carbon dioxide emissions of the agricultural sector in China from 2005 to 2013. Renewable and Sustainable Energy Reviews, Volume 94, October 2018, Pages 748-761

Dellink, D. Hwang, H. Lanzi, E. Chateau, J. (2017) International Trade Consequences of Climate Change. OECD Trade and Environment Working papers (2017). OECD Library.

Dogan, N., (2016). Agriculture and environmental Kuznets curves in the case of Turkey: Evidence from the ARDL and bounds test. Agricultural Economics, 62(12): 566–574. FAO, 2014. The Water-Energy-Food Nexus: A New Approach in Support of Food Security and Sustainable Agriculture. FAO, Rome.

Dou, Y., Zhao, J., Malik, M. N.& Dong, K., (2021). Assessing the impact of trade openness on CO_2 emissions: Evidence from China-Japan-ROK FTA countries. Journal of Environmental Management. Vol. 296, Issue 15, October 2021, PP 113-241

Farhani, S., Chaibi, A., & Rault, C., (2014). CO2 emissions, output, energy consumption, and trade in Tunisia. Economic Model, 38(2014): 426-434.

Farhani S, Chaibi A, & Rault C. J. E. M. (2014). CO2 emissions, output, energy consumption, and trade in Tunisia. Econ Model. 38: 426-434. doi:10.1016/j.econmod.2014.01.025

Farhani, S., & Ozturk, I., (2015). Causal relationship between CO2 emissions, real GDP, energy consumption, financial development, trade openness, and urbanization in Tunisia. Environmental Science and Pollution Research, 22(2015): 15663-15676.

Faridul, I., Shahbaz, M., & Butt, M. S., (2013). Is There an Environmental Kuznets Curve for Bangladesh? Evidence from ARDL Bounds Testing Approach. Bangladesh Development Studies Vol. XXXVI, No.4

Frankel, J (2009). Environmental effects of international trade. Harvard Kennedy School, Harvard University.

Francisco, J. C. D. Luis, J. B. U. Ana, B. D. F. & Francisco, C. F. (2023) Impact of environmental policies on the profitability of greenhouse agriculture in southeastern Spain. Sustainable Development, Volume 31, Issue 5, PP 3639-3656.

Fredrick, N. G. A. (2018). International trade and carbon emissions: The role of Chinese institutional and policy reforms. Journal of Environmental Management Vol. 205, January 2018, Pages 29-39.

Gagnon, B., Ziadi, N., Rochette, P., Chantigny, M.H., Angers, D.A., Bertrand, N., & Smith, W.N., (2016). Soil-surface carbon dioxide emission following nitrogen fertilization in corn. Canadian Journal of Soil Science, 96(2): 219-232. Global Carbon Atlas, 2018. CO2 Emissions.

Hongxing, Y. Abban, O.J., & Boadi, A. D. (2021). Foreign aid and economic growth: Do energy consumption, trade openness and CO2 emissions matter? A DSUR heterogeneous evidence from Africa’s trading blocs. PLOS One. Published: June 25, 2021

Halicioglu, F., (2009). An econometric study of CO2 emissions, energy consumption, income and foreign trade in Turkey. Energy Policy, 37 (3): 1156-1164.

Jebli, M.B., Youssef, S.B. & Ozturk, I. (2016). Testing environmental Kuznets curve hypothesis: the role of renewable and non-renewable energy consumption and trade in OECD countries. Ecological Indicators, Vol. 60, pp. 824-831.

Lean, H. H. & R. Smyth. R. (2010). CO2 Emissions, Electricity Consumption and Output in ASEAN. Applied Energy, 87: 1858-1864.

Mutascu M (2018). A time-frequency analysis of trade openness and CO2 emissions in France. Energy Policy 115:443-455

Mutascu M, & Sokic A (2020). Trade openness-CO 2 emissions nexus: a wavelet evidence from EU. Environ Model Assess 1-18

Musah M, Kong Y, Mensah IA, Li K, Vo XV, Bawuah J, & Donkor M. (2021). Trade openness and CO2 emanations: a heterogeneous analysis on the developing eight (D8) countries. Environ Science and Pollution Research. PP 1-16

Managi, S., Hibiki, A., & Tsurumi, T. (2008). Does trade liberalization reduce pollution emissions? RIETI Discussion Paper Series 08-E-013.

Muhammad, S., Long, X., & Dauda, MSL. (2020). Effect of urbanization and international trade on CO2 emissions across 65 belt and road initiative countries. Energy, Volume 196, 117102

Michieka, N.M., Fletcher, J., & Burnett, W., (2013). An empirical analysis of the role of China's exports on CO2 emissions. Applied Energy, 104 (2013): 258-267.

Mihai M. (2018). G7 countries: between trade openness and CO2 emissions. Economics Bulletin, Volume 38, Issue 3, PP 1446 -1456.

Özilgen, M., & Sorgüven, E., (2011). Energy and energy utilization, and carbon dioxide emission in vegetable oil production. Energy, 36(10): PP 5954-5967.

Kandel, G. P. Bavorova, M. Ullah, A. Kaechele, H. Pradhan, P. (2023) Building resilience to climate change: Examining the impact of agro-ecological zones and social groups on sustainable development. Sustainable Development, Volume 31, Issue 5, PP 3796-3810.

Kankesu, JK. Reetu, V., & Ying, L., (2012). CO2 emissions, energy consumption, trade and income: A comparative analysis of China and India. Energy Policy, Vol. 42, PP 450-460

Kashem, MA, & Rahman, MM, (2020). Environmental Phillips curve: OECD and Asian NICs perspective. Environmental Science and Pollution Research, 27, PP 31153-31170.

Karp, L. (2011). The Environment and Trade. Department of Agricultural and Resource Economics, University of California, Berkeley, California 94720; and Ragnar Frisch Center for Economic Research, NO-0349 Oslo, Norway

Karedla, Y. Mishra, R., & Patel, N. (2021). The impact of economic growth, trade openness and manufacturing on CO2 emissions in India: an autoregressive distributive lag (ARDL) bounds test approach. Journal of Economics, Finance and Administrative Science. Vol.26. No.52.

Knight KW, & Schor JB (2014). Economic growth and climate change: a cross-national analysis of territorial and consumption-based carbon emissions in high-income countries. Sustainability (Switzerland) 6(6): PP 3722-3731

Khan, ZA, Koondhar, MA, Khan, I. Ali, U & Tianjun, L. (2021). Dynamic linkage between industrialization, energy consumption, carbon emission, and agricultural products export of Pakistan: an ARDL approach. Environmental Science and Pollution Research (2021) 28: PP 43698-43710.

Khan, Z., Ali, S., Umar, M., Kirikkaleli, D., & Jiao, Z. (2020). Consumption- based carbon emissions and International trade in G7 countries: The role of environmental innovation and renewable energy. Science of the Total Environment, 730, 138945.

Koondhar, M. A., Udemba, E. N., Cheng, Y., Khan, Z. A., Koondhar, M. A., Batool, M., & Kong, R., (2021). Asymmetric causality among carbon emission from agriculture, energy consumption, fertilizer, and cereal food production – A nonlinear analysis for Pakistan. Sustainable Energy Technologies and Assessments, Vol. 45.

Khuong, N.D., (2017). Factors affecting CO2 emission in Vietnam: A panel data analysis. Organizations and Markets in Emerging Economies, 9(2): PP 244-257.

Kumaran K J, Verma R, & Liu Y. (2012). CO2 emissions, energy consumption, trade and income: a comparative analysis of China and India. Energy Policy. 2012; 42: PP 450-460.

Marije S. Ilda, D. Lacour, M. A. Benis, N. E. Dewa, P. E. Arilson, F. Sonny M. Louise, N. Jonas, N. P. Marieke, S. Thiago, K. U. & Zoe, M. (2023) Mapping social impacts of agricultural commodity trade onto the sustainable development goals. Sustainable Development, Volume 31, Issue 4, PP 2363-2385

Pesaran, M. H., Y. Shin, & Smith, R. J. (2001). Bounds Testing Approaches to the Analysis of Level Relationships. Journal of Applied Econometrics, 16, PP 289-326.

Rahman, M.M., Alam, K. & Velayutham, E. (2022). Reduction of CO2 emissions: The role of renewable energy, technological innovation and export quality, Energy Reports, 8, 2793-2805.

Rahman MM, & Mamun SAK (2016). Energy use, international trade and economic growth Nexus in Australia: new evidence from an extended growth model. Renew Sustain Energy Rev 64:PP. 806 - 816

Rahman, M.M., Nepal, R. & Alam, K. (2021). Impacts of human capital, exports, economic growth and energy consumption on CO2 emissions of a cross-sectionally dependent panel: Evidence from the newly industrialized countries (NICs). Environmental Science and Policy, 121, PP 24-36.

Rahman, M.M. & Vu, B. (2020). 'The nexus between renewable energy, economic growth, trade, urbanisation and environmental quality: A comparative study for Australia and Canada', Renewable Energy, 155: PP 617-627.

Rahman, M.M. (2017). Do population density, economic growth, energy use and exports adversely affect environmental quality in Asian populous countries? Renewable & Sustainable Energy Reviews, Vol. 77, PP. 506-514.

Raza, S.A. & Shah, N. (2018), 'Testing environmental Kuznets curve hypothesis in G7 countries: the role of renewable energy consumption and trade', Environmental Science and Pollution Research, Vol. 25 No. 27, PP. 26965-26977.

Romero-Ávila, D. (2008). Questioning the Empirical Basis of the Environmental Kuznets Curve for CO2: New Evidence from a Panel Stationarity Test Robust to Multiple Breaks and Cross-Dependence. Ecological Economics, 64: PP 559-574.

Sarkodie SA, Adams S, Owusu PA, Leirvik T, & Ozturk I. (2020). Mitigating degradation and emissions in China: the role of environmental sustainability, human capital and renewable energy. Science of Total Environment. 719: 137530.

Salman, M. Long, X., Dauda, L., Mensah, C. N., & Muhammad, S. (2019). Different impacts of export and import on carbon emissions across 7 ASEAN countries: A panel quintile regression approach. Science of the Total Environment. Vol. 686, Issue 10, PP 1019-1029

Santiago-De la Rosa, N., Mugica-Alvarez, V., Cereceda-Balic, F., Guerrero, F., Yáñez, K., & Lapuerta, M., (2017). Emission factors from different burning stages of agriculture wastes in Mexico. Environmental Science and Pollution Research, 24(31): PP 24297–24310.

Solarin SA, Al-Mulali U, Musah I, & Ozturk I (2017). Investigating the pollution haven hypothesis in Ghana: an empirical investigation. Energy 124: PP 706-719

Sarkodie S. A, Ntiamoah, E.B., & Li, D., (2019). Panel heterogeneous distribution analysis of trade and modernized agriculture on CO2 emissions: The role of renewable and fossil fuel energy consumption. Natural Resources Forum, Issue 43, PP 135-153.

Shin, Y, Yu, B., & Greenwood-Nimmo, M. (2014). Modelling Asymmetric Co-integration and Dynamic Multipliers in a Nonlinear ARDL Framework. Festschrift in Honor of Peter Schmidt: Econometric Methods and Applications, eds. by R. Sickels and W. Horrace: Springer, 281-314.

Shahbaz, M., Hye, Q.M.A., Tiwari, A.K., & Leitão, N.C., (2013). Economic growth, energy consumption, financial development, international trade and CO2 emissions in Indonesia. Renewable and Sustainable Energy Reviews, 25(2013): PP 109-121.

Tamazian, A., Chousa, J.P., & Vadlamannati, K.C., (2009). Does higher economic and financial development lead to environmental degradation: Evidence from BRIC countries? Energy Policy, 37(1): PP 246-253.

Uddin G A, Alam K, & Gow J (2016). Estimating the major contributors to environmental impacts in Australia. J of Ecological Econ & Stat 37(1):1–14. ISSN 0973-1385 (print); 0973-7537

Wahab, S., Zhang, X., Saf, A., Wahab, Z., & Amin, M. (2020). Does energy productivity and technological innovation limit trade adjusted carbon emissions? Economic Research-Ekonomska Istraživanja, PP 1-16.

Waheed, R., Chang, D., Sarwar, S., & Chen, W. (2018). Forest, agriculture, renewable energy, and CO2 emission. Journal of Cleaner Production, 172: 4231-4238. WDI, World Bank, 2018

Xia, R. Long, Z. Xing, L. and Khan, A. Y. (2023) Achieving sustainable development through economic growth energy consumption, and agricultural productivity in China. Sustainable Development, Volume 31, Issue 5, PP 3428-3442.

Yang, Z., & Zhao,Y., (2014). Energy consumption, carbon emissions, and economic growth in India: Evidence from directed acyclic graphs. Economic Model, 38(2014): PP 533-540.

Zamil AM, Furqan M, & Mahmood H (2019.) Trade openness and CO2 emissions nexus in Oman. Entrep Sustain Issues 7(2):PP 1319 -1329

Zhang S, Liu X, & Bae J (2017). Does trade openness affect CO 2 emissions: evidence from ten newly industrialized countries? Environ Science Pollution Research 24(21): PP 17616 -17625

Zakarya, G.Y., Mostefa, B., Abbes, S.M., & Seghir, G.M., (2015). Factors affecting CO2 emissions in the BRICS countries: A panel data analysis. Procedia Economics and Finance, 26(2015): 114 -125.

CHAPTER 5

DOES TRADING AGREEMENT DIVERT AUSTRALIAN AFF EXPORTS?

ABSTRACT

Export destinations of a country can be determined by number of factors. Among them, preferential (PTA) and free trade (FTA) agreements might be considered important one. In recent years, Australia has joined in number of trading agreements. But how do they contribute in determining Australian Agro, Forest, and Fish (AFF) export destinations? In this research, we have attempted to answer this question. Applying the panel data econometric technique, we have got confirmed evidence that Australian AFF exports are diverted by such agreements. Our results overwhelmingly reveal that "trade diversion" and "trade creation" are happening due to Bilateral (BTA) and Multilateral Trading (MTA) Agreements for Australian AFF products. It may be blessings for the country in the short-run but could have ominous consequences in the long-run. Australian agricultural commodity trade is perilously lopsided to a few countries due to trading agreements. Such profound inclination to a small group of countries could hamper its long-term AFF export growth. Additionally, Australia has much potential to increase AFF exports to the European Union (EU) and high income Middle Eastern countries. This result is supported by the alternative robustness test as well.

Keywords: Agro products exports, Trading Agreements, Trade Policy, Australia.
JEL Classification: F13, F14, F15

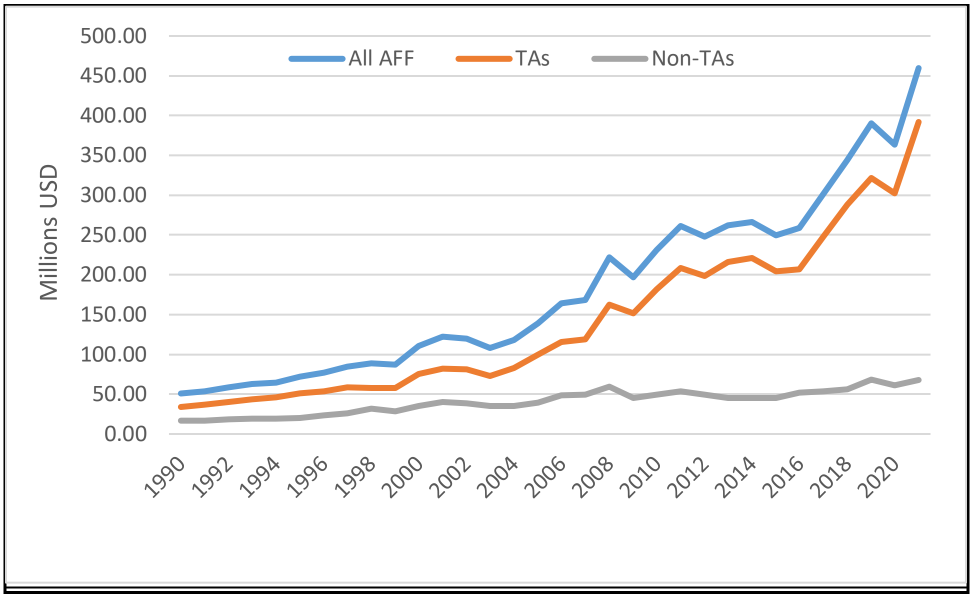
5.2. INTRODUCTIONS:

The World Trade Organization (WTO) advocates for completely open trade borders among countries and opposes the formation of multilateral trade agreements (MTAs), regional trade agreements (RTAs), or bilateral trade agreements (BTAs). In this regard, the WTO argues that such agreements simply "divert" trade from one country or area to another without incurring optimal welfare for the countries involved, as would be the case with absolute global free trade. However, deep-rooted political rifts among nations have historically hindered the achievement of this global free trade regime. As a result, countries worldwide have resorted to forming MTAs, RTAs, and signing up for BTAs with like-minded trading partners as a makeshift alternative to promote their trades as much as possible. Australia is no exception to this trend and has signed a total of 23 MTAs and BTAs with various trading partner countries and blocks over the last two decades, and 19 of which have already come into force (Appendix II). Australian agricultural exports have been persistently increasing since the inception of current century (DFAT, 2023). Accordingly, a question is raised regarding whether this growth of Australian agro, forest, and fish (AFF) exports are happening just because of MTAs and BTAs' "trade diversion effect"? Is this growth in AFF exports coming from the increased demand of partner countries and regions only?

Now, promoting exports is an important measure of economic growth for many countries. Linking a particular sector with overseas markets is an effective way to strengthen demand for that sector (Stiglitz, 2015). Keeping this technique in mind, Australia has signed a number of RTAs and BTA since 2003 so that its exports can be boosted up. It is argued that MTAs or BTAs might have contributed to the gradual increase of Australian AFF exports. Australian trade balance is doubling in size every ten years (Chatellier, 2021). The volume of Australian total agricultural exports both to developing and advanced countries has increased due to its continuous growth of agricultural productivity. This reflects both Australian agro trade integration with the rest of the world through trading agreements and increased demand of agro products from the rest of the world (Grundy el. al., 2016). However, engaging in these trading agreements introduces a query regarding the impacts of these new trading agreements on Australian AFF exports growth. Besides of domestic production increase or for rising international demand for Australian AFF goods, how the "trade diversion" and "trade creation" effects originated from trading agreements are playing role.

Australia signed its first bilateral trade agreement (BTA) with New Zealand in 1983, and for the next two decades, it did not enter into any other trading agreements (TA) with any other country. Then in 2003, Australia reached in a contract for trading agreement with Singapore, and since then, it has signed a total of 23 RTAs and BTAs. Figure 1 below shows the trend of Australian AFF exports to partners with and without trading agreements. The orange line represents exports to countries with trading agreements, while the grey line represents exports to countries without trading agreements. The blue line (vertical summation of orange and grey lines) represents total Australian AFF exports.

Figure 1: Trend of Australian AFF exports to the countries with Trading Agreements and Non - Trading Agreements

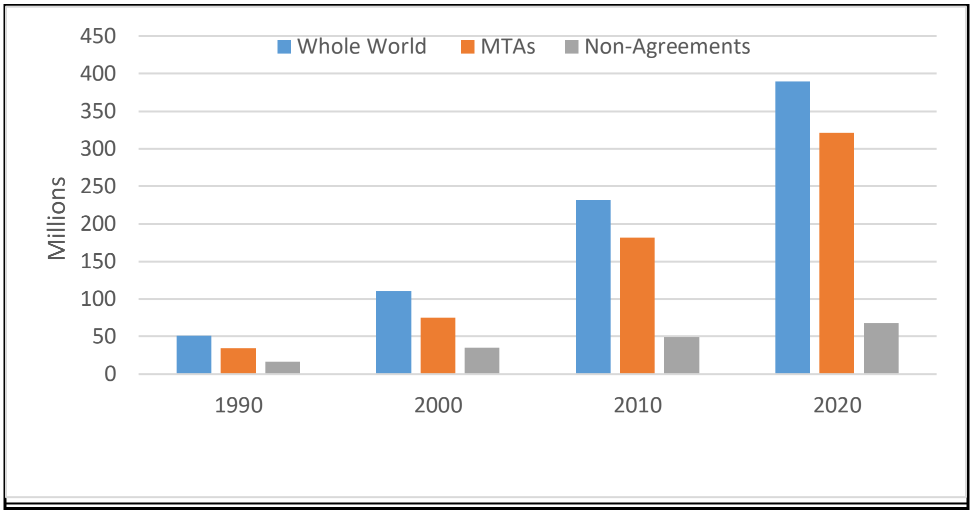


Source: Authors own compilation with data of DFAT, Australia

It is clear that Australian total AFF exports are mostly driven by exports to countries with trading agreements. AFF exports have increased rapidly since 2003, which coincides with the inception of increased momentum in Australian AFF exports and the signing of MTAs and BTAs. This figure shows an important and interesting observation that the increase of Australian AFF exports since the beginning of new millennium to countries with trade agreements might be due to "trade diversion" and "trade creation" effects resulting from these newly enforced trading agreements. Therefore, it can be noted that the signing of BTAs and MTAs might have substantially worked as a driving force behind Australian AFF exports.

The following figure 2 displays the decade-ending Australian AFF exports in true volume to the whole world (blue), to countries with either multilateral or bilateral free trade agreements (orange), and to the remaining countries in the world (grey) in (millions of) Australian dollars. It is evident that in the last two decades, Australian AFF exports have been primarily destined for countries with which Australia has a trading agreement. AFF exports to countries with which Australia has no contract have remained stagnant for the past three decades. This observation suggests that trading agreements may be the main determinant of Australian AFF exports. This is another piece of evidence that trading agreements are an important driver of Australian AFF export growth.

Figure 2: Australian AFF exports to Worlds (Blue), countries with Agreements (Orange), & Non agreements (Grey)



Source: Authors own compilation with data of DFAT, Australia

If this is true, Australia should explore further trade opportunities with other countries in the world to achieve maximized targets of its AFF exports. Since the already performed exports to the nations holding BTAs and MTAs with Australia has given prospective indications of export, the country should search or consider the potential for further agreements with the remaining nations of the world. Australia is a land abundant country holding major prospects of a marine communication network with rest of the world that decreases communication barriers as well as transport costs.

It is important to note that Australia's AFF exports to countries with which it has a bilateral or multilateral free trade agreement (BTAs and MTAs) have shown potential for trade growth between Australia and its agreement partners. Notably, Australian AFF exports to these countries have increased since 2000 (Figure 01 and 02), coinciding with the signing of these agreements. Therefore, it is evident that these agreements have important implications for Australian AFF trade.

The above outcome indicates that Australian AFF exports have the potential to divert to developing and developed countries in both the eastern and western hemispheres. The country's agricultural exports have increased with major industrialized countries such as the United States, Japan, and China, and there are high prospects for increased trade within the region, as well as with developed countries in the European Union.

Against this backdrop, the aim of this study is to investigate the impact of Australian trading agreements conducted since 2003 on its AFF exports. We relied on a self-crafted augmented Gravity model using panel data techniques for estimation and collected data primarily from the Department of Foreign Affairs and Trade (DFAT), Australia, International Financial Statistics (IFS), and World Development Indicators (WDI).

Our findings suggest that Australian AFF exports are heavily dependent on the BTAs and MTAs conducted by the country in the last two decades. During this period, the trade creation effect of these agreements has redirected the country's agricultural exports, resulting in increased growth. Consequently, the growth of Australian AFF exports is heavily dependent on the import demand of a small group countries.

Magnitudes of novelty of our paper is enormous. Though FTAs are considered unacceptable in the eyes of WTO, the impact of them in the quantity of the Australian AFF exports is positive and encouraging. Our paper invents that trading agreements are the strongest propeller of Australian AFF exports in the post-2000 era. By joining in FTAs, Australian export growth against countries with whom it has no trading agreement is completely halted which in fact confirms the validity of "trade deflection effect" by the non-agreement countries of the world. Though overall, export response is positive to FTA, and has broken down the export growth balance between agreement and non-agreement countries. Further, FTA also has reshuffled the combination of Australian AFF export destinations.

The findings of this research will help not just Australian agricultural commodity traders, but also for the whole world. There are number of countries both in the developed and developing world where agriculture is an important sector in their economies, and agricultural trade plays an important role in their economy as well as in aggregate trade balance. This research will guide to formulate new policies for global agricultural trades. Thus, the implication of this research is also applicable for the whole world. New findings of this work will lead to the agricultural economists to new research directions too. The techniques, instruments, and concepts of this research will help to explore the dynamics of the agricultural trade in other areas and countries in future. The insightful and intuitive findings of this research will certainly benefit the trade researchers, academicians, practitioners, and policy makers across the world.

The structure of the remaining parts are as follows: Section II reviews the related literature; Section III describes trade model, and Section IV presents the empirical model., Section V provides the data, summary statistics, and correlation matrix, Section VI explains the process of estimation and analyzes the results, and Section VII concludes the paper with and policy implications.

5.3. LITERATURE REVIEWS

Theoretically preferential trading agreements (PTAs) and free trade agreements (FTAs) are always welfare enhancing. This is why economists have suggested the promotion of global free trade after the Second World War. However, since the world cannot reach in a consensus on introducing a world-wide free trade region and almost all countries in the world turn to BTAs or MTAs. At present, Australia has total 30 BTAs/PTAs/FTAs with the rest of the world, with some of them already validated and the remainder to come into effect soon. However, empirically welfare enhancement is not imperative. Trading agreements do not always ensure welfare increases (Saheen, 2013, Breuss, 2022). This uncertainty is justified by the following empirical researches by the most recent data:

Breuss (2022) has argued that the last decade has slowed down the globalization process, coining the terms 'slowbalisation' and 'deglobalization'. According to him, the recent Covid-19 pandemic has reinforced this process. He has opined that to overcome this stalemate, implementing more FTAs can be a second-best solution. He analyzed a selected set of FTAs around the world which are already in effect. He has concluded that overall, the strongest countries in world trade, the EU and the United States are not reflected as the largest winner in those nine FTAs. Japan might be considered as the winner participant because it participates in four overlapping FTAs: EU-Japan, USA-Japan, CPTPP and RCEP. However, the USA would not gain much from further participation FTAs and similarly, the 27 nations of the EU would not acquire profit further joining in the of FTAs.

Kasteng *et. al.* (2022) have drawn a hypothesis that FTAs are not automatically applied to all imports. Rather an importer needs to make request to the authority to apply FTA benefits by placing the documents of rules of origin, etc. According to them it is costly in terms of time, bureaucratic complications, etc. and for which the FTA facility is not always used. They have attempted to analyze the EU-Korea FTA accord in light of this hypothesis for firm level data for Swedish imports from Korea where the research question was, “who uses EU-Korea FTA?” Several variables such as firm size, commodity categories, import-mode (i.e., import or customs warehouse etc.), preference margin, potential duty savings, and transaction size, etc. were taken into considerations. The result shows that the difference across Swedish importers is not related to firm size which is usually identified by the prior research conducted around the world. Rather their findings note that the size of the import transaction holds more influence than the size of the preference margin that primarily determines preference facility utilization.

Jin (2020) has attempted to justify the impact on the export duration of Chinese agricultural commodity exports due to the formation of FTA using disaggregated firm level data for the period of 2000-2016. According to his findings, export completion duration has substantially decreased in FTA member nations against the non-FTA importing destinations of Chinese agricultural goods. Further, export related hazards for the Chinese firms have drastically fallen if the trading partner firms are situated in a Chinese FTA member country. In this way, he has reached in a conclusion that the formation of FTA can decrease agricultural export complexities for the Chinese exporting agro firms.

For the export of Indonesian food and beverage industry Darma and Hastiadi (2019) have conducted a research aimed to analyse the trade creation and trade diversion effects which usually take place in case of international FTAs. For the 12 Indonesian trading partners either of member or non-members of the FTA with Indonesia for the data from 2005 to 2015. An augmented Gravity model has been applied using an FTA dummy for the trading blocs ACFTA, AKFTA, and AIFTA. The results show that the implementation of ACFTA, AKFTA, and AIFTA provides positive and significant effect on trade creation and trade diversion in exporting Indonesian food and beverage products. They have concluded that the creation of these three FTAs incur trade creation effects and, thus, increase intra-regional trade, however, this is not at the cost of trade diversions from the non-FTA members of Indonesia.

Alawadhi *et. al*., (2019) have noted high trade diversion effects among the 57 nations of GCC and EU after joining in PTA in 1991. Their further finding is that if they were joined in FTAs, trade could be further diverted among the nations. So, the bloc of this pact should pay attention for formation of an FTA for further welfare gain by the member countries.

Campoamor, *et.al*. (2018) have applied a computable general equilibrium (CGE) model for the USA and Central American counties trading bloc to evaluate the DR-CAFTA trade agreement impact on their regional trade. They have concluded that although Central American countries are extremely reliant on the USA for trade, formation of FTAs by them have remarkably increased intra-regional trade further than the trade increases with the USA for the sample period.

Udbye (2017) has attempted to examine the impact for 20 FTA contracts for trade with the USA. Using DID model he considered 80 non-FTA trading partner countries as a control group. His research question was, "did these FTA bring any extra yield in the US trade?'' His findings show that the introduction of FTAs give mixed results for the USA. Accordingly, he has concluded that the overall effects of these FTAs on the US exports are low.

Martincus and Gomez (2010) has explored the Colombian FTAs with the USA keeping the main research target to explore whether this FTA has brought any concentration on Colombian exports to the USA which is one of the prime concerns for reaching an accord between the developing countries and an industrialised country. According to them, both effects (export concentration or diversification) were revealed in the past researches. So, they have contemplated that whether the FTA with the USA has helped Colombia to diversify its exports. They have found that lower tariffs have favored Colombian export diversification. They have concluded that existing trends projects that this FTA is likely to provoke further diversification of Colombian exports in the future.

Here we have tried to analyse the findings of recent research articles related to our present topic. Their findings are not uniform, and regardless the development conditions (LDCs, and so on) of the countries, research results are mixed in nature. There is no guarantee that if a country stays in the high-income status it would have positive gains from FTAs. On the other hand, a less developed country may gain by signing up an FTA with a developed country like the USA. So, based on the findings of the past studies, drawing any definite conclusion is not possible as the outcomes are mixed and conflicting. That is, the eventual impact of FTAs is a country specific matter. Any prediction is impossible without conducting a proper empirical investigation. To this end, since there are currently no studies regarding the impact of FTA accords on Australian AFF exports, in this paper, we decide to explore this uninvestigated issue.

However, compared to the existing studies of FTAs impact analysis resorting the gravity model, this research has invented several novel findings. First of all, disaggregated agriculture data based quarterly data are used in order to take account of specific variation in exports enhancement and searching ways to sustainable trade balance. Secondly, the issue of the overlapping preferential pacts with a single country without emphasizing number of trading agreements making an assumption of uniform impact regardless the type of agreements and country's development status. Third, country heterogeneity, endogeneity, and sample selection by adopting the fixed effect model are not controlled so that true and real impact of trading agreements can be revealed. Fourthly, the export creation effects of Australia's AFF products by FTAs are lower than the intra-block export diversion effects at disaggregate levels. Fifthly, the changing effects of Australia's FTAs on AFF exports over time is analyzed. Finally, non-trading agreements countries and regions in rest of the world are also specified so that agro trade potential for Australia can be defined for future Australian AFF export doors opening.

5.4. METHODOLOGY AND MODEL

5.4.1. *Gravity model of trade*

The Gravity model is firstly applied in an international trade analysis by Tinbergen (1962) and Poyhonen (1963). Since then, this model is a very popular tool especially in the empirical analysis of international trade. This model is also applied in the analysis of international migration, foreign direct investment, and international remittance flows. The model is considered highly logical in applying and explaining trading relations among countries. Anderson (1979) firstly has made a formal Gravity model assuming product differentiation. Following this, Bergstrand (1989) also has used this model jointly with monopolistic competitive model to explore the determinants of the trade between two regions. Later, Halpman and Krugman (1985) have also used the Gravity model for a framework of differentiated products in the situation of increasing return to scale. Further, Deardroff (1995) has proved that the Gravity model is consistent with different Recardian and neoclassical trade theories. Again, Anderson and Wincoop (2001) have formulated an operational Gravity model based on CES expenditure method that can be easily estimated and assists with clarifying inter country trades. Though the above techniques have led the economists to diversified results, however, they have agreed that its manipulated specification and application can unveil enumerable vague of international trade those were out of focus by the different conventional theory based models. The number of works are enumerable because of its strong explaining power of trade among nations. Likewise, Deardroff (1995), and Helpman (2004) have shown the coherence of the claims of conventional trade theories and the Gravity model. One advantage of the Gravity model is that it is very easy to understand and interpret. The essential aspect of the Gravity model is that trading is simply a function of the income and geographical distance between the trading partners. For an augmented type of Gravity model generically, trade between two countries is a function of their GDPs, distance, and a set of necessary dummy and control variables

5.4.2. *Building the model*

Empirically in an augmented Gravity model, exports from country i to country j are explained by their GDP (size of the economy), population (size of the market), direct geographical distance (proxy of the transportation and other costs of trade) and a set of quantitative and qualitative (i.e., dummy) variables to represent economic, institutional, infrastructural and other socioeconomic and cultural characteristics that play an important role as trade determinants. So, in this paper, in addition to the above variables, the model has been augmented by adding additional crucial factors of modern day trade. These can be considered bilateral real exchange rate, import-GDP ratio a proxy of openness of the economy (or partner country's trade policy), and four important Dummies which are land lockedness, common tastes and cultures (proxied by common language), multilateral trading agreement (MTAs), and bilateral trading agreement (BTAs). The selected variables are included as part of a trial-and-error process where insignificant variables are excluded from the model. These variables are very common Gravity variables suggested by various research papers.

To explain Australian AFF exports to its 19 major partner countries in our panel data model we have used a set of ten (10) independent variables for both features. Interestingly, totally nine have shown statistical significance in the random effect regression model where the model type is selected by the Hausman (1978) test. Here, for our purposes MTAs and BTAs are our target variables and remaining eight variables are control variables. The chosen variables and their rationale are noted below:

Australian Agro GDP: Income (proxied usually by GDP or GNP) and distance between the trading countries are the two core Gravity variables defined by the economists (Kumar and Ahmed. 2015). In the usage of Gravity model to analyze the trade flow between two countries theoretically it is mandatory to include these two variables in the model. From the exporting country's point of view, the logic is that the higher the GDP of the exporting country has a higher supplying capacity of the economy in exporting goods to other nations. According to basic economic theories, the level of GDP can have a direct causal effect on supplying goods and services to foreign lands. Therefore, it is believed that there will be a positive correlation between GDP and export supplying capacity and the expected sign of this variable is positive. However, in our present case, as we are dealing with a specific kind of goods (i.e., AFF goods), we have used Australian yearly AFF outputs instead of Australian Real GDP.

Importing partner country's Real GDP: Due to the above reasons, an importing country's GDP is another core variable of the Gravity variables. Here, the main assumption is that importers' GDP or income level directly measures the importing power of the economy for purchasing goods and services from other countries. Based on this notion it is assumed that the expected sign of the correlation coefficient of the importing country's GDP and import level should be positive.

Geographical distance with Australia: The geographical distance between two trading countries is a proxy for transportation costs (Porojan, 2001). In international trade transportation, associated costs play a very important role. It is anticipated that transportation and other costs can have a strong impact on the product price and, thus, on the demand of imported goods. This core Gravity variable provides a direct measurement of the demanding capacity of the product by an importing country. However, measuring this variable (transportation costs) faces several problems as trading goods are transported among the countries via air, land and sea ports. The transportation cost of the same volume of product can be different for similar trading partners due to these variations. Thus, it can be difficult to measure the quantity of this variable. To overcome this problem, researchers consider the geographical distance between two trading partners. In our present model, the distance between the Australian capital and the importing country's capital is considered as the distance between them (the possible air distance).

Bilateral Real Exchange Rates: Bilateral Real Exchange Rate is a proxy for the relative price of tradable goods. The main assumption in using bilateral Real Exchange Rate is that trade actually happens at international prices where Exchange Rate has a vital impact in defining the price of tradable goods in a country. Since it is not the only variable that has impact on the price of the imported goods it is very difficult to measure the effects of all factors on trade levels. However, Real Exchange Rate is a simplifying proxy for all omitted effects of the price of an imported item (Bahmani-Oskooee and Hegerty, 2007). Here we have considered the exporter Real Exchange Rate in terms of its local currency with an assumption that the depreciation of exporter currencies will be expected to lessen the price of goods in importing country and, hence, to raise export. In this paper, we define bilateral real exchange rate as follows:

Bilateral Real Exchange Rate (EXR) = (CPI^{im} X NER / CPI ^{AUS}) where NER is the nominal bilateral exchange rate defined as the number of the respective importing country's currency for per AUD. CPI^{IM} is the Consumer Price Index (CPI) of Importing Countries, and CPI^{AUD} is the Consumer Price Index (CPI) of Australia.

Trade border openness of the partner country: This variable indicates the openness of the Australian trading partners to import Australian products. The more open the partner country trade border is, the more exports from Australia to that partner (Rahman and Dutta, 2012). In other words, the higher the level of openness of a partner country the higher the tendency of importing Australian AFF goods that country will have. It is an antithesis of protectionism where it will have strictly opposite interpretation. Researchers use a number of standard indicators to calculate the openness of a country such as import-GDP ratio, trade (= Export + Import) – GDP ratio, tariff-revenue ratio etc. Here, we have used the import-GDP ratio as it is simple, used by most of the papers in existing literature, and data is available. Further, in the present world almost every country follows export promotion policies. So if trade-GDP ratio is included in the model as an indicator of openness it may be considered misleading. Tariff - revenue ratio is frequently used by researchers for measuring the degree of protectionism by a country. However, it can be argued that less protection means higher openness, but it is difficult for us to collect the data of tariff and revenue for Australian trading partner countries individually.

Importing partner country population: There are some standard ways of measuring the size of the market of an economy. GDP, GNP, Population, or Land Area are usual variables chosen by the researchers to measure the trading strength or capacity of an economy. As a core variable of the Gravity model we have used GDP, we cannot use the same variable again within the same model. Further to this, land size is not representative of market size of the country. The remaining determinant indicator is population. In each level of income, population is a proxy of the size or consumption ability for a country as the higher the population, the higher consumption would be (Emikonel, 2022). That is why population has been used instead of land area because the larger the population the higher the demand in the economy with a same income level.

Regional Trading Agreements (RTA): There are number of Australian trading partners which are members of one or more than one multilateral trading agreement (RTAs). The dummy variable indicating "1" if the partner country is a member of a regional trade agreement jointly with Australia and "0" otherwise. If two countries (Australia and its trading partner) are members of the same multilateral trading agreement they do not need a bilateral agreement for trade purposes. However, Australia has a number of trading partners where the country is a member of an RTA at the same time as signing a bilateral trading agreement to facilitate their trading bond. When two countries are jointly signatories of an RTA and/or a BTA, they have a high probability of diverting trade between them and these two trading partners will have experience of the trade expansion effect in that case (Abafita and Tadasse, 2021). So, in this case, the expected sign of the estimated coefficient will be positive.

Bilateral Trading Agreements (BTA): Due to the above reasons, when two countries reach a BTA they have a high probability of increasing bilateral trade between them. Since 2003, Australia has signed several BTAs to increase bilateral trades with other countries. In a similar manner to the RTAs, the dummy variable indicates "1" if the partner country has signed a BTA with Australia and "0" otherwise. So, in this case, the expected sign of the estimated coefficient will be positive.

Common Cultures: It is another dummy variable to identify a pair of countries that are adjacent in their cultures, tastes, and consumption patterns. This variable is also proxy of common colonial legacies that has shaped consumption patterns historically. Common cultures are represented by similarities in religion, language, geographical proximity, colonial heredity, etc. It is very natural when there are similarities in culture, for two trading countries to engage in large volumes of official and formal commodity trades (Zhou, 2011). It is expected where such commonalities exist, their communication will be simplified and the demanded product variety between them will be higher. In our present research we have used language as a proxy of common cultures between Australia and its trading partners. This dummy variable is indicating the value of unity if two countries have one or more than one common language(s) border and “0” when they do not.

Landlockedness: If a country is landlocked, the trading cost for it will be higher than a country that owns a sea port in its territory. Thus, citizens of a landlocked country can face higher prices for foreign goods and, thus, decreased demand of imported commodities (Lohani, 2020). On the other hand, if there are political disagreements with neighboring sea accessible countries, trade can be hampered due to transportation bottlenecks. In our assumption, this dummy variable has considerable impact on international trade for a country where it is indicating “1” if the country is landlocked and “0” otherwise.

5.5. MODEL FOR EMPIRICAL ESTIMATION

Using the above variables, we can construct the following augmented Gravity model for the Australian AFF exports:

$$\log(Export_{ijt}) = \beta_0 + \beta_1 \log(ARGDP_{At}) + \beta_2 \log(RGDP_{jt}) + \beta_3 \log(REX_{Ajt}) + \beta_4 \log(Open_{it}) + \beta_5 \log(PoP_{it}) + \beta_6 \log(LLOCK_i) + \beta_7 \log(Culture_i) + \beta_8 \log(RTA_{ijt}) + \beta_9 \log(BTA_{ijt}) + \beta_{10} \log(Dist_{ij}) + (U_{ij})$$

Where

$Export_{Ajt}$ = Exports from Australia to Country i at time t,

$ARGDP_{At}$ = Real agro GDP of Australia at time t,

$RGDP_{jt}$ = Real GDP of country i at time t,

REX_{Ajt} = Bilateral real exchange rate between Australia and country i at time t,

$Open_{it}$= Degree of openness index of country i at time t,

PoP_{it}= Population of country i at time t,

$LLOCK_i$ = Landlockedness of country i,

$Culture_i$ = Culture which is proxied by common language between Australia and country j,

BTA_{Ajt} = Bilateral trade agreement between Australia and country i at time t,

$Dist_{ij}$ = Distance between capital of Australia and capital country I, and

U_{ij} = Error term

5.6. DATA

For estimation purpose, we have relied on the annual data of 20 countries. Our targeted country is Australia, and the remaining 19 are its trading partners. Australian yearly AFF GDP, information on multilateral or regional (RTAs) and bilateral trading agreements (BTAs), as well as partner-wise yearly AFF exports figures are collected from the Department of Foreign Affairs and Trade, Australia, website. Annual inflation rates and bilateral real exchange rates were collected from International Financial Statistics (IFS), IMF. Bilateral distance in kilometers (KM) between the

Australian capital of Canberra to the trading partners capital cities is collected from the Google search engines. Data for the trading partners annual Real GDPs, import-GDP ratio (Openness), and trading partners' population sizes, etc. are collected from the World Development Indicators (WDI), World Bank website. Quantification of the qualitative variables are done by the following rules:

BTA = 1, if an Australian partners country has a bilateral free trade agreement (FTA) with Australia and 0, otherwise.
RTA = 1, if both Australia and its partner country are members of a multilateral FTA,0, otherwise.
Land lockedness = 1, if an Australian trading partners country has a seaport in its own territory
0, otherwise, and finally,
Common Culture = 1, if an Australian trading partners country's official language is English
0, otherwise.
All time variant variables used in the model are transformed into log-difference form. Since "0" cannot be logged and natural log of 1 equal to "0", some of our non-dummy variables have the value of "0". As our model is in log-linear form and some of the variables have values "0", to counter this problem all zeros (0) are replaced by zero + 1 (0+1) so that logarithm can be taken even for zero values and in this case we can get finally ln(0+1) = 0.

5.6.1. *Descriptive Statistics*

Table 1: Descriptive Statistics of Australian AFF export, Australian real GDP, partner countries' real GDP, population, openness, real exchange rate, and distance

	AGREXP	AUSAGGDP	PRGDP	PPOP	POPEN	BLREXR	DISTANCE
Mean	6544044	2.71E+10	1.51E+12	1.37E+08	47.84646	85.49239	7948.193
Median	1737499	2.68E+10	1.99E+11	44641540	30.29746	86.52253	7384
Maximum	1.80E+08	3.69E+10	2.05E+13	1.41E+09	221.01	109.0283	15934
Minimum	1.33E-18	1.92E+10	2.25E+09	253821	4.621748	67.56897	1152.02
Std. Dev.	16514401	5.00E+09	3.72E+12	2.85E+08	43.96558	10.39219	3264.827
Skewness	5.785288	0.368172	3.283143	3.492158	2.01581	0.33717	0.666903
Kurtosis	45.53386	2.246621	13.27159	14.49311	6.502975	2.59989	3.638849
Jarque-Bera	52218.33	29.82539	3994.209	4860.939	766.6036	16.52336	58.78004
Probability	0	0	0	0	0	0	0
Sum	4.22E+09	1.74E+13	9.76E+14	8.81E+10	30860.97	55142.59	5126585
Sum Sq. Dev.	1.76E+17	1.61E+22	8.90E+27	5.24E+19	1244834	69550.45	6.86E+09
Obs	645	645	645	645	645	645	645

Source: Authors' own compilation from the said sources, (in true figures)

Table 1 shows the descriptive statistics of the variables used in this research. Since all figures are in true values and the variability of the mean, median, maximum, minimum and standard deviations values show that Australian AFF exports may be explained by the Australian real agro-GDP, partners real GDP, populations and distance figures. However, figures of skewness, Kurtosis, and JB statistics clearly indicate that most of the variables are not normally distributed. Similarity of the figures in each variable reveals that there is no missing data in the sample meaning that our model is a balanced panel. We have excluded descriptive statics of dummy variables. Overall, the model is logically specified.

Table 2: Correlation Matrix

Variables	AFF EXP	RGDP	AUSGDP	BLR	RTA	POP	OPEN	LLN	EXR	DIST
RGDP	0.51490									
AUSGDP	0.22763	0.11352								
BLR	0.19465	0.21949	0.42493							
RTA	0.15016	-0.0695	0.55745	0.36896						
POP	0.57028	0.46996	0.03428	-0.01543	-0.11303					
OPEN	0.11083	-0.2579	0.07005	0.06672	0.04262	-0.26379				
LLN	-0.13509	-0.1337	-0.00026	-0.02064	-0.04787	-0.14426	-0.12514			
EXR	0.15800	0.07657	0.22538	0.26720	0.47024	0.02228	0.06816	-0.014		
DIST	0.17895	0.58562	-0.00052	-0.07463	-0.19085	0.30596	-0.24008	0.2730	-0.029	
CULT	0.10035	0.20291	-0.00051	0.28399	0.04654	-0.15927	0.48186	-0.234	-0.002	-0.1459

Table 2 shows the correlation coefficients among the used variables of the model. We do not need to evaluate all coefficients for our present research intents. If we look at the first column of Table 2 we see the correlation coefficients of Australian AFF exports with each independent variable individually. It is seen in the first column of the Table 2 that with the exception of the qualitative variable land lockedness of the partner countries, all others are positive which is similar to the theoretical expectation. Since the coefficient are higher for the Australian real agro-GDP, partner countries real GDP, populations, distances, exchange rates, multilateral trading agreement memberships have high values they might have high influence on the dependent variable (Australian AFF exports). Such probability will be justified by the econometric examination.

5.7. RESULTS AND DISCUSSION

5.7.1. *Cross Sectional Dependence:*

Baltagi (2012) pointed out that cross sectional dependence can lead spurious estimation like serial correlation problem. He further added that Cross sectional dependence problems can arise for unobserved common characteristics of the data that can ultimately affect the error terms of the model. He suggested that before estimation, one should detect whether data has the unobserved characteristics prior to estimation. Likewise, Driscoll and Kraay (2001) mention that cross sectional dependence problems may give inconsistent standard errors and thus t-statistics in the estimation process. We relied on the Peseran CD test to detect the cross-sectional dependence of the series used in this research. The result of this test is presented in Table 3 below:

Table 3: Residual Cross-section dependence test.

Period Included: 33
Cross-section included: 19
Total Panel Observation: 645

Test Name	Statistic	DF	Probability
Pesaran CD	-0.963145	171	0.3255

Source: Authors own calculation

Null hypothesis of this test is “there is no cross-section dependence in residuals”. Since p-value of the test is greater than of 0.05, the null hypothesis is not rejected meaning that our sample is free from cross section dependence.

5.7.2. *Panel Unit Root Tests*

Since the panel data series has both time and cross section properties, a set of panel data can also suffer from non-stationarity which will ultimately provide false results for the model. Moreover, if the period of the panel data series is high, the probability of having stationarity problem also increases. We have used a panel data series of 33 years and 19 cross sections (= number of Australian AFF goods importing countries). When time dimension is higher than cross section dimension of the data, the probability of having this problem is further increased. Therefore, testing stationarity of our data is imperative.

Table 4: Panel Unit Root Test Summary in level form of the variable:

Sample: 1988-2021
Cross-Sections: 19

Method	EXP	AusAGDP	RGDP	Pop	Open	REX
Levin, Lin, & Chu	-4.6728*	12.7757*	-3.5116*	-0.43925	-9.2656*	-3.1059*
(Observations)	(589)	(589)	(589)	(589)	(588)	(589)
Im, Pesaran, & Shin W-stat.	-11.419*	-14.2106*	-6.0439*	-0.65619	-13.636*	-7.8159*
(Observations)	(589)	(589)	(589)	(589)	(588)	(589)
ADF-Fisher Chi-Square	212.433*	237.234*	123.501*	56.268**	233.38*	125.17*
(Observations)	(589)	(589)	(589)	(589)	(588)	(589)
PP-Fisher Chi-Square	696.534*	1167.70*	271.342*	45.036**	741.85*	155.03*
(Observations)	(608)	(608)	(508)	(608)	(607)	(608)

Source: Authors own calculation
*indicates coefficients are significant at 1 percent level of significance
** indicates coefficients are significant at 5 percent level of significance

From Table 4 it is seen that according to the Levin, Lin and Chu (2002), Im, Pesaran and Shin (2003), Fisher ADF (2000), and PP-Fisher (2000) panel unit root all variables except population are stationary at level. Population is also stationary at 5 percent level of significance by Fisher ADF (2000) and PP-Fisher (2000) tests. Though the data has time series properties they are stationary at level as we have used them as the first difference level in our model. Since our data is free from cross sectional dependence and non-stationary problems at level, we can run OLS. However, before running the regression for the chosen model we need to conduct Hausman (1978) test to be sure about the right type of model between fixed effect (FEM) or random effect model (REM).

5.7.3. *Hausman Test*

We have conducted Hausman (1978) test for our full model choosing period random effect model and got the following results:

Table 5: Correlated Random Effect Hausman Test

Test Summary	Chi-Square Statistic	Chi-Square DF	Probability
Period Random	0.000000	8	1.0000

Source: Authors own calculation

Here the null hypothesis is that the random effect model (REM) is more suitable for the selected data set and the alternative hypothesis is that the fixed effect model (FEM) is suitable. According to the results given in Table 5, the Hausman (1978) test overwhelmingly nullifies the rejection of null hypothesis and we cannot run the model by choosing the fixed effect option. That is, we can decide that REM performs better than FEM. Based on this we will run the REM.

5.7.4. *Estimated Results*:

By choosing the period random effect model our result is as follows:

Table 6: Regression Results of Balanced Panel Data (Period) Random Effect Model

Sample Period 1989-2021 (33 Years with 19 Cross Section)
Total (balanced) panel observations = 627

Dependent Variable	**Explanatory Variables**	**Coefficients & Significance**	**t-statistics**	**Prob.**
	Constant (C)	-9.361564 ***	-5.901144	0.0000
	D(LOG(AUSGDP))	0.211989	0.277060	0.7818
	D(LOG(RGDP))	2.060641 ***	2.123822	0.0005
	D(LOG(POP))	107.4568 ***	10.30394	0.0000
	D(LOG(EXR))	-0.955434	-0.709471	0.4783
	LOG(LLN)	-1.642756 ***	-13.72702	0.0000
DLOG(AFF)	LOG(OPEN)	0.479933 ***	4.129682	0.0000
	LOG(BLR)	0.168117 *	1.791378	0.0737
	LOG(DIST)	-2.566815 ***	-15.41940	0.0000
	LOG(CULT)	0.409234 ***	4.636740	0.0000
	LOG(RTA)	0.231949 ***	2.659541	0.0080

Adjusted R^2 = 0.500671, F-statistic = 63.76826 Prob. (F-stat.) = 0.000000, D-W stat = 1.910899

*and *** are indicate significant at 10 and 1 percent level of significance

Econometric tests discussed above direct us to choose the panel random effect model. The result of the model is presented in the above Table 6. To explain Australian AFF exports, in this time specific random effects augmented Gravity model, we have resorted a set of quality (dummy) and quantity variables such as the Australian real AFF GDP, the membership of multilateral and bilateral trading agreements for Australia and its trading partners, importing countries real GDP, population, distance, common language, bilateral real exchange rate, import-GDP ratio, and, land lockedness. These variables are very common in the conventional Gravity models built by the trade researchers. Both dependent and explanatory variables are used in the model in log-difference form. So, it can be termed as a log-difference and log-difference model. Accordingly, the results will show us the association between dependent and independent variables in the elasticity of first difference (i.e., in growth). Since the research interest concentrates on the assessment of Australian trading agreements, (MTAs and BTAs) are our target variables and all other variables can be called as control variables which are required to complete the model. The research unveils Australian gains (or losses) stemming from those both MTAs and BTAs through trade creations or diversions. As per the results of the chosen model, importing countries real GDP, geographical distance, openness of the economies, commonness in cultures, and MTAs and BTAs are the main determinants of Australian AFF exports. The signs of the elasticities or coefficients are in line with theoretical expectation except bilateral real exchange rate. Adjusted R^2 is pretty large (0.500) and Durbin-Watson Statistics (1.91) mean that the chosen model explains the variation of the dependent variable very well, and the error term is free from serial correlation. F-test also says the model is not completely nonsense. All of the diagnostic tests postulate that our regression model is not spurious. Absolute value of the elasticities is more than one (means elastic) in the case of importing countries real GDP, population size, land lockedness, and distances. This indicates that partner countries disposable income, market size, bearing power of the trading, transportation costs, and non-tariff barriers are the major determinants of Australian AFF goods imports. However, Australia has minimal policy implications by such research outcomes. Interestingly, other variables such as importer countries openness, common cultures, BTAs and MTA trading agreements have significantly positive impacts on Australian AFF imports. The result further shows that importing countries, land lockedness and distance from Australia has a negative impact on the AFF imports from Australia.

5.7.4. *Discussion of results based on trading agreement*:

The result indicates that Australian AFF exports have positive relationships with bilateral and multilateral trading agreements. Elasticities of BTAs and MTAs on Australian AFF exports growth are 0.168117 and 0.231941 respectively. So, clearly these agreements are net export ‘diverting’ for the Australian AFF goods which means that exports are increasing to the member countries of these dual agreements at the cost of a ‘decrease’ of AFF exports to the non-agreement countries. It means that behind the robust increases of the Australian AFF exports growth to the BTAs and MTAs countries are actually ‘trade created’ by the trading agreements. Alternatively, Australian AFF exports to non-agreement countries are negatively affected as a direct consequence of these BTAs and MTAs joined by Australia. So, such trading agreements are making heavily dependent of Australian AFF export heavily dependent on these few favored countries which may make these sectors vulnerable in terms of future growth. Openness of the importing country economies significantly and positively affects Australian bilateral AFF exports over the sample period. The summation of the elasticities of three variables (BTAs + MTAs + Openness = 0.168117+0.231941+0.479933 = 0.879991) is almost equal to 1 where all variables are in first difference form. So, if the variables had been used in level form, this summation of the elasticities would have been more than one. It clearly implies that it is highly likely that reduction of tariff barriers due to signing up BTAs and MTAs may increase intra-agreement Australian AFF exports. Besides, bilateral real exchange rates have no significant impact on Australian exports meaning that depreciation of the Australian dollar will not bring good results for Australia.

Additionally, the estimated result shows that in the future, Australian AFF exports will face an unexpected reality. For the long-run sustainability of the AFF exports growth, the country should divert its attention to potential market searches. It needs to increase its AFF exports to extra-agreement regions and countries simultaneously. A clear fact is that the country has ignored the vast EU market particularly. Australia should move from the present trend of intra-agreement AFF export growth (i.e., trade diversion) gradually.

5.8. ROBUSTNESS TESTS

Table 7: Results of Panel (Balanced) Data Regression for Robustness tests
Sample Period and Cross Section Included: 1989 - 2021 & 19 with total observations 627

Dependent Variable	Explanatory Variable	Coefficients & Significance	t-statistics	Prob.
D(AFF)	Constant (C)	1959769.	0.863955	0.3879
	D(AUSGDP)	-1.41E-05	-0.298354	0.7655
	D(RGDP)	9.62E-06	11.96490	0.0000
	D(EXR)	35370.68	1.347016	0.1785
	LOG(DIST)	-577043.1	-2.414553	0.0160
	LOG(OPEN)	539871.0	3.171627	0.0016
	LOG(BLR)	250148.0	2.053764	0.0404
	LOG(CULT)	545461.8	4.809084	0.0000
	LOG(RTA)	244712.7	1.960251	0.0504
	LOG(LLN)	-41472.37	-0.257979	0.7965
	LOG(POP)	97030.12	1.323983	0.1860
	Adjusted R^2	0.245179	Prob. (F-statistic)	0.000000
	F-statistic	21.33356	Durbin-Watson stat	1.921463

Checking the robustness for panel data models is a very common practice for researchers. To test the robustness of our model we have waged to estimate our model in a different specification of the model. We estimated this specification using the first difference data in a pooled model. In this format, the estimated coefficients will not be termed as 'elasticity'. Table 7 shows the results of the robustness check. If we compare the results of this model the significance status and signs of the co-efficient are exactly the same as the original model which actually justifies the accuracy of our model specification as well as our estimation. According to the predominant diagnostic tests, the performance of the model in explaining the dependent variable is similar to the original model. Thus, the alternative model also postulates that determinants of Australian AFF exports are the same as before. So, we may infer that improvement of Australian AFF exports to intra-agreement countries or regions are basically driven by BTAs and MTAs for the chosen sample period. Moreover, coefficients of BTAs, MTAs, and Openness are quite large. Thus, the results do not differ between alternative specifications of the model. So, perhaps implication of our derived model is very high in the case of Australian AFF export performance.

5.9. CONCLUSION AND POLICY IMPLICATIONS

In this research we have used an augmented Gravity model to examine the impact of Australian trading agreements on its AFF exports. For this purpose, we relied on panel data technique with time specific random effects suggested by the Hausman (1978) test. The model detected that partner countries real GDP, population size, land lockedness, geographical distances, openness for the foreign trade, commonness of culture, and trading agreements have significant impact on Australian AFF exports. It is noted that along with openness, both BTAs and MTAs have significant impact on bilateral AFF exports. So, clearly increased openness has stemmed from tariff reduction and trading agreements and has an important positive impact on the increase of Australian AFF exports. Likewise, graphical investigations show that growth in Australian AFF exports have taken place mostly after conducting trading agreements with its 19 partner countries. So, both types of investigations confirm that trading agreements are the predominant driving force of the Australian AFF exports. Therefore, it is highly possible that bilateral and multilateral trading agreements are the main catalyst of the Australian agro exports. Thus, net export diversion originated by the trading agreements is the root cause of phenomenal growth of Australian AFF exports in the last two decades. Clearly, the Australian AFF export sector is dependent on the demand by this 19 countries only. Australia is ignoring the demand of the rest of the world for a long period. So, presently under the guise of gradual growth, the country may be heading towards a terrific reality. The present force of trade diversion can be disappeared over time as the AFF export market base is overwhelmingly dependent on a few selected countries. The dependence on trading agreements may be catastrophic for the sustainability of the Australian AFF export growth in the future.

Finally, Australia has capitalized well in increasing its export potentials with close neighbors like the USA, China, Japan, Korea, Singapore, India, etc. but failed to exploit the full potential with some remote partners such as the EU, Canada, etc. The country should remove the resistance factors affecting its exports to the EU and surrounding regions as there is considerable room for AFF export growth in those territories. Australia should consider a Free Trade Agreement with the EU and high income Middle Eastern regions.

Performance of the VAR model depends on the variables and sample size selected and included in the model. This raises risk of inclusion of too many and thus unnecessary variables or omitting important variables. Also much care is required for proper lag selection of the model. Trade of a country depends on multiple issues and including all of them in a quantitative model is a complex process and sometimes impossible. If the sample size is not fairly large the VAR can perform like an over-fitted model and begets inaccurate estimations. Further, this model also ignores structural change and non-linearity properties of the data. Moreover, for a reliable result of the VAR process, stability of the model and homoscedasticity of the data are essential issues. These issues sometimes cannot be managed and detected by the available econometric methods and softwares. Thus, the result of this research cannot avoid these common criticisms. Therefore, future researches can focus on alternative models and methodologies with good sample size and reliable data of other economically important determinants of trade.

5.10. REFERENCES

Abafita, J. and Tadasse, T. (2021). Determinants of global coffee trade: Do RTAs matter? Gravity model analysis. Cogent Economics and Finance. Volume 9, Issue 1.

Alawadhi, A., Al-Shammari, N., and Alshuwaiee, W. (2019) Effects of the EU-GCC Economic Agreement on the Margins of Trade. Emerging Markets Finance and Trade. Volume 57, 2021 - Issue 8, PP 2370-2388.

Anderson, J. E. (1979). A Theoretical Foundation for the Gravity Equation, American Economic Review, 69(1), 106 -116.

Anderson, J. E. and Wincoop, W.V. (2001). Borders, Trade and Welfare NBER Working Paper No. 8515 JEL No. F0

Bergstrand, J. H. (1976). The Generalized Gravity Equation, Monopolistic Competition, and the Factor-Proportions Theory in International Trade. The Review of Economics and Statistics. Vol. 71, No. 1 PP. 143-153.

Breuss, F. (2022). Who wins from an FTA induced revival of world trade? Journal of Policy Modeling. Volume 44, Issue 3, PP 653 – 674

Campoamor, AC., Flores, MAC, Pozo, PCD, and Nekhay, O (2018) Intra-Regional vs. Extra-Regional Trade Liberalization in Central America. Emerging Markets Finance and Trade, Volume 55, 2019 - Issue 8, PP 1880-1892

Chatellier, V. (2021) Review: International trade in animal products and the place of the European Union: main trends over the last 20 years. Animal: The international journal of animal biosciences, Issue 15, 100289.

Darma, W.S and Hastiadi, F.H. (2019) Trade Creation and Trade Diversion Effects of the ASEAN-China FTA, ASEAN-Korea FTA, and ASEAN-India FTA Implementation on the Export of Indonesia's Food and Beverages Industry Products. Globalization, Productivity and Production Networks in ASEAN, PP 147-168.

Deardorff, A. V. (1995). Determinants of Bilateral Trade: Does Gravity Work in a Neo-Classic World? National Bureau for Economic Research Working Paper, PP 53-77.

Driscoll, D., Kraay, A., 2001. Trade, Growth, and Poverty. The World Bank Policy Research Working Paper. World Bank, Washington No. 2615.

Emikonel, M (2022). The Impact of International Organizations on Chinese Trade as the Determiner of Trade: The Gravity Model Approach. The Chinese Economy. Vol. 55, Issue 1. PP 26-40.

Grundy, M.J. Bryan, B.A. Nolan, M. Battaglia, M. Dodds, S.H. Connor, J.D. Keating, B. A. (2016) Scenarios for Australian agricultural production and land use to 2050. Agricultural Systems, Vol. 142, Pages 70-83

Hausman, J. A. (1978). Specification Tests in Econometrics. Econometrica. 46 (6): 1251–1271. ISSN 0012 - 9682. JSTOR 1913827.

Helpman, E. (2004). The Mystery of Economic Growth. Cambridge, MA: The Belknap Press of Harvard University Press.

Helpman, E. and Krugman, P. R. (1985). Market Structure and Foreign Trade. Cambridge, MA: MIT Press.

Im, K.S., Pesaran, M.H. and Shin, Y. (2003) Testing for Unit Roots in Heterogeneous Panels. Journal of Econometrics, 115, 53-74.

Jin, Y. (2020) The impact of FTAs on export duration: Evidence from China's agricultural firms. The Journal of International Trade & Economic Development, An International and Comparative Review

Kasteng, J., Kokko, A., and Tingvall, P. (2022) Who Uses the EU's Free Trade Agreements? A Transaction-Level Analysis of the EU–South Korea FTA. World Trade Review, Volume 21, Issue 1. PP 93-108.

Kumar, S. and Ahmed, S. (2015) Gravity Model by Panel Data Approach: An Empirical Application with Implications for South Asian Countries. Foreign Trade Review, Volume 50, Issue 15.

Levin, A., Lin, C., Chu, C.J., 2002. Unit root test in panel data: asymptotic and finite sample properties. J. Econ. 108, 1–24.

Lohani, K.K. (2020) Trade Flow of India with BRICS Countries: A Gravity Model Approach. Global Business Review. Volume 21, Issue 1.

Matincus and Gomez (2010) Trade Policy and Export Diversification: What Should Colombia Expect from the FTA with the United States? The International Trade Journal, Volume 24, 2010 Issue 2, PP 100-148.

Pesaran, M.H., (2007). A simple panel unit root test in the presence of cross-sectional dependence. J. Appl. Econ. 27, 265–312

Porojan, A. (2001) Trade Flows and Spatial Effects: The Gravity Model Revisited. Open Economies Review. Volume 12, PP 265-280.

Poyhonen, P. (1963). Toward a General Theory of International Trade. Ekonomiska Samfundets Tidoskrf,, Tredje Serien, Argang 16,69-77.

Rahman, M.M. and Dutta, D. (2012). The Gravity Model Analysis of Bangladesh's Trade: A Panel Data Approach. Journal of Asia-Pacific Business. Volume 13, 2012 - Issue 3

Saheen, I. (2013) South Asian Association for Regional Cooperation (SAARC): Its Role, Hurdles and Prospects. Journal of Humanities And Social Science. Volume 15, Issue 6, PP 01-09

Stiglitz, J.E. (2015). The Great Divide. Penguin Books Limited. PP. No. 20.

Tinbergen J (1962). Shaping the world economy: suggestions for an international economic policy. The Twentieth Century Fund, New York.

Udbye, A. (2017). The United States Free Trade Agreements: How Successful Have They Been? The International Trade Journal, Volume 31, - Issue 5.

Zhou, M. (2011) Intensification of geo-cultural homophile in global trade: Evidence from the gravity model. Social Science Research, Volume 40, Issue 1, PP. 193-209

5.11.1. APPENDIX I

Table 1: List of Australian AFF Trade Partners Connected Either by MLAs or BTAs.

Serial No.	Trading Partners	Serial No.	Trading Partners
1	Brunei	11	Malaysia
2	Cambodia	12	Myanmar
3	China	13	New Zealand
4	Chili	14	Peru
5	Hong Kong	15	Philippines
6	India	16	Singapore
7	Indonesia	17	Thailand
8	Japan	18	USA
9	Korea	19	Vietnam
10	Laos		

5.11.2. APPENDIX II Australia's free trade agreements (FTAs) supranational

Australian Free Trade Agreement (FTA) is a supranational trading contract either bilateral or multilateral that abolish or reduces some targeted trade barriers in goods and services, and in some cases investment as well. Like all other countries Australia usually negotiates FTAs to ameliorate Australian economy and citizen's welfare by helping Australian exporters, importers, producers and investors. According to the DFAT, Australia chronologically following are Australian currently FTAs in force (listed with the entry or enforcing dates of the agreements):

Serial Number	Name of Pacts or Agreements	List of Australian partner countries	Date of the pacts come into force
1	ANZCERTA	New Zealand	1 January 1983
2	SAFTA	Singapore	28 July 2003
3	AUSFTA	United States	1 January 2005
4	TAFTA	Thailand	1 January 2005
5	ACl-FTA	Chile	6 March 2009
6	AANZFTA	ASEAN** and New Zealand	1 January 2010
		Thailand	12 March 2010
		Laos	1 January 2011
		Cambodia	4 January 2011
		Indonesia	10 January 2012
7	MAFTA	Malaysia	1 January 2013
8	KAFTA	Korea	12 December 2014
9	JAEPA	Japan	15 January 2015
10	CHAFTA	China	20 December 2015
11	CPTPP	Comprehensive and Progressive Agreement for Trans-Pacific Partnership - countries situated Pacific basin	30 December 2018
12	A-HKFTA	Hong Kong	17 January 2020
13	PAFTA	Peru	11 February 2020
14	IA-CEPA	Indonesia	5 July 2020
15	PACER	Pacific Agreement on Closer Economic Relations Plus	13 December 2020
16	RCEP	Regional Comprehensive Economic Partnership Agreement (Brunei Darussalam, Cambodia, China, Japan, Laos, New Zealand, Singapore, Thailand and Vietnam. Republic of Korea, Malaysia, and Indonesia:	1 January 2022
17	ECTA	India	29 December 2022

** ASEAN member countries are Brunei, Burma, Malaysia, Philippines, Singapore, Vietnam, Thailand, Laos, Cambodia, and Indonesia.

FTAs not yet in force

- Australia-United Kingdom Free Trade Agreement (A-UKFTA)
- Trans-Pacific Partnership (TPP)

FTAs under negotiation now

- Australia-European Union Free Trade Agreement
- Australia-India Comprehensive Economic Cooperation Agreement (CECA)

FTAs under consideration

- Australia-Gulf Cooperation Council (GCC) Free Trade Agreement
- Australia-UAE Comprehensive Economic Partnership Agreement

5.11.3. APPENDIX III

In this research list of AFF products exports where AFF is classified by Australian Department of Foreign Affairs and Trade (DFAT) considered as agro products (as TRIEC* four digits) given in the pivot table:

1. Live animals chiefly for food
2. Seafood fresh chilled dried smoked salted
3. Vegetable fruit and nuts fresh chilled or provisionally preserved
4. Cereal grains
5. Unprocessed food
6. Hides, skins, and furskins raw
7. Cork and wood
8. Textiles fibers unprocessed and waste
9. Meat and meat preparations
10. Seafood frozen and processed
11. Dairy Products
12. Vegetable fruit and nuts preparations
13. Cereal Preparations
14. Animals and vegetables oils and fats and waxes
15. Sugar, Honey, Coffee, cocoas and confectionaries
16. Preparations of food beverages and tobacco
17. Non-metallic minerals processed
18. Rubber natural synthetic and reclaimed
19. Wood simply worked and pulp
20. Textile fiber processed
21. Non-metallic mineral manufactures simply transformed
22. Organic chemicals
23. Other semi manufactures simply transformed
24. Other simply transformed manufactured
25. Non-metallic mineral manufactures elaborately transformed

* Where TRIEC means “Trade Import and Exports Classifications”

CHAPTER 6

PRICE AND EXCHANGE RATE SENSITIVITY OF AUSTRALIAN AGRO FISH AND FOREST ITEM EXPORTS TO MAJOR DESTINATIONS

ABSTRACT

Agro-forest & fish (AFF) products are significant exportable items of Australia. However, research on identification of their determinants is absent or limited to date. Therefore, this paper has tried to shed light on identifying Australian agro-forest & fish (AFF) products export determinants and their short- and long-run elasticities. Considering quarterly data of 1988Q1-2021Q4, we have used a standard Panel Vector Autoregressive (PVAR) model. Our investigation shows that bilateral real exchange rate, Australian export price, and importing countries import price are the key determinants of Australian AFF exports where bilateral exchange rate depreciation and Australian export price have positive, and importing countries import price has negative impact on Australian AFF exports. Another major finding is that as predicted by theories, trade elasticities are higher in the long-run than in the medium-run, and higher in the medium-run than in the short-run. So, prices and exchange rates can be used as expansionary tools for these sectors future exports. Since multiple and cross investigations have provided similar findings, these results are very stable and robust.

Keywords: Price; Exchange Rate; Agricultural Exports; Australia
JEL Classification: F13; F14; F17.

6.2. INTRODUCTION

Export flows of a country can be determined by a number of factors such as factor endowments and natural resource gaps, technological gaps, consumer preferences or tastes, returns to scale of the production firms, cost of trade, heterogeneity of production plants, standard of human capital, trade policy of the country, transportation system and costs etc. (Berkum and Meijl, 1992, Yilmaz, 2015). These factors can be divided into two groups: non-changeable (factor endowments, consumer preferences etc.) and changeable (trade cost, transportation cost, etc.). Factors that cannot be changed in the long-run may have little policy implications. However, those are immediately changeable can have high importance to policy makers in defining the future trade direction of a country. In this regard, identifying important export determinants of a country is important and a vital exercise for the research community around the world (Carlos, et. al. 2008). To this end, estimating and analyzing trade elasticity is considered as a valued process among international trade affair economists.

As a further extension of the above discourse, it can be considered that trade volume among countries may change for various reasons such as policy changes (tariff and duty rate, imposing quota and sanctions joining in a free trade agreement (FTA), etc.) (Hakan, 2019), income changes (Bahmani-Oskooee and Kara, 2006), and exchange rate changes (Bahmani-Oskooee, and Ardalani 2006). Moreover, sudden economic slowdown, financial crisis, supply shocks for natural calamity, imposing trade sanctions by international community joining by a country into a new economic or trading bloc or FTA (Hayakawa, *et. al.* 2017), etc. also create shock or innovation can influence the international trade of a country. Quantification of the impact of such shocks from other factors is a much-practiced efforts by researchers around the world. Determining trade elasticity that resorts in an econometric model is a one way of detecting and measuring such ramifications. Therefore, estimating trade elasticities regarding policies and trade determinants such as income, price and exchange rate is a very common practice in international trade literature (Krugman, 1989). In the conventional empirical studies, a common tendency is determining trade elasticity with respect to income changes. However, estimation of trade elasticity for AFF products for exchange rate, price and income changes is an area yet to be explored. Such non-exploration may be caused by lack of sector level trade data.

Further, a common consensus as well as expectation in the economic theory and literature on the notion of trade elasticity is that it is small in the short-run but higher in the long-run (Fontana and Palacio-Vera, 2007). Despite this widely held opinion there are many disagreements and variations across the empirical findings in the available literature. Literature fails to reach a consensus (Fitzgerald and Haller, 2018, and Hakan 2019).

To this end, this research intends to contemplate on this unsettled issue of trade elasticities with respect to the exchange rate, price and income variations across trading sectors and economies using VAR framework on panel data for bilateral AFF exports to its major partners: USA, China, Japan, South Korea and Thailand. Quarterly aggregate AFF exports data between Australia and its five major partner countries. GDPs as a surrogate of income, and bilateral real exchange rate, export price index, and import price index will be used in the VAR approach to determine the elasticities of Australian AFF exports.

In the empirical model, elasticities will be estimated based on the conventional conception of export elasticities. Aggregate AFF exports will be considered as a dependent variable and prices, real GDP and real exchange rate as independent variables for the quarterly logarithmic value. Trade Policy incorporation in the model is ignored as Australia follows only one free trade policy throughout the sample period. Standard panel VAR approach, Wald test, variance decompositions, and individual or variable specific impulse response function techniques will be used and estimated to make inferences regarding the short-, medium- and long-run export elasticities of the significant variables of the selected AFF export demand function where estimates related to one, two to five, and above five years will be considered as short-, medium-, and long-run respectively.

The contribution of this research is extensive. This study sheds light on an area of the international (AFF) trade that is not currently explored enough by academics, practitioners and policy makers so far. Hence, the findings of this research are an extension of the existing empirical knowledge as well as a novel evidence in international trade literature. It can be considered a fresh and different identification of trade phenomena that we believe is worth renewed attention. Thus, this research is going to fill up both knowledge gaps the existing literature.

The rest of the paper is organized as follows. Section II reviews existing literature that discusses our main hypotheses. Section III analyses the underlying variables, data, methodological framework, and the applied econometric procedure. Section IV and V report the potential empirical model and results, respectively. Finally, the concluding remarks and policy implications of the empirical results are drawn up in section VI.

6.3. PAST LITERATURES ON TRADE DETERMINANTS AND THEIR ELASTICITIES

Analysis of international trade determinants and their elasticities is an important issue for the researchers. A large volume of studies have explored the matter (Hoch, Kim, Montgomery, & Rossi, 1995, Bahmani-Oskooee, 1998, Bahmani-Oskooee, and Kara, 2006, Matias and Caroline, 2008, and, Chen, 2011). As a result, diverse research outcomes have been revealed. The Ricardian trade model proposes that factor endowment differences are the main source of differences of production costs, and, thus, the specialisation or comparative advantage of trading goods (Stephen and Hsieh, 2002, & Siggel, 2006). Therefore, it is the key driving force of international trade for a country. To assess this claim, Krugman (1981) has found that each country specializes its production activities and exports those goods and services. This production requires a higher quantity of the more abundant factors and, imports the goods and services those production activity requires the scarcest factors of the country. According to them this is true for both intra- and inter-industry overseas trade. He also emphasizes the role of economies of scale in the production process for intra-industry trade. However, their findings have ignored some important factors of modern day trades such as exchange rates, prices, and trade policy variations among nations. Later when Gravity model entered into the playground, some more determinants are invented such as geographical distance between the trading countries, land-lockedness or location of the country, most importantly trade openness or policy of the country which are denied by the Ricardian trade models (Deardorff, 1998).

Keeping in mind the above backdrops, Helpman *et.al.* (2008) have invented that firm heterogeneity in terms of productivity scale is one of the key determinants of international trade flows among nations. They also point out some other factors such as transportation costs, cultural differences, trade agreements, etc. also play a vital role in today's international trade.

Likewise, Reina et.al. (2009) have added further factors such as logistics difference, transportation cost, and tariff costs as the main bottlenecks in trade between Colombia and South Korea.

Later, Chen (2011) and Bahmani-Oskooee, *et.al*. (2018) recognized that income and exchange rates play a key role in China and Bangladeshi exports to the USA. However, Bahmani-Oskooee, *et.al*. (2018) shows that the role is asymmetric between the short- and long-run.

Regarding trade elasticity, theories predict that it would be lower in the short-run but higher in the long-run. However, Obstfeld and Rogoff (2007) have found that there is no significant difference in trade elasticities between short-and long-run. Their findings are supported by the discovery of Alessandria *et. al*. (2018). In contrast, Hakan (2019) has noted that it is higher in the long-run but significantly lower in the short-run.

In a more comprehensive study, Hooper *et. al.* (2000) have discovered some interesting findings. They have calculated three types of export and import elasticities with respect to income, exchange rate, and price for G7 countries. According to their findings, export elasticities are higher than import elasticities both in short- and long-run with respect to income, exchange rate, and prices for each of the seven countries. However, the difference between short- and long-run elasticities is infinitesimal. In this way, they have concluded that only exchange rate depreciation may be an unsuccessful tool for G7 countries to improve trade balance and thus, the Marshall-Lerner condition may not have any substantial validity for these seven high income countries in the world.

Kim (2008) has attempted to calculate the elasticity of substitution between foreign and domestic goods (widely known as "Armington elasticity") to determine the behavior of trade flows for price and tariff changes. He has found that firms do not change export levels in response to temporary shocks in price and tariff, but tariff decrease leads some non-exporters to engage in export business. Accordingly, in a calibrated model, he has found that the entry of new exporters in the export-based industry increases the measured export elasticity with respect to a tariff change to a higher value in the long-run (numerically 6.4), while the elasticity in response to tariff change in the short-run is of a smaller magnitude (numerically 1.2).

Jatuporn *et. al.* (2016) have paid attention to measure the impact of exchange rate on major agricultural export commodities of Thailand using time series analysis over the period of 2001 - 2013. An autoregressive integrated moving average (ARMA) modeled is used to detect the impact of Thai currency fluctuations on export supplies for major agricultural products. After identifying trend and seasonal stationarities, SARIMA (p,d,q) (P,D,Q) is performed for the same data series for few products as well as SARMA (p,q) (P,Q) for the remaining products. The results show that exchange rate significantly effects the exports of rice, tapioca, poultry and fishery, but it seems not to have a significant impact on natural rubber even though the time lag effect is included.

Ozdemir (2017) empirically investigates the causal link between agricultural exports and real exchange rate in India employing linear and nonlinear causality analysis. They carry out investigation using annual index of the quantity of agricultural exports in India and real US Dollar to Rupee exchange rate covering the period 1961-2013. They find that there is no significant changes in the linear and nonlinear causal relations between agricultural exports and exchange rates over the above sample period. Further, their investigation also does not provide any evidence of bidirectional or unidirectional causality between the agricultural exports to real exchange rate in India.

Almost in the similar time, Imbs and Mejean (2017) have found that the values for the aggregate trade elasticities vary greatly across countries, and they do so because of the heterogeneity of the country characteristics and their trading partners.

A further outcome is revealed from a study by Fitzgerald and Haller (2018). Using data from Ireland they have estimated export elasticity with respect to tariff and exchange rate and have found that long-run elasticity of exports with respect to exchange rate is higher than that of short-run. However, in the case of tariff elasticity, the result is the opposite meaning that long-run export elasticity is smaller than short-run elasticity.

Mashilana and Hlalefang (2018) have assessed the impact of exchange rate on exports in South Africa for the period of 1994-2016, and to establish whether a statistically significant relationship exists between export and exchange rate. They have incorporated real interest rate, investments and inflation as control variables. After conducting ADF and PP unit root tests, by applying the ARDL approach, the study empirically investigates the impact of real exchange rate on exports in South Africa. The results obtained reveal that exchange rate has a significant negative relationship with exports in South Africa.

Kohler and Ferjani (2018) have investigated how sensitive Swiss agricultural and food exports to exchange rate changes. They use both time series and panel data models to estimate short and long-run exchange rate elasticities. This allows them to assess how sensitive the results are with respect to model specification, estimation methods and data structure. The study finds that the estimated elasticities are remarkably similar across all model specifications, estimation methods and data structure. The short-run exchange rate elasticity of Swiss agro-food export is between 0.7 and 0.8, whereas the long-run exchange rate elasticity is between 0.8 and 0.9. Interpreting the exchange rate elasticity as the price elasticity of foreign demand implies a relatively inelastic foreign demand for Swiss agro-food products. This suggests that on average, no close substitutes for Swiss agro-food products are available. A possible explanation is that Swiss producers are able to successfully differentiate their products based on variety and quality and, thus, avoid price competition.

Alegwu, *et. al.* (2018) examine the effects of real exchange rate volatility on agricultural products export in Nigeria using annual data from 1970-2013. The long-run, short run, and causal effects of real exchange rate volatility on agricultural products export were evaluated. The ADF and PP unit root tests confirm that all variables are stationary at the first difference. So, VECM was used to evaluate the effects of real exchange rate volatility on agricultural products export. Further investigation based on the Johansen co-integration tests indicates that one co-integration exists between exchange rate volatility and each of the agricultural products export while controlling for other variables. Exchange rate volatility has negative long-run effect on all agricultural exports studied. The results based on VECM show evidence of negative but insignificant short-run effects of real exchange rate volatility on agricultural products export. From the Granger causality test, there exists bi-directional causality between agro exports and real exchange rate volatility.

Mao (2018) contemplates for empirical investigations of the relationship between real exchange rates and agricultural exports to the firm-product-country level with the use of disaggregated panel data of China's food industry. Real appreciations are found to reduce export quantities and the probability to enter destination markets. In addition, real appreciations also reduced the yuan-denominated export price and increased firms' probability to exit destination markets. Taking the exchange rate reform as a natural experiment, evidence suggests that the negative exchange rate effects on exports are robust to the endogeneity issue. Finally, heterogeneous export responses are identified with respect to firm productivities and ownerships, income levels and locations of destination markets, as well as product groups.

Ali (2020) examines the effects of domestic currency depreciation on agricultural exports from Pakistan including the responses of price and quantity margins. It uses disaggregated firm-level data for the period 2000-2015 that contains the exchange rates of the actual currencies of invoicing at the transaction level. The study gets that the currency depreciation positively affects both intensive and extensive margins. The intensive margin increase in agricultural exports operates mainly through prices, whereas the response of quantities is relatively smaller. Moreover, depreciation improves the extensive margins of firms and products and expands the client base in existing markets. These responses vary widely across firms' exporting experience, trade orientation, sectorial, and spatial distribution, exchange rate regimes, and invoicing currencies.

Dang (2020) evaluates the influence of Vietnam Dollar and US Dollar exchange rate on Vietnamese coffee export price. The study uses co-integration test, Granger causality test, and VAR model. The results reveal that there is no co-integrating equation between two variables. It means the exchange rate does not have an effect on coffee price of Vietnam in the long-run. Furthermore, there is one Granger causality relationship between Vietnam and US Dollar exchange rate and coffee price of Vietnam in the short-run, but not vice versa. The study suggests that the first previous period of coffee price of Vietnam is the most closely related variable which has the greatest impact on the variation of coffee price of Vietnam among the selected variables, meanwhile the effect of Vietnam and US Dollar exchange rate on it, contrarily, is positive and very trivial. In overall, the impact of Vietnam and US Dollar exchange rate on Vietnamese coffee export price has been analyzed deeply.

In another study, Boehm (2022) have seen the opposite result. According to his findings, the long-run tariff elasticity of trade is smaller than short-run elasticity. It is a very different outcome than the conventional wisdom in the literature and international economics textbooks regarding trade elasticities and it has been suggested that the trade policy change may bring opposite results to what was previously recommended for a country in the long-run.

Very recently, by applying commodity level data Kashem *et. al.* (2022) has found the Marshall-Lerner condition validity for the majority of Australian AFF commodities trade balance which suggests an importance of prices and exchange rates in Australian AFF exports.

Clearly, research findings regarding causality and its directions of international trades, in other words trade determinants and their elasticities are mixed, contradictory, and highly diversified, and the issue has no consensus and is not adequately explored. Further, agro based products trade determinants and their elasticities in any of the above studies have not been focused on. Almost no prior study has considered the issue using the VAR model. The past research findings are varied across research methods and models. There are empirical knowledge and evidence gaps regarding the determinants and elasticities of Australian AFF exports. To adopt a suitable policy for the Australian AFF sector, an evaluation is needed using sector-level data. So, this research is necessary to generate further policy insights for future trade strategy settings by the Australian government.

6.4. VARIABLES, DATA AND METHODOLOGY

First, we need to select the variables to be used in a model that can explain the export demand function for Australian AFF commodities. Conventionally in the literature, researchers firstly constructed an export demand function by including the rational variables which are suggested in the textbooks of international economics and empirical studies. Accordingly, we have selected the following variables by trial-and-error methods:

Bilateral Real Exchange Rate: Aside from conventional income and price variables, trade is affected by the variations of real exchange rate and in the expected real exchange rates (Warner and Kreinin, 1983). So, when Australian exchange rate depreciates relative to a singular trading partner country such as the USA, the price of Australian goods and services decreases in the USA. The US traders feel an incentive to import Australian products as it increases their profit margin. In this way, Australian exports to the USA would increase if its real exchange rate depreciated. Similarly, the opposite phenomenon takes place when Australian real exchange rate appreciates. In this way, real exchange rate is an inevitable factor in the international trade models.

Export Price Index: Beyond the exchange rate, if for any reason(s) (such as, domestic price increase for supply shock export duties increased by Australian government, international transportation cost increase due to such as fuel price increase) Australian export prices increase, the US traders may lose the incentive to import from Australia. In this way, Australian export price increases will decrease the level of Australian AFF product export to the USA even if the exchange rate stays constant (Reserve Bank of Australia, 2022).

Importing Country's Import Price: Further, noting the above two factors of real exchange rate and export price index, there is a third factor which can affect the importing country's residents' purchasing power. This is import prices due to the shocks caused by internal factors. In this way, the import price index of an import partner country can play a powerful role as the determinant of Australian AFF export (Feenstra, 1996).

Real GDP: Since the budget for human consumption directly depends on income level, income can serve as a basis trade determinant. If taste of consumers is assumed to be uniform across the world, and if trade neutralizes neutralises the price differences among countries, trade direction then solely depends on income gaps among the nations (Linda and James, 1986).

The quarterly panel data model of Vector Autoregressive Regression (PVAR) is applied for the period of 1988 Q1-2021 Q4. Our sample size is quite large (i.e. 136). So, we do not need to be concerned about the lag selection process due to the threat of losing the degrees of freedom. As listed, the variable series above the targeted model can be implicitly expressed as:

$EXP_{j,t} = (EXP_{j,t-i}, EXR_{j,t-i}, EXPR_{j,t-i}, IMPR_{j,t-i}, RGDP_{j,t-i})$

$EXR_{j,t} = (EXP_{j,t-i}, EXR_{j,t-i}, EXPR_{j,t-i}, IMPR_{j,t-i}, RGDP_{j,t-i})$

$EXPR_{j,t} = (EXP_{j,t-i}, EXR_{j,t-i}, EXPR_{j,t-i}, IMPR_{j,t-i}, RGDP_{j,t-i})$

$IMPR_{j,t} = (EXP_{j,t-i}, EXR_{j,t-i}, EXPR_{j,t-i}, IMPR_{j,t-i}, RGDP_{j,t-i})$

$RGDP_{j,t} = (EXP_{j,t-i}, EXR_{j,t-i}, EXPR_{j,t-i}, IMPR_{j,t-i}, RGDP_{j,t-i})$ (1)

Where,

$EXP_{j,t}$ = Australian AFF exports to country j at quarter t.

$EXPR_{j,t}$ = Exports Price Index of Australia at the quarter t.

$EXR_{j,t}$ = Bilateral Real Exchange Rate of Australia with its' trading partner j at the year t.

$IMPR_{j,t}$ = Import Price Index of Australian importing partner country j at quarter t.

$RGDP_{j,t}$ = Real GDP of Index of Australian importing partner country j at quarter t.

This targeted model can be further concretize as following standard PVAR framework:

$$LnEXP_{i,t} = \theta + \sum_{n=1}^{p} \psi_n \, LnX_{i,t-n} + \omega_{i,t} \quad (2)$$

Where *ω, i, t* is a vector which is not suffering from any autocorrelation and $X_{j,t-1}$ is the lags of both the dependent variable (X) and all controlled independent variables, and also there is no cross section dependence among them.

The VAR models are extensively used by researchers for both panel and time series data. It is an increasingly popular approach to deal with dynamic relationships among variables where there is no co-integration relationship found by researchers (Abrogo and Love, 2016). Like a time series VAR model, Panel Vector Autoregressive (PVAR) models also treat all variables in the system as dependent and their lags are independent variables i.e. all variables in this model are considered as endogenous. Besides of conventional simultaneous panel data model, PVAR also accounts for unobservable individual heterogeneity of the sample unit, and so using time invariant control variables is not necessary in this approach. We do not consider any exogenous variable in our estimation process.

Since in the PVAR system all variables are dependent and their lags are independent variables, so we will have a total of five equations in this model. However, after estimation of the model, we are not reporting and analyzing all five equations individually. We are presenting only the targeted or necessary model which econometrically and explicitly can be specified as follows:

$$EXP_{j,t} = Cj + \sum_{i=1}^{p} \alpha_j \, EXP_{j,t-i} + \sum_{i=1}^{p} \beta_j EXR_{j,t-i} + \sum_{i=1}^{p} \gamma_j EXPR_{j,t-i} + \sum_{i=1}^{p} \delta_j IMPR_{j,t-i} + \sum_{i=1}^{p} \lambda_j RGDP_{j,t-i} + \varepsilon_{t,j} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots . (3)$$

Where:

Dependent and explanatory variables are as explained above;
P = Maximum lag
C_j = Constant, and importing countries j = 1 to 5;
α to λ are giving usual connotations;
ε_{jt} = white noise error terms for each five equations.
Here the target equation is where the AFF export of Australia is treated as dependent variable. In this case, after getting the significant coefficients of this targeted equation, impulse response function and other relevant investigations will be done to check the duration of impact arising from the changes of real exchange rate, and, export price, import price, and income levels.

6.4.1. VAR as an empirical model

We have collected data on Nominal Exchange Rate (NER) of the importing countries with the US, and Australian Dollar, Real GDP index of importing countries, import price index of importing countries and export price index of Australia from International Financial Statistics (IFS). However, the import price index of China is absent in the IFS. So, alternatively, we have used Chinese consumer price index (CPI) as a proxy of Chinese import price index. The bilateral real exchange rate of Australia against the five importing countries is calculated using the textbook definition of real exchange rate[3] which uses the NER of importing countries with USD and CPI of Australia and respective importing countries. The base year considered for all data is 2010. Theoretically, the expected signs of Australian export price index, real GDP, and bilateral real exchange rate should be positive and the signs of importing countries import price index should be negative.

For estimation, we relied on an original version of Eviews-12. In Economics and Finance discipline, sometimes, it is very difficult to define dependent and independent variables as each variable may effect each other. So, a bidirectional impact and interdependence of variables may be working in the actual world. Due to such complicated relationships among macroeconomic and financial variables, Sims (1980) has criticised the usual econometric modelling using the concept of exogenous and endogenous variables as there may not have any exogenous variables. So, Sims (1980) opposes this kind of segregation of exogenous and endogenous variables. He suggested treating all the variables as endogenous variables in empirical econometric modelling of the real world where any distinction between endogenous and exogenous variables is abandoned. This means that in its generalized reduced form, each equation has the same set of regressors which ultimately modelled as VAR model in Time Series Econometrics. The basic pillars of VAR model are as follows:

1. Autoregressive: Besides of other explanatory variables and their lags, lagged values of the dependent variable are also considered as explanatory variables which is usually termed as Autoregressive nature.
2. All the variables in the VAR system are endogenous, there is no exogenous variable.

[3] Bilateral Real Exchange Rate (EXR) = (CPI^{im} X NER / CPI ^{AUS}) where NER is the nominal bilateral exchange rate defined as number of the respective importing country's currency for per AUD. CPI^{IM} is the Consumer Price Index (CPI) of Importing Countries, and CPI^{AUD} is the Consumer Price Index (CPI) of Australia.

3. Number of vectors equal to number of variables: Thus to form the VAR model at least two vectors are needed as the number of endogenous variables and the number of column vectors are the same in the empirical VAR model.
4. VAR model is applicable if each variable of the model is integrated in either order one i.e. I(1) or level i.e. I(0) or mixer of both, i.e., each variable must be stationary at level or after the first difference.
5. Finally, VAR model is applicable if the variables are not co-integrated.
6. Conventionally VAR model is specified in levels, however, VAR in difference can also be considered if required by the empirical conditions.
7. Error terms across vectors are uncorrelated and considered as white-noise error terms.

The error term is stochastic in nature and incurs white-noise if any sudden shock or, innovation or impulse enters into the system. The model must be constructed with optimal lag length. Otherwise, spurious specification problems would disturb the coefficients. However, too many lags would lose the degrees of freedom, and may cause coefficients to become statistically insignificant and multicollinearity problem. Similarly, if there are too few lags it would bring a serious specification error of the model. Thus, the model is specified by a set of information criteria such as SIC, AIC, HQIC, FPEC etc.

Interestingly, VAR models are simpler than Simultaneous models. They have attributions that ensure this model is highly accepted by the empirical researchers. In the case of this model, an empirical model builder does not need to be worried about the exogenous or endogenous status of the variable. Forecasts attained by the VAR model are better and more reliable than the forecasts obtained by the usual Simultaneous models (Erdem and Shi, 2011).

6.5. EMPIRICAL RESULTS

Correlation matrix of the variables are noted in the Table 1 below:

Table 1: Correlation matrix of variables of the Model

	EXP	EXPR	EXR	IMPR	RGDP
EXPR	0.503952 (77017910)	-	-	-	-
EXR	0.326487 (67659032)	0.051585 (481.7504)	-	-	-
IMPR	-0.473559 (-59143677)	0.348261 (294.0201)	-0.460072 (-4774.482)	-	-
RGDP	-0.220753 (-8.31E+18)	0.102710 (1.41E+13)	-0.227370 (-5.23E+14)	-0.096850 (-1.48E+13)	-

The above table shows that the correlation coefficients of the bilateral real exchange rate, export price index, and import price index with Australian AFF exports with its major five importing countries are quite large which accords with theoretical predictions. This finding implies that they may bring the favourable results in the econometric investigations as well. Corresponding covariances are given in the parentheses which are also fairly large against AFF exports. It also indicates that potential t-statistics of the estimated econometric model could be substantially large of the corresponding co-efficients with the expected signs when AFF exports will be regressed by the proposed independent variables.

For estimation purposes, first of all, stationary properties of the selected variables are checked. The results of unit root test are presented in Table 2 below:

Table 2: Unit Root Test of the individual variable

Variables	Individual Root: Fisher-ADF		Individual Root: Fisher-PP	
	Level	First Difference	Level	First Difference
EXP	0.78715	41.9616***	0.57661	359.739***
EXPR	0.15041	45.4959***	0.04011	300.516***
EXR	17.2405*	95.3926***	8.23085	274.047***
IMPR	9.29415	65.4209***	8.1265	261.218***
RGDP	0.93853	58.1791***	65.9277*	207.489***

*and *** indicate significance of the series at 10 and 1 percent levels, respectively.

From Table 2 above it is seen that by unit root tests, all variables are confirmed stationary at first difference. It means that each of the series used in the estimation are integrated at first difference when individual root is considered. This result is also confirmed by both ADF and PP tests. The unit root test by resorting common root process is as follows:

Table 3: Unit Root Test of the variable with common root

	Common Root: Levin-Lin-Chu (t*)		Common Root: Breitung	
	Level	First Difference	Level	First Difference
Statistic	7.53192	-3.20695***	5.79466	-8.17976***
(P-value)	(0.9996)	(0.0000)	(1.0000)	(0.0000)

*** indicates significance of the series at 1 percent level of significance.

From the above Table 3 we see that unit tests have given almost similar results when we consider the individual root for each variable. So using both individual root and common root methods, all variables are stationary at first differences or simply they are I(1).

After the unit root test, all variables in our model for Australian quarterly AFF exports to its major five destinations are their import price indices and bilateral real exchange rates with Australia, Australian export price index, and Real GDP of each importing partner of Australia. These are integrated to one i.e., I(1) or stationary at first difference. Relying on several information criteria we have confirmed that the optimal lag length is 4 for our data set. This lag value is also supported by AIC and LR criteria (Table A1, in the Appendix). Since the data is in level form to reduce many ups and downs of the data we have used natural logarithmic values of all variables. Following that, we have got that optimal lag length and logged values of all variables, in our first attempt, we have tested cross section dependence. According to the results of the cross section dependence test it is confirmed that selected series have no cross-section dependence (Table A2) by the test of Pesaran Scaled LM and Pesaran CD tests. However, according to the results from the Breusch-Pagan LM test, the selected series are not free from cross section dependence problem. At first attempt, we tried to determine whether the selected variables are co-integrated. By utilising various alternative selections in the Eviews-12 we failed to get any such long-run equilibrium relationships among the variables relying on the Kao Residual Co-integration test. Since the variables are I(1) and they are not co-integrated or have no long-run equilibrium relationships, we have no other option than to use Standard vector autoregressive (VAR) model for searching econometric relationships.

The results of the standard PVAR model are given in the Table A3 in Appendix. Empirical results are quite inspirational as they support the theoretical predictions with limited exceptions. Our target vector is the first one of the results postulated in Table A3. Empirical results show that Australian AFF exports are mostly caused and accelerated by their own lag values. The t-statistics of all four lag values of Australian AFF exports are statistically significant with positive signs meaning that prior AFF exports help to increase present AFF exports to these five major importing countries. However, the magnitude of the elasticities is not so high. Now, the coefficient of the second and third lag value of Australian export price are significant with a positive impact on AFF exports. Similarly, the coefficients of the first and fourth lag value of Australian real exchange rate are also significant, and the impacts are positive as expected by the trade theories. Further, the first and third lag values of the import price index of the respective countries are significant, and the sign of the coefficients are negative which also agrees with the theoretical expectations. However, coefficients of none of the lag values of importing countries real GDP is significant. This means that imports of Australian AFF products do not have any impact by importing countries Real GDP. We do not need to consider the other vectors as they are not related to our present research objective. So, we are not going to explain them in this article. Other statistics such as Adjusted R-squared and F-statistics situated in the bottom of the estimated outputs are also quite well meaning that estimated coefficients are not statistically insignificant. In brief, Australian AFF exports to its major five destinations are caused by the Australian export price, bilateral real exchange rates, and importing countries import prices but not by their income levels.

In the journey of causality search, as a second attempt we have also estimated the panel Granger causality or Block Exogeneity Wald test. In this causality test the hypothesis is set as follows:

Null Hypothesis: All the lag coefficients of Australian real exchange rate, export price index, partner countries import price index and real GDP are not causing Australian AFF exports.

Alternative Hypothesis: The lag coefficients of Australian real exchange rate, export price index, partner countries import price index and real GDP are causing Australian AFF exports.

The interpretation of this test lies in the corresponding P-values of the coefficients (Table A4 in Appendix). In the estimated Granger causality results that the top panel is related to our research target. In this panel it is seen that P-values corresponding to Australian export price index and importing countries import price index are less than 5 percent level of significance, and the P-value corresponds to Australian real exchange rate is significant at 10 percent level of significance. Therefore, according to this test Australian AFF exports to its five major importing partners are statistically Granger caused by these three variables (Australian export price index, Importers' import price index, and Bilateral real exchange rate). This means that these three factors or variables are Granger causing the level of Australian AFF exports in the sample period. The remaining four lower panel tables are not related to our present research objective. So, we do not need to interpret them. We can summarise the results up to this point as follows:

Table 4: Summary of the results

Dependent Variable	Explanatory Variable	Standard VAR Model	VAR Granger or Wald Test

Australian AFF Exports (EXP)	Australian export price index (EXPR)	2nd and 3rd lag coefficients of Australian export price index have impact on the dependent variable.	Australian export price causes the dependent variable.
	Australian real exchange rates (EXR)	1st and 4th lag coefficients of Australian real exchange rate have impact on the dependent variable.	Australian real exchange rate causes the dependent variable.
	Importers import price index (IMPR)	1st and 3rd lag coefficients Importers import price index have impact on the dependent variable.	Importer import price causes the dependent variable.

In the third layer of causality quest, we have relied on the Wald coefficient test. In this test, our null hypothesis is that lag of export price index jointly has no impact on Australian AFF exports in these five countries where the alternative hypothesis is lag of export price index has impact on AFF exports. Since the P-values reported in the Table A5 of the Appendix is less than 5 percent, we can conclude that null hypothesis is rejected, and thus Australian export price is affecting AFF product exports in these five nations. We further need to carry out the same test both for Australian real bilateral exchange rates and import price index of these five AFF export destinations. The result is the same for the Australian bilateral real exchange rate as depicted in Table A6 of the Appendix**.** Similarly, importers import price is also jointly affecting the AFF export of Australia (Table A7 of the Appendix). However, importers real GDP has failed to have any significant impact on the respective countries AFF imports from Australia (Table A8 of the Appendix).

In this effort of causality search, in the fourth attempt we have resorted Granger causality test for the first differenced variable as they are not stationary at level. Results with four lags are given in the Appendix Table A9. The result shows similar outcomes as the last three tests. The null hypothesis that Australian bilateral real exchange rate, export price index, importers import price index individually does not cause Australian AFF exports were rejected since the corresponding P-values are less than 10 percent level of significance. Further, interestingly importer countries import price index and Australian AFF exports are showing this time bidirectional causality too. However, importer countries GDP does not cause Australian AFF exports to them this time as well.

Now we shall consider some general tests of the model we have already specified and estimated. The results show that the residuals are suffering from the autocorrelation which is very usual characteristic of time series dimensioned data. In the case of the residual normality test of Choleski of Covariance (Lutkepohl), we see that our targeted model's (first equation) residuals are normally distributed as per the P-values we got from the conducted test. The normality test is also not so good as we can observe. Here the component like lag value related to AFF exports own export price and exchange rate show that residuals are normally distributed. However, the overall test of JB statistic shows that residuals are not normally distributed.

For residuals Heteroscadastcity tests we relied on White Heteroscadasticity Test (No Cross Term). The result is reported on Table A12 of the Appendix. Since the p-value of the joint test is less than 10% level of significance we can conclude that residuals are homoscedastic.

6.5.1. Variance Decomposition

After confirming the causality, we have attempted to explore the variance decomposition across variables. In econometrics and its application in multivariate time series analysis, usual practice is that once the model has been fitted, researchers try to interpret the VAR model by variance decomposition among the independent variables. It indicates that the amount of variation each independent variable contributes to explaining the variation of the dependent variable in the chosen autoregression process. In other words, it determines how much of the forecast error variance of each of the variables can be explained by the exogenous shocks to other variables.

Now, as our data is quarterly, up to four lags (one year), we can consider as the short-run forecast. Similarly, from five to twenty lags (two to five years) medium-run, and above twenty lags as long-run forecasts. The variance decomposition result are reported in the Table A13 in the Appendix. In the short-run, 6.15 percent error variance in AFF export is explained by the Australian export price index, bilateral real exchange rate, and importing countries import price index. The rest of the forecast error is explained by the lag of AFF export itself. It means that the chosen four explanatory variables in the model have very little influence on AFF export. Econometrically, these three variables have strong exogenous or weakly endogenous influences on Australian AFF exports in these five nations at least in the short-run. In the medium-run this endogenous influence is increased up to 20 percent. Similarly, when we look at the long-run (above five years) forecast error variance by these three explanatory variables is further increased which is more than 20 percent. It means that in the long-run these three variables are strong predictor of Australian AFF exports in these five major importing partners. Further, according to the variance decomposition analysis AFF export itself is the strongest predictor and importing countries real GDP has no influence over the periods of short-, medium-, and long-runs.

6.5.2. Impulse Response Analysis

Impulse Response Function allows us to trace out the time path of the variables of the proposed model. It shows the impact on the target variable due to one unit increase of the current value of the policy variable. That is, it explains the reaction of the target variable to one of the random or intentional shock of the policy variable. In other words, it helps to understand what the magnitude of effect of one unit shock or innovation of a policy variable is on the target variable. The technique is useful for detecting the empirical causal and policy effectiveness analysis. Alternatively, it helps to track the importance of dynamics of one (policy) variable on the dynamics of another (target) variable. In order to identify the impulse responses, usually a restriction is needed to apply in the main VAR matrix. The software E-views-12 by default chooses the Cholestky Decomposition (CD) as a restriction. Whatever the restriction is imposed in the estimation process the order of the variables plays a key role as the restriction on the matrix implies some shocks have no contemporaneous effects on some of the variables in the model. Economic theories and sensible logics are required to define the order the variables. However, if there is no clear cut theories and traditions for ordering of a certain model, econometricians usually choose an order for the VAR matrix arbitrarily. Whatever the imposed order of the matrix, at the end of signal processing, the impulse response of the dynamic system is its output when presented in brief input signal is called an impulse. The impulse response function can meaningfully trace or recognize the effects on present and future values of the endogenous variable on one standard deviation shock to one of the shocks or innovations.

In the interpretation of SD shocks to Australian AFF exports, the impulse response functions are shown in Figure 1 (A) in Appendix. Precisely, the findings of impulse response analysis can be shown in the following Table 5:

Table 5: Average responses on AFF exports by export price, exchange rate, & import price to

	Short-run	Medium-run	Long-run	Trend
Ln(AFF Exports)	0.270	0.400	0.420	Symmetric
Ln(Export Price Index)	0.020	0.023	0.029	Symmetric
Ln(Real Exchange Rate)	0.030	0.074	0.092	Symmetric
Ln(Importer Import Price Index)	0.011	0.035	0.038	Symmetric
Ln(importer Real GDP)	-ve	-ve	-ve	Symmetric

Source: Authors' own compilation by E-views 12

It is seen that impulse response coefficients are gradually increasing over time for each of the three explanatory variables of Australian AFF exports and they are gradually increasing from short- to long-run i.e. AFF export coefficients are in short-run < medium-run < long-run. So the impact by these three variables is continuously and steadily increasing on AFF exports from short-run to the long-run. Thus, the effect or influence by them is symmetric across the periods.

As figure 1 (A) is highly related to our research, it is more worthy for a detail discussion. The first panel shows the result of a shock of agro export on agro export. It shows that most part of the dynamic changes of AFF exports are explained and defined by the AFF exports itself. It means that Australian agro exports are mostly determined by prior period AFF exports. Other related variables impacts are not as big as AFF exports. It means that main drivers of the Australian AFF exports are defined by the AFF exports supply capacity. So, the country should increase production level of goods to increase to increase the AFF exports.
In the cross effect results show that other important variables of AFF exports in Australia those have direct positive impact are export price index, exchange rate, and import price index. However, real GDP has no significant impact on AFF exports. Shocks generated by the exchange rate and export price index are sustained for longer time that import price index as the impact by the earlier two variables do not die out until 24 four quarters. However, impact generated by the import price index shock on AFF exports is died out within 12 quarters.

Since the order of variable is highly important in the impulse response process, alternative ordering is also considered and presented in the analysis. The output of alternative ordering is given in the panel B, C, and D of Figure 1 in appendix. In case of alternative ordering, it is seen that the own impact of AFF exports and considered other four endogenous variables are bit changed. In the alternative ordering influence of past values of AFF exports seem higher than the firstly selected order. Impact of Real GDP and import price are negative in the initial period. However, later both of the variables impact turns into positive. Further, these two variables impact show that they are upward going through out the chosen 20 periods. It means that selection of higher period may reveal a better picture of impact by Real GDP and import price on AFF exports. However, since our data period is only 32 years it is not suitable to impose lag period for IRF function higher than 20 periods. Additionally, in case of the impact generated by the exchange rate and export price for alternative specification are positive and upward rising for the whole 20 periods. It means that the impact of exchange rate and export price index are not die out within the chosen 20 periods.

Precisely, in the alternative order, impact by all four variables do not die out in the chosen period. Thus, it indicates that they have positive and higher impacts on AFF exports in the long-run than the short-run.

6.5.3. AR/MA Roots Tests

This root view displays the inverse roots of the AR/MA characteristic polynomial. Here this root is displayed as a graph only. This graph plots the roots in the complex plane where the horizontal axis is the real part, and the vertical axis is the imaginary part of each root. As per the rule of AR root for the stability of PVAR model all the points should lie inside the unit radius circle. From the Figure 2 of Appendix, it is seen that all the dots are inside the circle. It means that the estimated ARMA process or VAR is stationary i.e., ARMA process is invertible. Precisely, our estimated model is stable.

6.6. CONCLUSIONS AND POLICY IMPLICATIONS

In this study we have investigated the Australian AFF export determinants and have estimated their coefficients (elasticities). By using suitable econometric approaches, our findings have both agreements and disagreements with conventional theoretical wisdoms. Our investigations reveal that exporter' (Australian) export price index, importers import price indices, and exporter real exchange rate are the main, significant and both short- and long-run determinants of Australian AFF goods exports in its major five destinations: the USA, China, Japan, Thailand, and South Korea. This result has theoretical coherence with the standard trade theories. However, income has no significant impact on the exports of these sectors of Australia which is a disagreement with the common trade theories. However, since depreciation of bilateral real exchange rate promotes Australian AFF exports, it means that exchange rate depreciation has an expansionary impact on the AFF sector of Australia. Results also indicate that further openness may bring positive impact on the AFF sectors of Australia as prices are significant determinants.

Further, bilateral trade elasticities of the above three significant determinants are more than one (i.e., elastic), and they have an increasing tendency as time periods increase after a shock originated from them. So, the results reveal that elasticities of exchange rates and prices are large enough to work as growth factors of Australian AFF exports. Precisely, estimated elasticities indicate that along with price manipulation, real exchange rate depreciation could increase Australian AFF exports.

The results of this research can be further interpreted that although there are three variables working as long-run determinants of Australian AFF products in its top five export destinations, prices are working as a relatively important determinant than real exchange rate. That is, prices have more powerful impact on Australian AFF exports than real exchange rate.

The results indicate that as price level directly affects consumers' disposable income levels, Australian government, exporters and investors in AFF export sectors should pay careful attention to the price and exchange rate trends to maintain a steady growth of exports. Because Australia and its importing partner inflation rates can lead to a deteriorating consequences on its AFF exports if importing countries consumer income levels do not increase enough to subsidise the price effect of their consumption baskets.

This research could give greater exposure to the ramifications of exchange rates and prices if commodity level disaggregated data was used and, therefore, future researchers should shed light for such exercises to disclose more clear and perceptible consequences of Australian AFF exports. Nevertheless, the significant status of the chosen variables is indicating that a majority of the commodities are individually influenced by them.

Performance of the VAR model depends on the variables, sample size selected, and included in the model. This raises risk of inclusion of too many and thus unnecessary variables or omitting important variables. Also much care is required for proper lag selection of the model. Trade of a country depends on multiple issues and including all of them in a quantitative model is a complex process and sometimes impossible. If the sample size is not fairly large the VAR can perform like an over-fitted model and begets inaccurate estimations. Further, this model also ignores structural change and non-linearity properties of the data. Moreover, for a reliable result of the VAR process, stability of the model and homoscedasticity of the data are essential issues. These issues sometimes cannot be managed and detected by the available econometric methods and softwares. Thus, the result of this research cannot avoid these common criticisms. Therefore, future researches can focus on alternative models and methodologies with good sample sized and reliable data of other economically important determinants of trade.

6.7. REFERENCES

Abrigo, M. & Love, I. (2016): Estimation of Panel Vector Autoregression in Stata, Stata Journal Vol.16. PP. 778-804.

Alegwu, F. O., Aye, G. C. and Asogwa, B. C. (2018): Effect of Real Exchange Rate Volatility on Agricultural Products Export in Nigeria. Agricultural Papers in Economics and Informatics, Vol. 10, No. 3, PP. 3-15.

Alessandria, G., Choi, H., (2018): The Dynamics of the US Trade Balance and the Real Exchange Rate: The J Curve and Trade Costs? Discussion Paper, mimeo.

Ali, S. (2020) exchange rate effects on agricultural exports: transaction-level evidence from Pakistan. American Journal of Agricultural Economics. Vol. 102, Issue No. 3, PP. 1020-1044

Bahmani-Oskooee, M. (1998): Cointegration Approach to Estimate the Long-Run Trade Elasticities in LDCs. International Economic Journal. Vol. 12, Issue 3.

Bahmani-Oskooee M and Ardalani Z (2006): Exchange Rate Sensitivity of U.S. Trade Flows: Evidence from Industry Data. Southern Economic Association, Vol. 72, Issue 3, PP: 521-763

Bahmani-Oskooee, M. and Kara, O. (2006): Income and price elasticities of trade: some new estimates. The International Trade Journal, Vol. 19, Issue 2.

Bahmani-Oskooee, M., Rahmanb, M.O. and Kashem, M.A. (2018): Bangladesh's trade partners and the J-curve: an Asymmetry Analysis. Macroeconomics and Finance in Emerging Market Economies.

Berkum, S. V. and Meijl H V. (1992): Understanding competitiveness from trade theories. Agricultural Economics Research Institute, The Hague, Netherland.

Boehm, C. E. Levchenko, A. A. and Pandalai-Nayar, N (2022): The Long and Short (Run) of Trade Elasticities. University of Texas, Austin, NBER and CEPR

Bottega and Romero (2021): Innovation, export performance and trade elasticities across different sectors. Structural Change and Economic Dynamics, Vol. 58, PP 174-184

Carlos, M.P.S., Francisco, J., Lopez, M., and Coelho, F., (2008): The determinants of export performance: A review of the research in the literature between 1998 and 2005. International Journal of Management Research, Volume 10, Issue 4, PP 343-374. British Academy of Management.

Chen, H. (2011): The effect of China's RMB exchange rate movement on its agricultural export: A case study of export to Japan. China Agricultural Economic Review. Vol. 3 No. 1. PP. 26-41

Dang, T. T. Zhang, C. & Nguyen, T. H. (2020): Assessing the influence of exchange rate on agricultural commodity export price: evidence from Vietnamese coffee. Journal of Economics and Development, Vol. 22, Issue No. 2. PP. 297-309

Deardorff, A. (1998): Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World? National Bureau of Economic Research, PP. 7-32.

Erdem, E., and Shi, J. (2011): ARMA based approaches for forecasting the tuple of wind speed and direction. Applied Energy, Vol. 88, Issue 4, PP. 1405-1414

Feenstra, R.C., (1996): US imports 1972-1994: data and concordances. NBER Working Paper Series - 5515.

Fitzgerald, D., and Haller, S. (2018): Exporters and shocks. Journal of International Economics. Vol. 113. PP 154-171.

Fontana, G. and Palacio-Vera, A. (2007): Are long-run price stability and short-run output stabilization all that monetary policy can aim for? Metroeconomica, Vol. 58, Issue 2, PP 269-298

Hakan, Y. (2019): Estimating the trade elasticity over time. Economics Letters, Vol. 183, 108579

Hayakawa, K, Kim, H. S, and Yoshimi, T. (2017): Exchange rate and utilization of free trade agreements: Focus on rules of origin. Journal of International Money and Finance, Vol. 75, PP 93-108

Helpman, E., Melitz, M. & Rubinstein, Y. (2008): Estimating Trade Flows: Trading Partners and Trading Volumes. Quarterly Journal of Economics, 123441-487.

Hoch, S. J., Kim, B.-D., Montgomery, A. L., & Rossi, P. E. (1995): Determinants of Store-Level Price Elasticity. Journal of Marketing Research. Volume 32, Issue 1. PP 17-29

Hooper, P., Johnson, K., and Marquez, J. (2000): Trade elasticities for the G7 countries. Princeton Studies in International Economics. No. 87.

Hunter, L. and James, R.M. (1986): Per capita Income as a determinant of trade. Center of study of international economic relations. Working Paper Series, No. 86200.

Imbs, J., and Mejean, I., (2016): Trade Elasticties. Review of International Economics. May-2017. Vol. 25, Issue 2. PP 383-402.

Jatuporn, C. & Sukprasert, P. (2016): Assessing the impact of exchange rate on major agricultural export commodities of Thailand. Journal of Agricultural Technology 2016 Vol. 12 Issue 6, PP 973-982

Kashem M. A., Rahman, MM, and Khanam, R. (2022): Improving Australia's trade balance: A case study of agro-forest and fish products. Australian Economic Paper, Vol. 61, Issue 3, PP 493-533.

Kohler, A. & Ferjani, A. (2018): Exchange rate effects: A case study of the export performance of the Swiss agriculture and food sector. World Economy. Vol. 41. PP 494–518.

Kim, J R. (2008): International Elasticity puzzle. Working paper series, Research Papers in Economics, New York University, Leonard N. Stern School of Business, Department of Economics.

Krugman, P. (1989): Differences in income elasticities and trends in real exchange rates. European Economic Review, Vol. 33, Issue 5, PP 1031-1046

Krugman, P. (1983): New Theories of Trade among Industrial Countries. The American Economic Review, 73, PP 343-347.

Mao, R. (2019): Exchange rate effects on agricultural exports: A firm level investigation of China’s food industry. China Agricultural Economic Review, Vol. 11 No. 4. PP. 600-621

Matias, B. and Caroline, F. (2008): On the conservation of distance in international trade. Journal of International Economics, Vol. 75, Issue 2, PP 310-320

Ngondo, M. & Khobai, H. (2018): The impact of exchange rate on exports in South Africa. Munich Personal Research Paper Archive. Paper No. 85079

Obstfeld, M., Rogoff, K., (2007): The unsustainable US current account position revisited. In: G7 Current Account Imbalances: Sustainability and Adjustment. University of Chicago Press, PP. 339 - 376.

Ozdemir, D. (2017): Causal Relationship between Agricultural Exports and Exchange Rate: Evidence for India. Applied Economics and Finance. Vol. 4, No. 6. PP. 23-32

Reina, M., Salamanca, C. & Forero, D. (2009): Feasibility of a Free Trade Agreement between Colombia and the Republic of Korea. Federal Bank of Colombia. Working Paper Series 49.

Reserve Bank of Australia, (2022): Exchange Rate and the Australian Economy. 2022. Link:https://www.rba.gov.au/education/resources/explainers/pdf/exchange-rates-and-the-australian-economy.pdf?v=2022-12-28-14-26-20

Siggel, E. (2006): International Competitiveness and Comparative Advantage: A Survey and a Proposal for Measurement. Journal of Industry, Competition and Trade. Vol. 6, PP. 137–159

Stephen, S.G. & Hseih, C.T. (2002): Classical Ricardian Theory of Comparative Advantage Revisited. Review of International Economics, Vol. 8, Issue 2, PP. 221-234

Warner, D. & Kreinin, M.E. (1983): Determinants off international trade flows. The Review of Economics and Statistics. Vol. 65, No. 1 PP. 36-104.

Yimaz, A (2015): New foreign trade theories. The Journal of Academic Social Science Studies, Number: 40, PP. 509 – 521.

6.8. Appendices

Table A1: Lag selection Test

VAR Lag Order Selection Criteria
Endogenous variables: EXP EXPR EXR IMPR RGDP
Exogenous variables: C
Sample: 1988Q1 2021Q4
Included observations: 660

Lag	LogL	LR	FPE	AIC	SIC	HQ
0	-40948.96	NA	2.62e+49	127.9811	128.0160	127.9946
1	-31555.44	18610.91	5.06e+36	98.70449	98.91362	98.78566
2	-31353.95	396.0446	2.92e+36	98.15297	98.53638	98.30179
3	-31249.78	203.1249*	2.28e+36	97.90558	98.46326	98.12204
4	-31199.34	97.57912	2.10e+36*	97.82606*	98.55802*	98.11017*
5	-31164.07	67.68311	2.04e+36	97.79396	98.70019	98.14571
6	-31155.86	15.61221	2.15e+36	97.84644	98.92696	98.26584
7	-31135.07	39.25046	2.18e+36	97.85959	99.11437	98.34663
8	-31095.74	73.60771	2.08e+36	97.81483	99.24389	98.36952

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table A2: Cross Section Dependence Test

Residual Cross-Section Dependence Test
Null hypothesis: No cross-section dependence (correlation) in residuals
Periods included: 134
Cross-sections included: 5
Total panel observations: 660
Note: non-zero cross-section means detected in data
Cross-section means were removed during computation of correlations

Test	Statistic	d.f.	Prob.
Breusch-Pagan LM	29.79812	10	0.0009
Pesaran scaled LM	1.842695		0.1165
Pesaran CD	1.108921		0.2675

Table A3: Empirical Results of the standard PVAR Model

Vector Autoregression Estimates
Sample (adjusted): 1989Q1 2021Q4
Included observations: 660 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	EXP	EXPR	EXR	IMPR	RGDP
EXP(-1)	1.233148***	-5.10E-08	2.38E-06	-5.56E-06***	-3148.582
EXP(-2)	0.119641**	1.89E-07	-2.09E-06	1.36E-06	2701.893
EXP(-3)	0.430293**	1.42E-07	-2.89E-06	9.13E-06***	3805.238
EXP(-4)	0.092122**	-2.90E-07*	2.63E-06	-4.52E-06**	-3242.016
EXPR(-1)	8.202548	1.135593***	0.239465	0.159025	-1.83E+09
EXPR(-2)	3.012908**	0.052663	2.352516	0.357981	2.30E+09
EXPR(-3)	5.124142**	-0.143225**	-2.908208	-0.449665	-5.50E+09**
EXPR(-4)	-6221.866	-0.036800	0.328790	-0.048703	5.06E+09***
EXR(-1)	10.43061**	-0.001274	1.198740***	-0.001602	13531259
EXR(-2)	7.462522	0.001201	-0.383472***	0.001672	-14297247
EXR(-3)	-235.3034	0.000197	0.234143***	0.001231	3623505.
EXR(-4)	8.439925***	-7.78E-05	-0.053958	-0.002349	-4897081.

IMPR(-1)	-21.75969***	-0.002876	-0.029152	0.123503***	6971086.
IMPR(-2)	-145.6801	0.003579	-0.040767	0.297128***	-21241434
IMPR(-3)	-22.59108***	-0.003588	-0.022017	0.184978***	9203283.
IMPR(-4)	223.7211	0.003624	-0.028581	0.355936***	-35907940
RGDP(-1)	-5.98E-08	4.38E-13	2.48E-12	1.06E-13	1.307098***
RGDP(-2)	4.99E-08	-1.46E-12	-1.42E-11	-8.09E-13	-0.111217*
RGDP(-3)	4.29E-09	1.18E-12	1.15E-11	-1.48E-13	-0.167653**
RGDP(-4)	5.95E-09	-1.56E-13	2.98E-14	8.58E-13	-0.025743
C	17769.50	-0.290437	11.33363*	2.600203*	5.76E+09
R-squared	0.897298	0.998825	0.794992	0.889505	0.918965
Adj. R-squared	0.887276	0.998789	0.784835	0.886046	0.901896
Sum sq. resids	1.98E+13	425.7265	524877.7	48995.46	7.93E+23
S.E. equation	176086.6	0.816234	28.66016	8.756439	3.52E+10
F-statistic	45496.54	27167.51	6347.654	257.2022	916550.3
Log likelihood	-8897.792	-791.8134	-3140.464	-2357.890	-16954.01
Akaike AIC	27.02664	2.463071	9.580194	7.208757	51.43943
Schwarz SC	27.16958	2.606006	9.723129	7.351691	51.58237
Mean dependent	3438253.	75.19763	273.9311	96.31864	2.85E+12
S.D. dependent	6545463.	23.45132	398.7932	25.93959	5.88E+12

Table A4: PVAR Granger Causality or Block Erogeneity Wald Tests

VAR Granger Causality/Block Erogeneity Wald Tests
Sample: 1988Q1 2021Q4
Included observations: 660

Dependent variable: LOG(EXP)

Excluded	Chi-sq	df	Prob.
LOG(EXPR)	7.104605	4	0.0135
LOG(EXR)	1.813646	4	0.0770
LOG(IMPR)	7.336423	4	0.0191
LOG(RGDP)	0.538024	4	0.9697
All	22.98485	16	0.1141

Dependent variable: LOG(EXPR)

Excluded	Chi-sq	df	Prob.
LOG(EXP)	3.543380	4	0.0413
LOG(EXR)	0.572372	4	0.1661
LOG(IMPR)	5.788300	4	0.0215
LOG(RGDP)	4.792399	4	0.0093
All	14.12294	16	0.5896

Dependent variable: LOG(EXR)

Excluded	Chi-sq	df	Prob.
LOG(EXP)	2.306359	4	0.0796
LOG(EXPR)	1.906527	4	0.7529
LOG(IMPR)	2.796070	4	0.0592
LOG(RGDP)	3.769621	4	0.0438
All	11.72826	16	0.7625

Dependent variable: LOG(IMPR)

Excluded	Chi-sq	df	Prob.
LOG(EXP)	2.222703	4	0.0949
LOG(EXPR)	3.674489	4	0.0518
LOG(EXR)	1.963672	4	0.7424
LOG(RGDP)	2.319896	4	0.1771
All	17.35455	16	0.3630

Dependent variable: LOG(RGDP)

Excluded	Chi-sq	df	Prob.
LOG(EXP)	8.695965	4	0.0692
LOG(EXPR)	11.62310	4	0.0204
LOG(EXR)	16.31295	4	0.0026
LOG(IMPR)	45.72140	4	0.0000
All	70.84213	16	0.0000

Table A5: Wald Test for Export Price

Wald Test:
System: %system

Test Statistic	Value	df	Probability
Chi-square	7.178585	4	0.0267

Null Hypothesis: C(5)=C(6)=C(7)=C(8)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(5)	0.019356	0.087862
C(6)	0.118705	0.031790
C(7)	0.136015	0.031178
C(8)	0.020591	0.086174

Restrictions are linear in coefficients.

Table A6: Wald Test for Australian Real Bilateral Exchange Rates

Wald Test:
System: %system

Test Statistic	Value	df	Probability
Chi-square	1.817499	4	0.0769

Null Hypothesis: C(9)=C(10)=C(11)=C(12)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(9)	0.216263	0.020212
C(10)	0.117358	0.031729
C(11)	0.117597	0.031904
C(12)	0.199108	0.020280

Restrictions are linear in coefficients.

Table A7: Wald Test for Importers Import Price Index

Wald Test:
System: %system

Test Statistic	Value	df	Probability
Chi-square	7.347889	4	0.0186

Null Hypothesis: C(13)=C(14)=C(15)=C(16)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(13)	-0.108359	0.012042
C(14)	0.012203	0.012110
C(15)	-0.206335	0.011953
C(16)	0.009264	0.012499

Restrictions are linear in coefficients.

Table A8: Wald Test for Importers Real GDP

Wald Test:
System: %system

Test Statistic	Value	df	Probability
Chi-square	0.496129	4	0.9739

Null Hypothesis: C(17)=C(18)=C(19)=C(20)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.

C(17)	0.009284	0.032788
C(18)	-0.002439	0.037876
C(19)	-0.017213	0.038019
C(20)	0.010305	0.031965

Restrictions are linear in coefficients.

Table A9: Bi-variate Granger Causality Test.

Pairwise Granger Causality Tests
Sample: 1988Q1 2021Q4
Lags: 4

Null Hypothesis:	Obs	F-Statistic	Prob.
EXPR does not Granger Cause EXP	660	2.35352	0.0527
EXP does not Granger Cause EXPR		0.74422	0.5621
EXR does not Granger Cause EXP	660	3.47430	0.0546
EXP does not Granger Cause EXR		0.07937	0.9886
IMPR does not Granger Cause EXP	660	-3.16955	0.0135
EXP does not Granger Cause IMPR		-10.2781	4.E-08
RGDP does not Granger Cause EXP	660	0.01894	0.9993
EXP does not Granger Cause RGDP		0.02097	0.9991

Table A10: Autocorrelation Test of Residuals

VAR Residual Serial Correlation LM Tests
Sample: 1988Q1 2021Q4
Included observations: 660

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	199.4924	25	0.0000	8.286981	(25, 2341.8)	0.0000
2	48.62529	25	0.0031	1.955641	(25, 2341.8)	0.0031
3	97.03657	25	0.0000	3.943233	(25, 2341.8)	0.0000
4	207.5100	25	0.0000	8.634943	(25, 2341.8)	0.0000

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	199.4924	25	0.0000	8.286981	(25, 2341.8)	0.0000
2	280.8939	50	0.0000	5.851979	(50, 2853.8)	0.0000
3	323.7448	75	0.0000	4.501998	(75, 2973.9)	0.0000
4	389.0037	100	0.0000	4.082087	(100, 3005.0)	0.0000

*Edgeworth expansion corrected likelihood ratio statistic.

Table A11: Residual Normality Test

VAR Residual Normality Tests

Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: Residuals are multivariate normal
Sample: 1988Q1 2021Q4
Included observations: 660

Component	Skewness	Chi-sq	df	Prob.*
1	1.343843	1.6507	1	0.1524
2	1.695056	3.0537	1	0.1161
3	0.033134	0.1207	1	0.7282
4	0.933181	95.79101	1	0.0000
5	-0.301765	10.01680	1	0.0016
Joint		1.6329	5	0.2631

Component	Kurtosis	Chi-sq	df	Prob.
1	7.580733	7.0357	1	0.0523
2	1.264913	0.1406	1	0.2214
3	17.85124	5.3792	1	0.0000
4	16.40365	4.5911	1	0.0000
5	1.664659	9.2612	1	0.1726
Joint		12.4112	5	0.0024

Component	Jarque-Bera	df	Prob.
1	75.6864	2	0.0000
2	69.1944	2	0.0000
3	65.500	2	0.0000
4	56.382	2	0.0000
5	25.2780	2	0.0000
Joint	26.0424	10	0.0000

*Approximate p-values do not account for coefficient estimation

Table A12: Residuals Heteroscadasticty

VAR Residual Heteroskedasticity Tests (Levels and Squares)
Sample: 1988Q1 2021Q4
Included observations: 660

Joint test:

Chi-sq	df	Prob.
1443.597	600	0.0000

Individual components:

Dependent	R-squared	F(40,619)	Prob.	Chi-sq(40)	Prob.
res1*res1	0.117710	2.064590	0.0002	77.68878	0.0003
res2*res2	0.154894	2.836319	0.0000	102.2303	0.0000
res3*res3	0.112555	1.962701	0.0005	74.28633	0.0008
res4*res4	0.375874	9.319654	0.0000	248.0765	0.0000

res5*res5	0.331422	7.671146	0.0000	218.7386	0.0000
res2*res1	0.083602	1.411766	0.0507	55.17728	0.0556
res3*res1	0.041336	0.667251	0.9434	27.28157	0.9372
res3*res2	0.051947	0.847924	0.7354	34.28490	0.7246
res4*res1	0.223114	4.444271	0.0000	147.2553	0.0000
res4*res2	0.104869	1.812971	0.0020	69.21348	0.0028
res4*res3	0.144306	2.609741	0.0000	95.24212	0.0000
res5*res1	0.092491	1.577170	0.0147	61.04397	0.0176
res5*res2	0.054739	0.896143	0.6551	36.12788	0.6452
res5*res3	0.147378	2.674905	0.0000	97.26977	0.0000
res5*res4	0.159695	2.940940	0.0000	105.3989	0.0000

Table A13: Variance Decomposition

Variance Decomposition of EXP using Choleski (d.f. Adjustment Factors)

Period	S.E.	LOG(EXP)	LOG(EXPR)	LOG(EXR)	LOG(IMPR)	LOG(RGDP)
1	0.022140	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.032819	98.90505	1.004255	0.053086	0.032135	0.005478
3	0.043515	96.86787	2.025503	1.079422	0.018553	0.008653
4	0.054919	93.85104	3.036594	2.050950	1.055889	0.005524
5	0.065273	92.83449	4.065990	2.036221	1.059215	0.004085
6	0.075110	91.78379	4.101388	3.027418	1.084308	0.003096
7	0.084445	90.70932	4.141848	3.022835	2.123518	0.002480
8	0.093215	89.61151	5.188613	3.020468	2.177375	0.002038
9	0.101516	88.50735	5.240269	4.019549	2.231114	0.001721
10	0.109386	88.38396	5.296727	4.019748	2.298031	0.001534
11	0.116866	87.24612	5.358546	4.020560	3.373348	0.001421
12	0.124006	86.09306	6.425272	4.021808	3.458464	0.001393
13	0.130836	85.92903	6.496881	5.023382	3.549281	0.001424
14	0.137393	85.75050	6.573300	5.025198	3.649467	0.001540
15	0.143708	84.55962	6.654511	5.027183	4.756977	0.001710
16	0.149805	83.35604	7.740419	5.029300	4.872293	0.001949
17	0.155707	82.14115	7.830950	6.031528	4.994133	0.002240
18	0.161434	81.91424	7.926015	6.033850	5.123307	0.002593
19	0.167004	81.67631	7.025534	6.036245	5.258912	0.002994
20	0.172433	80.42745	7.129409	6.038703	5.400990	0.003452
21	0.177732	89.16830	8.237545	6.041216	5.548978	0.003957
22	0.182916	88.89895	8.349845	7.043778	5.702910	0.004514
23	0.187993	87.61998	8.466210	7.046381	6.862316	0.005115
24	0.192974	86.33163	8.586538	7.049020	6.027048	0.005764
25	0.197866	86.03437	9.710727	7.051689	6.196758	0.006455

Short-run

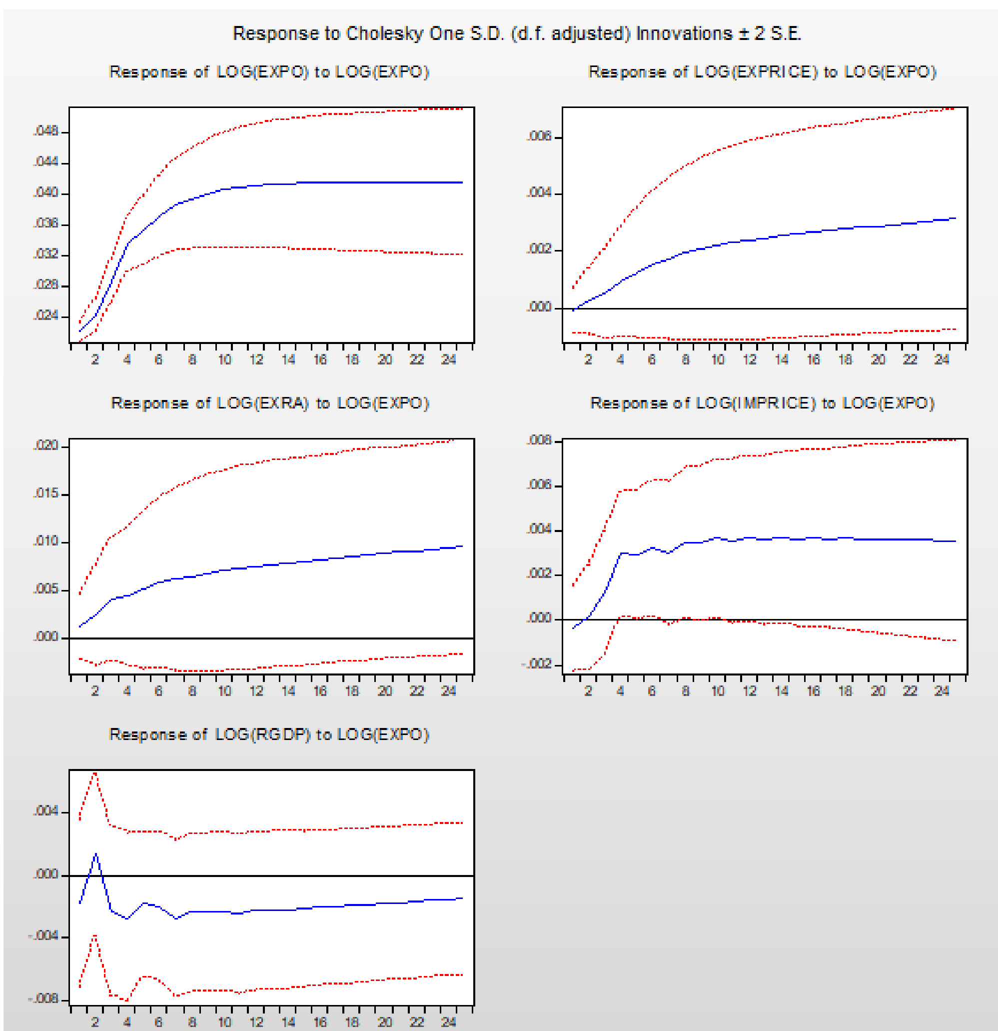
Medium -run

Long-run

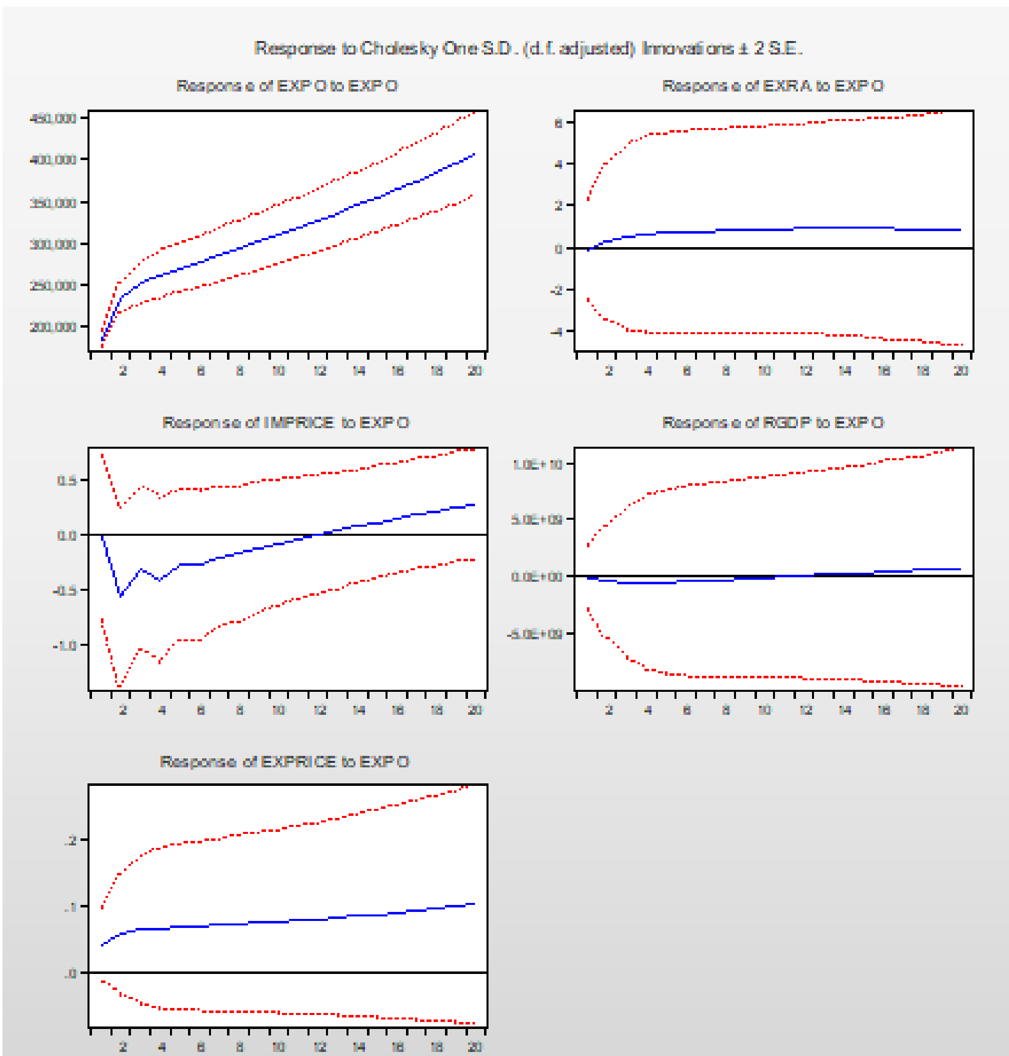
Cholesky Ordering: LOG(EXPO) LOG(EXPRICE) LOG(EXRA) LOG(IMPRICE) LOG(PGDP)

Figure 1: Graphical Representation of Impulse Response Functions

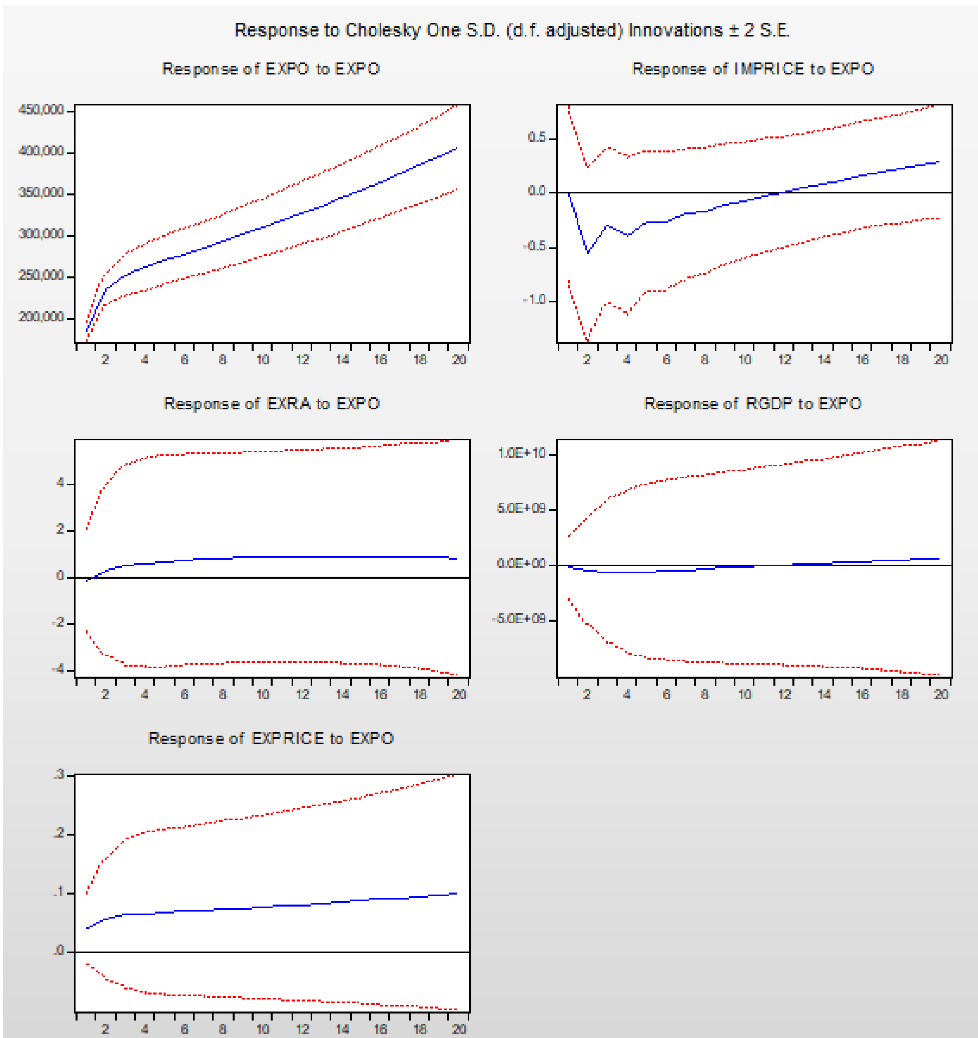
(A)When “export price index” is placed in first of the order of variable



(B)When “exchange rate” is placed in first of the order of variable



(C)When "import price" is placed in first of the order of variable



(D)When "RGDP" is placed in first of the order of variable

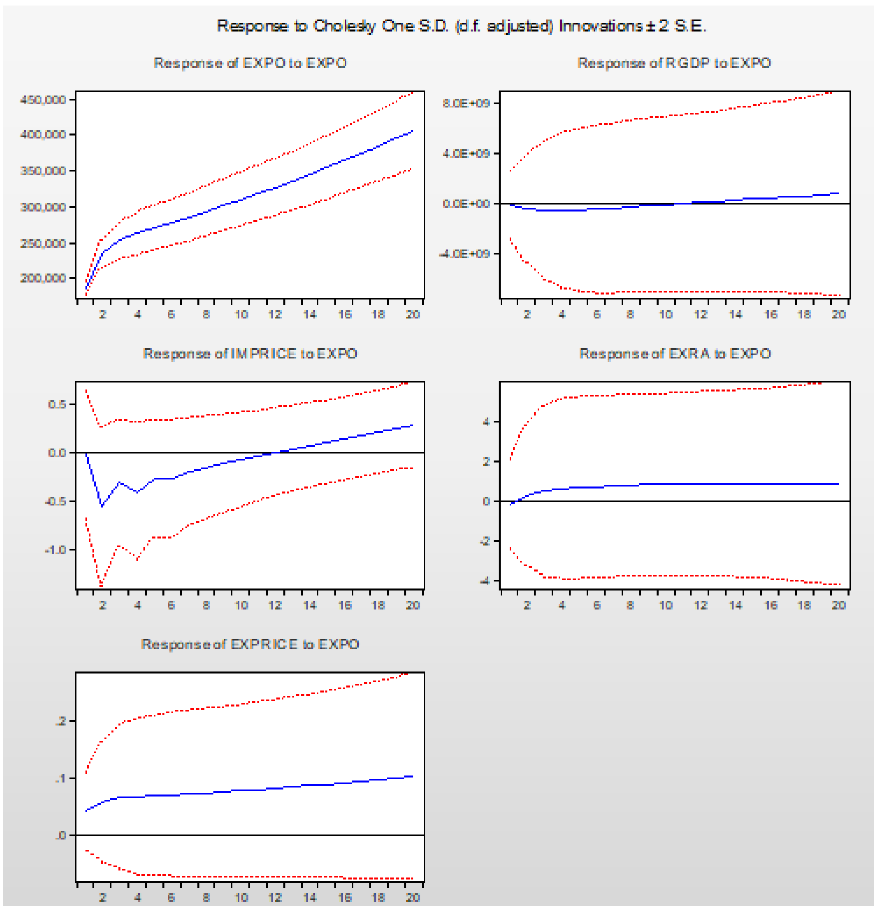
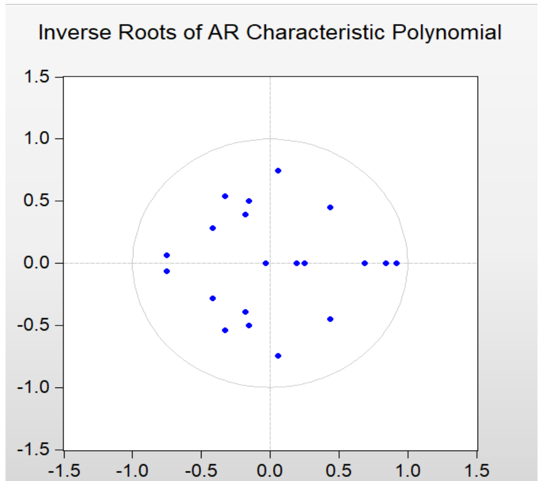


Figure 2: AR / MA Roots Test



CHAPTER 7

CLIMATE CHANGE IMPACT ON THE AUSTRALIAN AGRICULTURAL EXPORTS

ABSTRACT

The Australian agricultural sector has high importance as a predominant contributor to GDP and export earnings. However, rapid global warming or climate change may cause obstacles for the agricultural export earnings. Existing literature shows that the issue is not gaining enough attention from policy makers, researchers and academics as it should be. In this paper, we have investigated the impact of global climate change on the Australian agricultural export earnings. Our analyses based on graphical, statistical, and econometric estimation, (ordinary least squares) for the data period of 1990 - 2021 reveal that climate change caused by the environmental pollutions is harming Australian agricultural export performance. Specifically environmental degradation and the average yearly temperature increase of Australia triggered by the exponential growth of CO2 emissions have an empirically negative impact on Australian agricultural export growth. As the agriculture sector contributes approximately one-third of Australian total export earnings, the rapid decline of its export earnings may create multiple imbalances in the Australian economy in the

future. Thus, the country should launch immediate preventive actions for amelioration of the environmental condition to defend its agricultural export performance and to maintain environmental sustainability.

Keywords: Climate Change, Environmental Degradation, Agro Exports, CO_2 Emissions, and Australia**.**
JEL Classification: D61, H43, Q43, Q52

7.2.INTRODUCTION

Agro-forest-fish (AFF) products are one of the major category of Australian exports. However, complexities stemmed from rapid global climate change are gradually jeopardizing this sector of the country (Roobavannan, *et. al*. 2017, and Bouchaou, *et. at*. 2017). Australian agricultural production activities are mostly determined by climate condition, water availability, type of soil, proximity to markets and international demand (DFAT, Australia, 2023). So, climate condition is one of the prime driving forces of Australian agriculture (Tsakiris, 2017). AFF goods contribution is about 31.21 percent of Australian total exports (DFAT, Australia, 2023). Australian major AFF exportable can be divided into four subcategories which are (a) poultry and dairy products, (b) seafood items including fishes, mollusks, crustaceans, (c) crops, corns, cottons, etc. (d) forest products and logging, etc. The contribution by the above major four AFF sectors in 1990 were 36, 23, 21, and 20 percent respectively (DFAT, Australia, 2023). Besides of sectorial contribution, these statistics show that Australian agricultural exporting items are highly diversified which is rarely seen in most economies of the world. Altogether the AFF items constitute about one third of total Australian exports over the period 1989-2020 (Kashem, *et. al*., 2022). This is reasoned as geographical location and ecological diversity of the country. It can be considered as natural blessings for Australia. It also postulates the agricultural and natural resource exports potential for this country (Ben Salha, *et. at.* 2021). However, over the last three decades the composition of AFF sector exports has changed considerably (Roobavannan, et. al. 2017). Very recently in 2020 contribution by these four categories: poultry and dairy, fishes, crops and forests items are 44, 36, 14 and 6 percent, respectively. According to the change of contribution by these four subcategories, it is very much clear that presently poultry and dairy sector is in expanding trend while corns and forest products are gradually shrinking. It may be due to combined effect of two alternative reasons (1) Poultry, dairy, and sea items sector growth rates are higher than corns and forest items, or (2) corns and forests sectors contributions are gradually shrinking because their higher land demand for higher growth rate or negative impacts generated by climate change is higher in these sectors as they are land intensive products. Further factor might be that environmental bargaining groups are hindering increased logging and deforestation for setting up more agricultural production activities (Chasek, and Downie, 2021). Thus, current trends implying that it is very likely that Australian agricultural exports are harmed relatively higher rate by gradual global climate change.

Table 1: Sector-wise Australian emissions in 2020

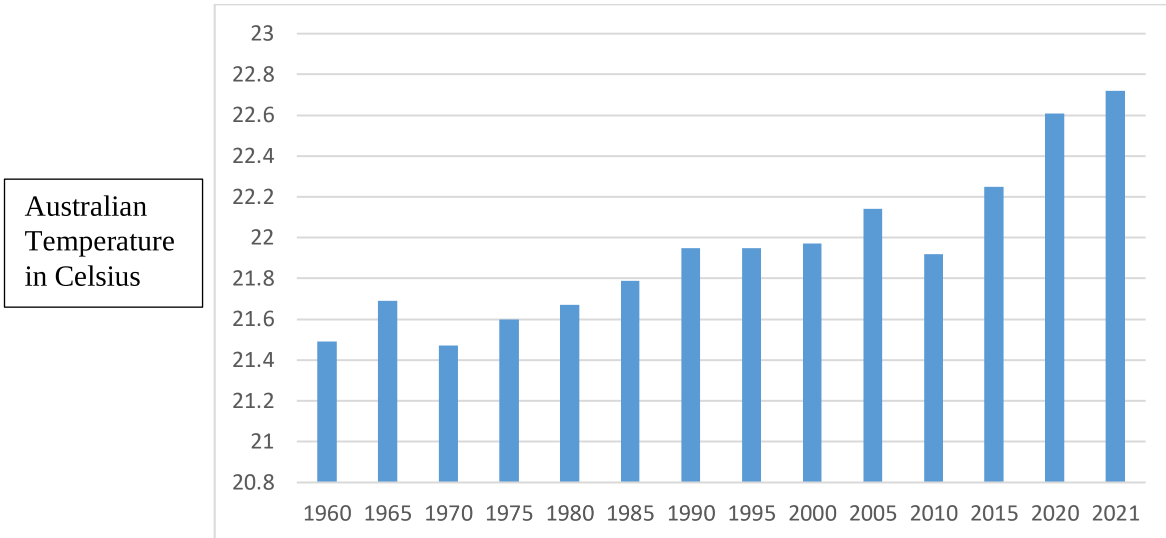
SL No.	Sector	Contribution in percentage
1	Energy (burning fossil fuels to produce electricity)	33.6
2	Stationary energy (including manufacturing, mining, residential & commercial fuel use)	20.4
3	Transport	17.6
4	Agriculture	14.6
5	Industrial Processes	6.2
6	Waste Management	2.7
7	Others (Fugitive emissions)	10.1

Source: Australian National Science Agency, 2023. (Authors' own compilation by the data from this source)

There is conceptual misunderstanding about AFF trade and climate change issues. It is obscure to the policy makers and researchers about the relationships and dynamics of climate change impact on agro sector trade (Kenan, 2015). Climate change process is a hazardous phenomenon affecting all sectors of the economy. Generally agriculture is the most vulnerable sector (Tsakiris, *et. al*. 2017). Climate change turns arable lands into semi-arable or even completely arid lands engaged with tourism, fishery, and agriculture (Bouchaou, *et. al*. 2017). Some studies addressed the issues of climate change impact on crop production only for some specific countries. That's why we have clarified the probable theoretical relationship between environmental pollution/climate changes and ever increasing agro based international trade in the next section of this paper. Under the aegis of Kyoto Protocol (UN, 2012) for calamities stemmed from the global climate change, there is no acknowledgement of the ramification of agriculture sector. Since there is no confession of addressing the hazards originated from agro sector, it has no clear cut vision or road map to overcome this hurdle on this protocol. However, later researchers have successfully defined the issue that agriculture sector is one of the major contributor in environmental degradation and, thus, global climate changes. There are many upward and backward linked industries built up in the present global economic order which are amplifying and even intensifying pollutions that are primarily based on agro production, those are related to domestic business and international trade of AFF sector (Olanipekun, *et.al*. 2019). One of the major causes of such negative externality arises from agro sector is its massive consumption of fossil fuel which intensifies Green House Gases (GHGs) emissions (Dethier and Effenberger, 2012). Presently agro sector in Australia directly and indirectly causing about 15 percent of GHG emissions. GHGs emissions by various sectors in the year 2020 is shown above Table 1. Clearly agricultural sector is the lowest emitter in Australian economy. However, this sector is damaged by the climate changes in the most level. Australia is the world's 14^{th} highest emitter (Gupta, 2009, and Tsakiris, *et. al*. 2017). In 2020 the country has emitted 499 million tons of CO_2 (Hansen, 2022). Energy sector is the highest contributor in emission followed by transport, industry and agriculture (Table 1). In 2021, Australia is expected to emit totally 37.9 billion tons of carbon to the atmosphere. Experts believe that the extent to which the agriculture sector is polluting the environment, the sector is being affected more by the polluted environment and extreme climate events like decline of precipitation, droughts, storms, heavy rainfalls, and sea level rise (Treesa, *et. al.* 2017, and Peres, *et. al.* 2017). Thus, it can be foreseen that the ultimate consequences for Australian agriculture is horrible and terrifying since the true direction of the upshot is unknown. Meanwhile, average temperature of

Australia has been constantly increasing for more than last six decades. The following Figure 1 shows this grimed picture very clearly:

Figure 1: Australian 5-years Average Temperature in Celsius



Source: World Development Indicators (WDI), World Bank. Authors own compilation

Australia is one of the worst affected countries by the global climate changes. Over the period of 1960-2021, the annual average temperature of Australia has increased about 1.2 degree centigrade (Figure 1) which has affected country's agricultural sector in most scale. Therefore, due to the climate related calamity the country has repeatedly made headlines in the front pages and interfaces of the news outlets around the world. Naturally it causes multiple harms for different sectors of Australian economy including agriculture sector. Such negative consequences on agriculture are putting the sector more vulnerable in recent years. Even after such catastrophic impacts, the issue is still underexplored by the researchers and academicians. Therefore, we have attempted to conduct this indecisive and outstanding investigation. The impacts will be, of course, further and systematically examined by proper econometric methods. Meanwhile, we have failed to get any prior work in this issue particularly for Australia. Since the issue is empirically unsettled and uninvestigated, still its status remains in speculative stage. Adopting any policy just depending on conjecture can have destructive consequence. So, due to the lack of any conclusive research, a remarkable uncertainty exists specially for Australian agricultural exports. We hope this paper will fill up this prolonged and overdue research gap.

Climate change is caused by the human factors (Treesa, *et. al*. 2017, Krommyda, 2017, and Balogh and Mizik, 2021). Several multilateral agreements (from Kyoto to Paris) have come into force to curb the carbon emissions. However, acceding to the current scenarios, carbon concentration should be doubled by 2030 and, thus, global temperature would be increased by 1.5-4.0 degree centigrade due to those man made factors (IPCC, 2019).

Researchers around the world are engaged in a constant effort to identify those man-made factors so that finding out of fruitful ways for the abatement of carbon emission becomes possible. A good number of researches have contemplated to identify the key emitting regions of the world (UN Environment program, 2020, Liddle 2017, Balogh & Mizik, 2021). Further, a substantial amount researches are now involved in exploring the impact of trade liberalization and trading agreements (PTA, BTA, FTA etc.) on environmental condition (Griffin, et. al. 2019, Solomon & Khan 2020, Hyel, et. al. 2021). Likewise, under the existing WTO rules (WTO, 2020), how member nations adopted trade related measures are enhancing environmental degradation and promoting the free trade agreements are causing high consequence on environment are explored by few studies too (Meyer, 2017, and Hyel, *et. al.* 2021). A vast amount studies have focused on the issue how climate change is decreasing the agricultural output level of various countries and regions (Huong *et. al.* 2019, Tanure *et. al.* 2020, Karimi *et. al*. 2018, Burke and Emerick 2016, Huynh *et. al.* 2020, Liu, *et. al.* 2020, Hossain & Qian 2018, and Ali *et. al.* 2020). Besides, a good number researches have explored the impact of exports on climate change (Jiang *et. al.* 2015, Friel, *et. al*. 2020, Weber, *et. al*. 2008, Barrows and Ollivier, 2021, Jayanthakumaran, *et. al.* 2012, Yunfeng & Laike, 2010, Ssekibaala, *et. al.* 2021, Can, *et. al*. 2020, Dent, 2022, Haq, *et. al.* 2022, and Mania, 2020). On the contrary, a very limited number of researches have concentrated to address the influences of climate change on international trade (Drabo, 2017, and Khan *et. al*. 2019). We were successful to get only these two of articles in this issue. So, the reverse causation (i.e. climate change effect on agro export level) as well as impact is utterly ignored by the researchers across the world. Therefore, this study aims to fill up this existing research lacuna by paying attention and exploring consequence of the climate change on agricultural exports taking Australia as a case of experiment. This study concentrated on the research question of how climate change affect the AFF exports and whether empirically it significantly decreases the agro exports of a country. More specifically, this article applies a systematic econometric investigation to explore the updated empirical conditions on the role of climate change on agro exports of a country over the period.

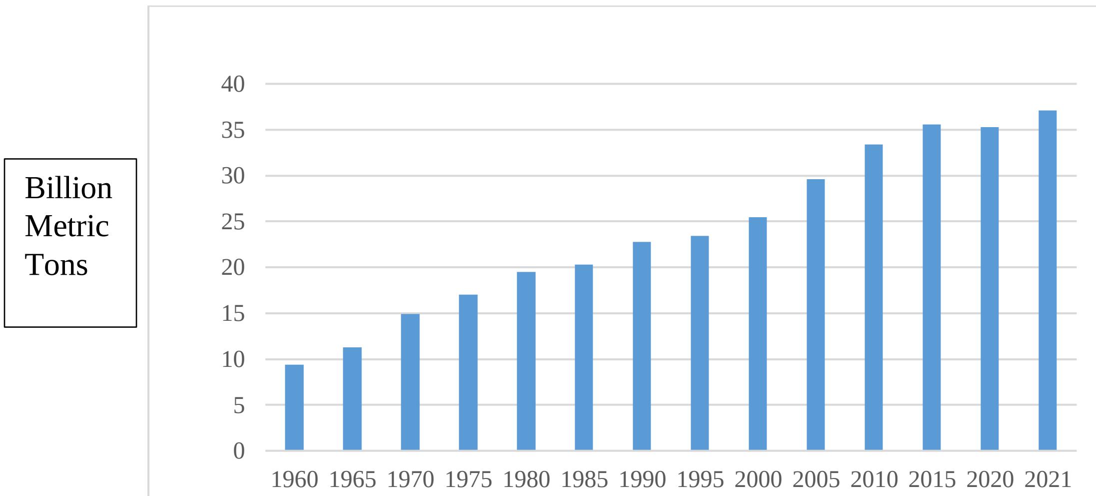
The contribution of the research to the existing literature is enormous. *First* of all, this paper is going to give a clear and updated empirical analysis of the impact of the climate change on AFF exports that will help to recognize how the present environmental policy is affecting Australia to pursue a sustainable AFF export growth which is also one of the prime concern of many developing countries in the present world those are adopting the export leading growth strategy. *Secondly*, it will successfully identify the climate change related factors those have direct ramification on AFF exports of a country. Thus, findings will assist in taking corrective measures in the future in increasing environmental standard and agro based trades. *Thirdly*, it will provide policy recommendations on how to tackle the present weaknesses of AFF trade policy those fail to protect the environmental sustainability. *Fourthly,* while there is a continuing need to strengthen the climate change knowledge base (through research), improved understanding of climate change science is needed for adaptation policy development and to drive adaptive actions. Developing suitable methodologies for assessment of climate change impact, vulnerability, and planning are pre-requisites for cost-effective adaptation (Iglesias and Garrote, 2017). This paper will play an important role in this affair as well. *Finally,* the existing dynamics between the climate changing factors and the present world common export expansion policy will define the future research direction and policy setting. Though the result of this research is only Australia based, the findings will have a wide range of implication around the world. By taking Australia as a country of case study, this research will help to gauge how climate change is being deteriorated by the agricultural trade around the world.

The rest of the paper is structured as follows: section 02 will try to identify agro sector responsibility for pollution, section 03 conceptualizes the relationships between environmental degradation or climate change and agro exports, Section 04 reviews the existing literatures or past papers which are highly related to our present topic. Section 05 describes the data issues in details, subsequently, section 6 and 7 will focus on methodology and discussion of results respectively. The penultimate section 8 concludes with policy implications.

7.3. AGRICULTURE AS A POLLUTER

Agriculture sector itself is also responsible for environmental pollution. Agro based industrial plants has dislocated human and animal habitats and destroyed their energy inputs by electricity and fossil fuels (Subhadra, 2010). In some cases, agriculture related industrial plants are less energy efficient than the traditional projects they have removed. Thus, there is no ambiguity that agriculture sector itself is also a big polluter.

Figure 2: Global Cumulative CO_2 emission in every 5 years



Source: World Development Indicators (WDI), World Bank (2023). Authors' own compilation

There are voluminous literatures those have explored the interrelationships between the key factors related to environment, energy, and income. Energy consumption and production is necessary for improving living standard as well as poverty reduction. However, the use of energy and increase economic activities have a serious negative externality which is degradation of environment and as an ultimate consequence climate change. Energy consumption is the single largest cause of GHG emission (Rahman, 2020, and Shrybman, 2020). Thus, energy consumption, economic activities, and environmental pollution are three variables which have high association. Energy use intensity by the agriculture is not less than other sectors of the economy. Increase of agricultural production in mass scale, nursing in the gestation period, harvesting, processing, packaging, transportation in longer distance, inventory preservations, massive marketing activities, distribution in larger scale, and repeated and greater recycling, etc. are highly involved in energy use (Kinsey, 2012). Besides, facets of agribusiness based corporate jobs are also energy intensive. Not only these, international agriculture trade policy is also partly responsible for the pollution by this sector. Relaxed trade and foreign direct investment (FDI) rules for this sector both in developing and developed world have intensified export leading agriculture sector and pollution in many countries (Mahmood, *et. al.* 2020). Unfortunately, this pollution backfires the agro sector itself.

7.4. THEORETICAL DISCOURSE REGARDING CLIMATE CHANGE IMPACT ON TRADE

The present climate changing trend and ever increasing trade across the globe have numerous socioeconomic implications. To this end, Brenton and Chemutai (2021) have pointed out in their famous book[4], "Trade exacerbate the emissions that cause global warming and is itself affected by the climate change through changing comparative advantages." They have further added, "production, movement and consumption of goods - within and across borders - is an undeniable practice of modern society. Each stage of process entails a fresh contribution to greenhouse gas emissions. In this way, trade undeniably exacerbates climate change. It is equally true that trade is disrupted by climate change. Extreme weather events often devastate transport and logistic infrastructure. These events erode capital stocks, debilitate export capacity, damage agriculture, and disrupt production security - all with adverse consequences for the long-run supply chain and trading activities." Clearly this theoretical statement proposes bi-directional correspondence between trade and climate change. Our investigation of the existing empirical research says that causation from trade to climate change is already widely explored by the researchers. However, the reverse causation climate change to trade is not investigated much. Clearly, this later nexus is suffering from the empirical evidence and updated investigations. We believe this research will help to bridge this gigantic and overdue empirical knowledge gap. Climate change is a serious problem faced by the current world. To curb this problem, scholars are trying to explore and understand the nature of linkage between climate change and its driving factors so that effective policies are generated to minimize the impact. The paper will help to understand and implement the scope of trade related measures should be incorporated in the future policies of sustainable trade and environment.

7.5. NEXUS BETWEEN AGRICULTURAL TRADE AND CLIMATE CHANGE:

Worldwide climate change has incurred public concern and thus provokes researchers to identify possible factors causing environmental pollution. In this course of scientific probe, researchers reach in a consensus that climate change originated by global explosion of carbon emission is an anthropogenic phenomenon and is primarily as a consequence of ever increasing human economic activities worldwide, and trade is one of the most important determinants amongst them (Dent, 2022). Since the contribution of trade in the gross domestic products (GDP) is increasing day by day almost in all nations of the world, climate change trend is also getting higher speed due to this ever increasing global trade (Darbo, 2017). Sector based share of agriculture on the global trade is also gaining high importance over time. However, reverse causation that climate change creates hindrance to the agricultural trade can also be equally important for a country (Khan *et. al*. 2019).

Australian agriculture is highly export oriented. Over the period 2001 - 2022, export of Australian total agricultural output varies from 65 percent to 72 percent. (DFAT, Australia, 2023). Linkage and reliance of agriculture sector on international market can be explained and perceived just by the following Table 2:

Table 2: Share of agricultural production exported by sector, three year average, 2018 to 2020

Items	Sugar	Beef & Veal	Mutton & Lamb	Canola	Wheat	Rice	Dairy Products	Fruits & Nuts

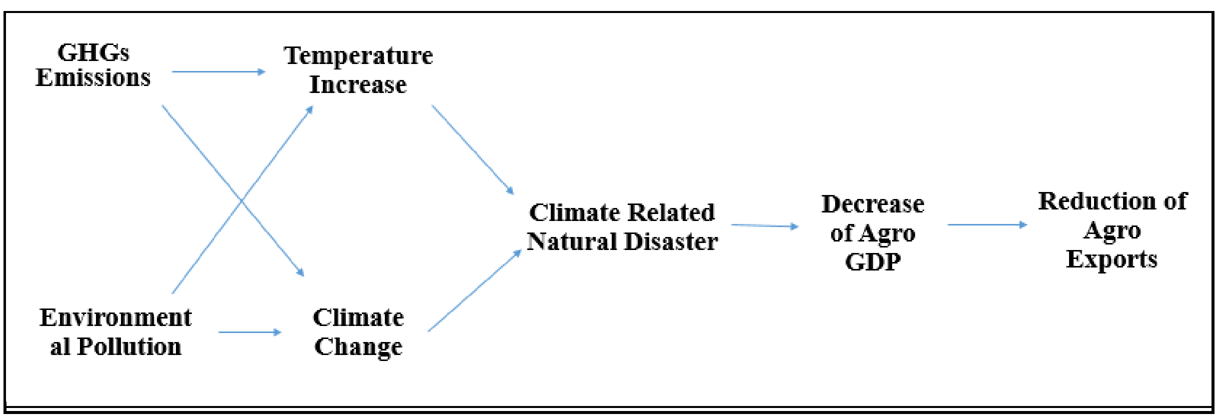
[4] The Trade and Climate Change Nexus: The Urgency and Opportunities for Developing Countries – by Paul Brenton and Vicki Chemutai. Published by Word Bank Group, 2021.

Share of Production exported	84 %	78 %	78 %	65 %	67 %	92 %	39 %	33%

Source: Authors own compilation based on the data of DFAT, Australia

As Table 2 shows that Australian agriculture is getting increasingly interconnected with overseas markets. Export orientation of the agro products are varied by commodity types and in some cases products are produced mostly for export purposes only. It is seen in the above Table 2 that nearly more than three-fourth of Australian sugar, beef, mutton, and lamb are marketed through exports only. Similarly, 92 percent of Australian rice is produced only for overseas consumers. Further, meat and live animals are the fastest growing exporting items which are growing 33 percent in value terms over the period 2018 - 2020, followed by horticulture up to 31 percent and oilseeds up to 13 percent (DFAT, Australia, 2023). Since the Australian agricultural sector is overwhelmingly lopsided to export purposes or foreign market demands, if agro production is fallen due to production hindrances like climate changes or lack of overseas demands, country's economy as well as trade balance would fall in trouble. Thus, Australian agriculture is more relied on international market demand than other growing economies like China, India, Brazil, etc. This is the reason of more jeopardy for Australia.

Increased international linkage of agriculture can either be blessings or curse for the sector. It is a boon for the sector as it has a larger market than the domestic market size. But at the same time, globalization of the sector is making it more vulnerable and dependent on various international affairs like war, political disagreement among nations, trade and economic sanctions, uncertainty of exchange rates, reform of agro trade policies by foreign governments, natural calamity, risk of environmental calamity, etc. Thus, this internationalization is likely to make the sector more susceptible due to the global environmental quality degradation. Therefore, Koneswaran and Nierenberg, (2008) has pointed out that potential impact of environmental pollution as well as global climate change is higher in case of agriculture sector than others. The claim can be explained in here by the following sketch:



Carbon emissions and environmental degradation are incurring climate change and global temperature increases. Consequently, across the world, climate related natural calamity is increasing day by day. In the climate related issues, as the production activities are land intensive and outspreaded throughout the country, Australian agricultural sector is more affected than any other sectors (Harle, at. al. 2007). Thus, production of agro sector is more vulnerable than other sector like industry, service, and manufacturing. Ultimately, impact of this production disruptions falls upon employment and exports dependent on the agricultural sector. So, by the above chain flow it is clear that increased environmental pollution caused, either by high consumption of fossil fuel or by something else, or for the purpose of improving living standard, gradually accumulates GHGs in the atmosphere in alarming level which in return hinders the production activities and export earnings performance of AFF sector itself.

Now, as above, agricultural exports have almost one to one negative relation with environmental pollution and climate change (Roger, *et. al.* 2005). It also true that combined effects of national and supranational agricultural activities and laws related to agro trade and FDI have fueled GHG emissions considerably. However, as it is seen in Table 1, pollution is mostly done by the other sectors. Nevertheless, agriculture sector is giving the price of this unexpected GHG emissions and there is no hope for any radical turn of this carbon emission growth trajectory in near future which actually ensures uncertainty and inconceivable consequences for the agriculture sector and human employment that depend on it.

Already it is clear by the above sketch that how climate change creates reverse impact against economic activities of agricultural sector which reduces its potential income level. Further, there are several subsectors of agricultural activities such as crop production, fishing, livestock, poultry, forestry etc. The negative impact incurred by climate change may harm the different subsectors within agriculture in different degrees which depends on production process of the item (Molua, 2016). It would be not imaginary if Australian agricultural export sector is hurt by the climate change more than other countries. An obvious question can be: “how?” Lack of agro products supply will cause fall of export earnings for obvious reasons. However, in case of Australia, this falling would be higher than other economies. Crops like rice, sugar, meat, etc. which have higher dependence on foreign market (as in Table 2) might be affected most as their production process is more land intensive than others like, poultry and fishing products. Thus, impact of climate change may have higher degree reactions and sensitivity in case of the corps mentioned in earlier than the items mentioned later due to the land intensity variation involved in the production process. Therefore, this uneven dependence and reduction of export income may cause relatively higher negative impact on the Australian agricultural exports earning as higher export oriented products’ output would decrease in higher magnitudes. Consequently, this may lead to a higher reduction on exports earnings for Australia than it would be for other countries because of climate change effect. The above analysis postulates how Australian agricultural export is more imperiled and one of the worst sufferer of global climate changes than that of other countries. Our econometric operation in the subsequent section of the paper will try to explore the production loss empirically.

7.6 LITERATURE REVIEW

Intension of the study is to explore the consequence of climate change on the Australian agricultural exports. After delving the related research articles (Dellink, *et. al.* 2017, Porfirio, *et. al.* 2018, Doanh, *et. al.* 2020, Yu, *et. al.* 2020, Dall’Ebra, et. al. 2021) our understanding says that relationships among agricultural output, trade, and environmental consequences explored by the scholars is very low, and agricultural production as a sole source of environmental pollution is under researched, and the role played by agriculture export on environment is highly denied.

Nevertheless, a few articles have tried to explore the relationship between agricultural trade and environmental pollution (Drabo, 2017, Dallmann 2019, Khan *et. al*. 2019, Yu, *et. al.* 2020, Doanh, *et. al.* 2020). However, consequence of environmental pollution on agricultural export is very few in the literature. Total progress on this issue will be clarified by looking at the remaining part of this section.

The existing global research repository of this issue has given us various research arguments and recommendations in the topic. Economists are apprehending that international trade might foster environmental pollution and pollution relocations (Lang and Ho, 2007). Trade acceleration and liberalization may facilitate this process further. In this way, expansion of agricultural trade might have environmental pollution and associated GHG emissions and climate change (Balogh, and Jámbor, 2020). In return, climate change due to widespread environmental pollution is threatening the sustainability of traditional agriculture system and products variability (Hochman et al, 2017). One of the recognized way to mitigate climate change impact is increasing the energy use efficiency by agro trade (Fisher et.al. 2014). Further, agro trade can also affect the environment positively in other ways. Relocation of agro production in relatively low energy required regions of the world or relocation in relatively efficient energy using regions can be environmentally benefitting. In that case, trade leads to relatively more efficient environment management and production process through promoting more efficient energy usage by accessing to the updated technology. Clearly, trade can either promote environmental sustainability or worsen the environmental pollution. In this regard, a few articles have addressed the influences of climate change on international trade (Dellink, *et. al.* 2017, Dallmann 2019, Brenton and Chemutai 2021, Dall'Ebra, et. al. 2021, and Gouel and Laborde 2021, Crowley and Murphy, 2023). Specifically, impact of global climate change on agricultural trade is rarer in the literature. Porfirio, *et. al.* (2018) have reached in the conclusion that climate change will make the agro based trade more centralized and more countries will be the net-importer of such goods owing to climate change. Similarly, Quraich, *et. al.* (2021) have given decision that if the present trend of climate change goes on by 2050 global welfare gains by agro trade will be increased for some countries and decreased for others. However, agro trade gains will not be large enough to offset the loss from climate change. Likewise, Doanh, *et. al*. (2020) have said that the quality of ecosystem vitality eroded by the climate change have the most substantial effects on the ASEAN's exports of food and live animals, and ecosystem vitality has the most potent effect on the ASEAN's agricultural exports to high-income countries. Conversely, Yu, *et. al.* (2020) have offered a bit promising results and pointed out that climatic changes in Kazakhstan, measured by precipitation and temperature, may increase the export of wheat and rice and the import of maize, and decrease the import of wheat. Increasing precipitation by 1 millimeter for climate change will significantly enhance export of wheat by 0.7% and reduce the import by 1.7%. Similarly, increasing temperature by 1°C during the cropping season will significantly increase export of wheat by 21.9% and reduce the import by 49.4%. This might be due to the geographical position of the country in the global map. In this regard, besides of small number of papers in the topic, we have failed to find out any research article focusing on the environmental impact by Australian agricultural exports - a country that has diversified agro items to exports in the global market. So, our research contributes to fill up this prolonged research gap to some extent. The research has importance for other countries as trade by agriculture sector is gradually increasing almost by all countries in the world. Agro trade is a pervasive issue as majority countries in the world are net importer of the food gains and other agro products.

In the literature, there are four conflicting or confusing research results regarding trade and environment nexus:

(1) Agricultural trade negatively affects the environment
(2) Agricultural trade has no significant impact on the environment
(3) Agricultural trade positively affects the environment, and
(4) Impact of agricultural trade on the environment is confusing.

(1) Agricultural trade negatively affects the environment

Saunders *et al.* (2006) have examined bilateral agricultural trade between New Zealand and European Union and concluded that agro trade increases GHG emissions in New Zealand but reduces in the Euro area. However, in contrast, Chang *et al.* (2016) .investigated the linkage between environmental condition and agricultural trade and got that a great magnitude of environmental degradation has been occurred through agricultural trades in Vietnam, India, Indonesia, Malaysia, Thailand, and Brazil. Others like Jorgenson and Kuykendall, (2008) and Jorgenson, (2007) export based crop production leads environmental damage through increased use of pesticides, inorganic fertilizers, deforestations etc. Similarly, Atici (2009) has explained his result that the trade liberalization and greater globalization led Australia and New Zealand to increase their gross agro exports significantly because of the higher comparative advantages. He has added that they do this by increasing the use of inputs such as fertilizers, which cause environmental pollution.

(2) Agricultural trade has no significant impact on the environment

Only a handful studies argued that trade has no significant impact on environmental conditions. Ervin (1993) tries to explore the impact of agro trade on environmental quality. She has reached to a conclusion that high liberalized agro trade has no significant impact on environment for NAFTA region. Bourgeon and Ollivier (2012) have studied the influence of agro trade on environmental pollution level and have reached to the conclusion that gradual liberalization of trade has promoted free trade around the world and consequent shoot up of trades either increased or decreased emissions depending on the country's comparative advantage gaps with the autarky state of the country. Likewise, some more studies like Galt (2008) and Jansen (1996) have provided their evidence on disagreement with the negative environmental effects of agricultural commodity exports.

(3) Agricultural trade positively affects the environment

Carter (1993) has given a conclusion that trade shifts food production activities from developed countries to relatively lower developed area of the world and decreases environmental pollution caused by the agro trade and in this way, promotion of free trade in agricultural sector may have beneficial impact for the environment. Likewise, Leitao (2011) have discovered that intra industry free trade in agriculture sectors is a boon for environment because it decreases carbon emissions significantly in the USA. In another attempt, Jebli and Youssef (2017) examined the relationship between international trade and carbon emissions. They have decided that agricultural trade in Tunisia had substantially decreased GHG emissions through vast adoption of renewable energy due to the trading partners pressure which ultimately benefited the Tunisian as well as global environmental conditions. Moreover, Jansen (1996) have concluded that all form of exporting crop productions have environmental good effect than the any type of industrial production.

(4) Agricultural trade impact on the environment is confusing

Buckingham (1998) has inspected the historical relationships between environmental protection measures and agro sector trade (among US, Euro area, Canada and Mexico) under the guidance of WTO agreement. He has reached to a decision that agro trade and carbon emissions which was deleterious to environment but it has increased the opportunity among countries to improve the environmental conditions through dialogue which ultimately gave a net positive impact on environmental conditions by hindering further deterioration which may could not have achieved without free trade. Similarly, Thrupp, *et. al.* (1995) explain that the environmental effect of agro-based trade depends on technology use, choice of implemented policies, and consumer requirements and preferences - implying a non-specific nexus and interrelationship contradictions in the ecological effect of export oriented cropping.

In next, Damodaran (2002) has emphasized for integrated efforts among all national, regional, and global efforts on environmental points so that trade related rules, regulation, conventions, and laws are formulated and implemented for the greater interest of global sustainable environment and agriculture especially in developing countries. If it is controlled by a uniform global rule, free trade would not incur any harmful impact on environmental conditions. He also underlines that if it is done from a global center like United Nations (UN) type organization, it will be applied and monitored in a harmonized way across the world. Otherwise, negative consequence of environment cannot be prevented only by trade reduction as it is not economically viable.

In addition, some studies have predicted the consequence of global trade by using various simulation methods pretending that global climate change will be continued in the same way up to a future specific time like 2050 or 2070 etc. (Dellink, *et. al.* 2017, Porfirio, *et. al.* 2018, Ouraich, *et. al.* 2019, and Dall'Erba *et al*. 2021). Prediction of these studies also show that very grim pictures of global trade are waiting due to the uncurbed dynamics of climate change. Table 8 in appendix is giving a glimpse of the profile of the existing studies in this topic presently we have. In this table, available research findings and suggestions in the topic are tabulated just in the range of one sight.

7.6.1 Identifications of literature Gaps

Clearly almost all papers explore the impact of trade on environment but a few of them have targeted to explore the reverse impact like impact of environmental degradation on agricultural export and not even on other sectors related international trade. Majority of the papers discussed above and arrayed in Table 8 in Appendix have ignored or failed to point out the converse impact by environmental condition on trade which is the focus of our present paper. Trade and environment relationship can be bidirectional (Omri, *et. al.* 2015). Impact analysis based on aggregate trade can be misleading. Impact of climate change on individual sectorial trade can be uneven. For, example impact of climate change on the trade by manufacturing sector can be lower than the impact on agriculture sector trade. So, for clear perception of impact research is needed to be done by sector based disaggregated data. Therefore, our present paper tries to detect the ramifications of environmental pollution on agricultural trade particularly by Australian AFF export data. Consequently, the central research question of this paper specifically, "What is the environmental catastrophe or climate change consequence on the Australian agricultural exports?"

Accordingly, keeping up with the purpose of this study, we have attempted to examine empirically the interrelationship between Australian AFF exports and energy consumption, AFF, GDP, population, and real exchange rate. To the best of our knowledge, in the case of Australia this issue is never investigated. Even the topic is under investigated in case of other countries and areas of the world. Thus, the research is going to fill up a major research gap. Further, it will reveal the historical inter-relationship between agricultural exports and the other variables mentioned in the model. So, this research will have high policy impact not only in the case of Australia but also other developed and developing countries across the world.

7.7. DATA

We have used all variables in the log difference from i.e. at first we have taken natural log of all variables to reduce volatility and then have calculated the first difference. The selected variables are CO_2 emissions is in Kilotons, annual average temperature in Celsius, AFF exports in million USD, real agricultural GDP in 100 million USD, real exchange rate with USD (global vehicle currency of trade) for per AUD, tariff earned by Australian government form agricultural exporters.

Table 3: Representations of the indicators in the used Model

Name of the variable	Representation of the variable	Precision and Unit of the variable
GAGEX	Agro Exports	Total Agricultural exports in million USD
GCO2	CO_2 Emissions	Total CO_2 emissions in kilotons
GENCONS	Energy Consumption	Total use of fossil oil in 1000 barrel
GRGDP	Real GDP	Total constant 2015 in 100 million US$
GPOP	Population	Total population in million

The yearly data of Australian agricultural real GDP and export tariff were collected from Australian DFAT office, and real exchange rate is taken from international financial statistics (IFS) of IMF websites. Data of CO2 emission is collected from World Development Indicators published by WB, and, finally annual average Australian temperature in Celsius is collected from Australian Government Bureau of Meteorology's website. Even though each variable is time series as the variables are in first difference (tantamount to growth) form we detected that all variables are stationary at level.

Table 4: Summary Statistics
Data 1990-2022

	AGEX	AGRGDP	REXR	TARIF	CO2	TEMP
Mean	0.637559	-0.005237	0.000854	0.633125	0.007670	-0.000380
Median	0.632657	0.000907	-0.002908	0.800000	0.006854	-0.000504
Maximum	4.277299	0.094688	0.057520	4.000000	0.114662	0.019072
Minimum	-0.060700	-0.191553	-0.044096	-3.800000	-0.061831	-0.024723
Std. Dev.	0.059060	0.067677	0.026932	1.726721	0.024456	0.009393
Skewness	1.945073	-0.825361	0.350485	0.710855	1.992337	-0.158190

Kurtosis	9.647714	3.523517	2.279549	3.430354	14.423240	3.189759
JB Stat.	79.100440	3.998600	1.347212	2.941952	195.157400	0.181473
Prob.	0.000000	0.135430	0.509867	0.229701	0.000000	0.913259
Sum	1.201900	-0.167573	0.027319	-20.26000	0.245453	-0.012145
Sum Sq. Dev.	0.108131	0.141987	0.022485	92.428490	0.018541	0.002735
Observations	33	33	33	33	33	33

Source: Authors own compilation collecting data from the said sources.

Results of the summary statistics show the nearness of the co-movement of the variables. Mean values of all variables are ranges from -0.000380 to 0.637559. Similarly range of the maximum and minimum values stands as 0.019072 to 4.277299. Further, standard deviations of all variables are hovering around 1 meaning that variation of all variables have no absurd ups and downs (or outliers). However, skewnesss, Kurtosis and JB statistics show that most of the variables are not individually normally distributed. Number of observations for each variable is 33 meaning that there are no missing data for any variable for the period of 1990 to 2022 and size of the sample is over 30 which is econometrically fairly large to reach in a decision about long-run.

Table 5.1: Correlation Coefficients between variables Correlation Coefficients

Variables	AGEX	AGRGDP	CO2	REXR	TARIFF	TEMP
AGEX	1					
AGRGDP	0.422528	1				
CO2	-0.651161	0.331876	1			
REXR	-0.095916	-0.102746	0.135947	1		
TARIFF	-0.035445	0.205889	0.068542	0.175541	1	
TEMP	-0.425105	0.395162	0.389732	0.125640	0.040499	1

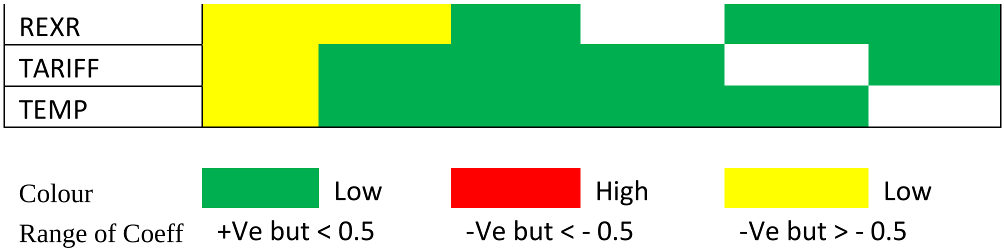
Source: Authors own compilation collecting data from the said sources

The below Table 5.2 is the Heatmap of correlation coefficients of all variables. The first column or the first row shows the relationships between agricultural exports and its explanatory variables. It is clear that correlation coefficient of agricultural export growth with CO_2 emissions and annual average temperature increase are negative. However, size of the values of the correlation coefficient with the growth of CO_2 emissions is less than - 0.5 but with temperature is greater than - 0.5. Other important variables which may have high impact on yearly agricultural GDP which is positive and close to + 0.5.

Table 5.2 : Heatmap of Bivariate Correlation Coefficient Matrix

Heatmap of correlation coefficients

Variables	AGEX	AGRGDP	CO2	REXR	TARIFF	TEMP
AGEX						
AGRGDP						
CO2						



Source: Authors own compilation collecting data from the said sources.

7.8. METHODOLOGY AND ECONOMETRIC ESTIMATION TECHNIQUES

Purpose of this research is to examine the impact of environmental pollution and climate change on agricultural exports using time series data of Australia. Since data is in time series form, we have to test the unit root test as it is mandatory to avoid spurious regressions. To this end, we transformed all data into first difference format after calculating the logarithmic values of each of them. We relied on ADF unit root test technique for every individual series. By searching different alternative options like intercept, intercept and trend, or none. We get all data is stationary at level. This is consistent with the usual trend of time series data which usually becomes stationary at level after first difference. Since every series stationarity is confirmed at level, we did not need to explore the stationarity status of the second difference or more. Results of the unit root test in level form is shown in the following Table 6:

Table 6: Results of the ADF Unit Root Test in the level form of the variable while lag 4 (SIC)

Variables	Intercept	Trend& Intercept	None
Agricultural Exports	-4.458791***	-4.467518***	-2.711560***
Agricultural Real GDP	-7.924207***	-7.744586***	-8.058245***
Australian Real Exchange Rate	-4.280217***	-4.225891**	-4.346912***
Total tariff from agricultural exporters	-3.975415***	-3.936521**	-6.114440***
Growth of CO_2 Emissions	-4.537144***	-5.169511***	-3.579481***
Australian Annual Average Temperature	-5.235615***	-5.000529***	-5.332856***

*** and ** mean significant in 99 and 95 percent confidence interval respectively

So, we can rely on OLS to run regression. If data permits researchers rely on OLS method, as it has several advantages than relying on other models: (1) if the classical assumptions of linear regression are met and data is free from outliers, OLS is more powerful than other regression techniques. (2) Estimated parameters of OLS are mathematically tractable, very easy to understand and interpret. (3) This model is highly suitable for small data set like ours present one. (4) Further, there are hardly any applications where OLS fails to make sense. Finally, (5) it correctly follows established estimation criteria like Gauss-Markov conditions and central limit theorem.

Although OLS is definitely an important and useful technique of estimation, it has number of defects and pitfalls, and is often considered not as the best method to apply in empirical investigation. Since the OLS methodology has many limitations and difficulties, it may under perform in number situations and in that case using this technique may give spurious result. For example, OLS cannot provide reliable regression estimation when there are problems like (1) Endogeneity (i.e. any explanatory variable of a regression model is correlated with error term), (2) Heteroscedasticity (it means the absence of homoscedasticity i.e. variance of the residuals is not constant as the value of explanatory variable changes), (3) omitted variable biasness (i.e. a model formulated leaving out one or more variables), etc. can be mentioned primarily. Moreover, OLS faces difficulties in case of (a) unnecessarily inclusion of explanatory variables that inflates the value of R-Square, (b) existence of high correlation between or among independent variables, (c) non-linear relationship between dependent and independent variables, (d) having outlier figures in the data of any variable, (e) having correlation of error terms over time (autocorrelation) that leads to biased standard errors, etc. In our present case, since agricultural exports and CO_2 emissions or annual average temperature relationship can be bidirectional, there is possibility of having a simultaneity problem that implies a potential source of Endogeneity problem that OLS cannot manage properly and thus it may yield biased estimates. However, we have conducted endogeneity tests for both of the models. We did not detect any endogeneity originated by the Australian Agricultural exports and temperature or CO2 emissions. Since empirically there is no endogeneity the tests results are not reported.

7.8.1. ESTIMATION

In this research our intension is very simple and clear that we want to infer the impact of climate change or environmental degradation on Australian agricultural commodity exports. Accordingly, null hypothesis is H_0 = environmental pollution or climate change has no impact on Australian AFF exports, and alternative hypothesis is H_A = environmental pollution or climate change has negative impact on Australian AFF exports. To reach in conclusion we have relied on the following econometric model for the yearly data of Australian economy:

$$AGEX_t = a_t + b_t\, AGRGDP_t + c_t\, REXR_t + d_t\, TARIFF + e_t\, GCO2_t + U_t \quad (1)$$

Where

$AGEX_t$ = Agricultural exports at year t.

$GRGDP_t$ = Agricultural real GDP at year t.

$REXR_t$ = Australian real exchange rate at year t.

$TARIFF_t$ = Tariff earned from the Australian agricultural exporters at year t.

$GCO2_t$ = CO_2 emissions at year t.

U_t = error term at year t.

The model is crafted based on the Bahmani-Oskooee and Kara (2003) export demand model. This sort of model is usually used by the researchers in international trade economics to find out the determinants of exports of a country. Our model is augmented version of this model just by an additional pair of variables i.e. annual average temperature or CO_2 emissions and tariff revenue earned from the Australian agro based exporters. Here, export tariff is highly pertinent as it has direct negative impact on any export and obviously CO_2 emission or temperature are just a proxy of the environmental degradation or climate change process. In this model, Australian agricultural exports are regressed by the agricultural Real GDP (ARGDP), Australian real exchange rate (REXR) with USD, total agricultural export tariff, and yearly CO_2 emissions or average temperature of Australia (TEMP). In the regression model, since all variables are stationary at level, we have relied on OLS regression to infer the functional form agricultural exports function for Australia. In this model, our target variable is Australian annual average temperature or CO_2 emission. Agricultural exports and real agricultural GDP are defined by DFAT, Australia. Except the agricultural real GDP, all other explanatory variables are expected to have negative sign since tariff rate, real exchange rate appreciation, and environmental pollution should have negative impact on agricultural export performance. A significant negative sign of CO_2 emissions or average temperature will confirm us the negative impact by the climate change or environmental degradation on Australian agricultural exports.

Table 7: Regression results

Dependent Variable: D(LOG(AGEXP))

Sample: 1990 2022	**Model 1**		**Model 2**	
Variable	**Coefficient**	**Significance Status**	**Coefficient**	**Significance Status**
C	0.996698	***	1.919797	***
D(LOG(AGRGDP))	0.126600	*	0.038654	**
D(LOG(REXR))	-0.164600	***	-0.398348	***
D(LOG(TARIFF))	-0.004332	***	-0.214797	***
D(LOG(CO2))	-0.501588	**	---	--
D(LOG(TEMP))	---	--	-0.340285	*
R-squared	0.943824		0.928012	
Adjusted R-squared	0.935182		0.915492	
Durbin-Watson stat	1.840085		1.949962	
F-statistic	109.2081	***	74.12436	***

***, ** and * mean significant in 99, 95 and 90 percent confidence intervals, respectively

In the above Table 7 shows that all explanatory variables have statistically significant impacts on Australian agricultural exports with theoretically expected signs including constant term. The negative sign of estimated coefficient CO_2 emissions (-0.501588) means that impact of environmental pollution on Australian agricultural exports is negative which means that if CO_2 emission increases Australian agricultural exports may decrease. Since the variables are in the first difference form after imposing logarithm we may think that the estimated relationships may represent the dynamic characteristics among them. Perhaps CO_2 emissions have long-run negative impact on Australian agriculture related exports since our data period is more than 30 years. According to the given default diagnostic tests by E-views 12 adjusted R^2 of the model is 0.94 meaning the about 94 percent of the variations of agricultural export is explained by the variations of the chosen independent variables. Further, DW statistic say that model is free from autocorrelation since it is very near to 2, and significant value of the F-statistic shows that model is not completely nonsense. In this way we can infer that climate change or environmental degradation has significant negative impact on Australian agricultural goods exports.

7.8.2 ALTERNATIVE SPECIFICATION

To test the robustness of our results we have resorted on an alternative specifications as well. In this case, we have used another variable annual average temperature of Australia in Celsius instead of CO_2 emissions since in the present world it is an established truth or fact that high pollution caused by human activities is increasing global temperature in alarming level. This data is compiled from the Australian weather office website. The newly fitted model is also dynamic in nature.

In the above Table 7 shows that all three explanatory variables (agricultural GDP, real exchange rate, tariff volume, and annual average temperature) have statistically significant impacts on Australian agricultural products exports with theoretically expected signs. The negative sign of changes of Australian annual average temperature on agricultural exports changes means that increase of annual average temperature decreases agricultural exports by Australia which means that climate changes have directly negative impacts on agricultural export performances. However, as per the magnitude of the coefficient (*i.e*., -0.340285 which means that elasticity is less than 1) the impact is very small. It also indicating that enforcement speed of negative impact of temperature increase in Australian agricultural export is very slow. It sounds logical since the economic effect of global climate change is considered and projected as long term impact and is not enforced just in one day.

7.9. DISCUSSION OF RESULTS

As it is seen in the above section, we have produced and rely on two different specification of functions to ascertain the impact of climate change complexities on Australian agricultural exports. To this end, we have detected negative impact by climate deteriorating indicators on Australian agricultural exports in two alternative specifications. Additional variables like Australian real GDP has positive and real exchange rate appreciation and agricultural export tariff level have negative impact on agro based exports. All signs accord with the theoretical expectation and each coefficient is also statistically significant. Here, growth rate of Australian CO2 emissions or annual temperature increase is target variable and all other explanatory variables are considered as control variables used to complete the functional form so that regression function does not suffer from any omitted variable(s) problem or wrong functional specifications. Precisely, decision is that association between environment pollution or climate change and agricultural exports is negative, i.e. Australian agricultural exports is negatively affected by the climate change. All variables are in the first difference of logarithmic form which actually means that coefficients are found as change of elasticity. In short, both of the specified models confirm us that environmental degradation or climate change has a harmful impact on the Australian agricultural export performance. Since the relationship between AFF export performance and pollution is negative, this result supports the decisions revealed by researches of Santeramo, *et. al.* (2021), Doanh *et. al*. (2020), Dallmann (2019), Chang *et al*. (2016), and Saunders *et al*. (2006). Further, finding of the study also consistent with the prediction of environmental impact on future global trade scenario reckoned by Dellink, *et. al.* (2017), Porfirio, *et. al.* (2018), Ouraich, *et. al.* (20219, and Dall'Erba *et al*. (2021). However, it is contradictory to the findings by Carter (1993), Leitao (2011), Jebli and Youssef (2017), and Yu, *et. al*. (2020). Carter (1993) concentrates on developing countries agricultural exports, and their agricultural and environmental policies. Agricultural farming in developing countries, their development stage, and trade policies are different from Australia and his study is based on panel data estimation technique. Further, focus of the Leitao (2011) study is somewhat different from the intension of this paper where he considers only the intra-industry agro trade of the US with the rest of the world. Since this sorts of industries are less polluter, price and exchange rate elasticities are small, they may have no relation with the environmental factors. Further, data period is also quite small (1995-2008) and decision based on such small period data is highly questionable too. Similarly, Jebli and Youssef (2017) study is based on Tunisia which composition of trade and environmental factors is highly different from Australia, and export base is relatively weak. The country is located in a convenient place (middle of three continents: Africa, Middle East, and Europe) of the global map and, thus, market size is big with small and different agro export items. Further, they have used renewable energy as an explanatory variable and used VECM method for a relatively old data period (1980-2011) for reaching in the decision. Likewise, since Yu, *et. al.* (2020) analysis is based on Kazakhstan - a country located in the middle Asia where agriculture is naturally affected by low temperature and precipitation. Global warming may increase both of them in that country and, thus, it is an anomaly and global warming is considered as a boon for this country. So, differences of their research findings may be due to different research techniques, data source and periods, and other country-specific factors.

Similarly, by the findings of our investigations, it is very clear that Australian agricultural exports are significantly and negatively affected by the uncertainty arisen by the environmental pollution or climate changes. In total, about one - third of Australian export earnings are coming from agricultural (AFF) sector. Unlike the city state Singapore, the sector has high potential for the Australian economy as it is a land (an input intensively used in agricultural production) abundant country, and agricultural sector around the world are earning high international connectivity gradually. Agro based business are expanding throughout the world day by day and the sector has high potential both for developing and developed worlds. However, rapid climate change caused by the constant environmental pollution is creating vast uncertainty for the sector globally. To protect the interest of this sector along with other countries Australia should abate GHGs emissions and thereby curb global warming immediately. Otherwise, this important sector will face irreversible calamity soon. Such consequences will incur severe economic downturn in the Australian economy in the long-run.

As per our inspection on existing global research repository it is clear that the paucity of literature in this topic leaves the researchers, policy makers, and governments in the dark to understand the need to address the issue as soon as possible. Most of the study refers to the negative consequences of global climate changes and warming on agricultural outputs only. Literature fails to show enough eagerness to identify the impact on agricultural exports earnings. This may be partly due to agricultural export does not contribute much to the economy and thus export earning of this sector is not important for many countries in the world now. However, some countries in the world like the USA, Australia, New Zealand, Canada, Netherland, etc. has high potential in this sector. Particularly, Australian economy has high degree inclination on agricultural exports earnings. So, negative consequences come from the global climate change would hurt the economy of the country jeopardizing it export earnings base. Econometric investigation of this study suggests that Australia itself is discharging GHGs in enormous scale. However, in return this emission is causing potential danger for the country itself. Further, still most of the countries around the world are net importer of agricultural goods. Few studies have predicted that countries as net importers of food grains will further increase the food imports, and present global composition of comparative advantages of agricultural goods trade will be rearranged in the future if ongoing climate change process continues. So, this will lead to severe uncertainty of global food security, as well as the dynamics of the agricultural trade will be drastically changed.

7.10. CONCLUSION AND POLICY IMPLICATIONS

Global climate change due to ubiquitous environmental pollution is creating multiple socioeconomic problems around the world. To this end, we discover that how climate change affects agricultural exports is still a less investigated issue. So, in this research we have tried to disinter the impact global climate change on agricultural exports of Australia.

Using annual increase of temperature and CO2 emissions by Australia as indicators of climate change we have regressed agricultural commodity exports by three control variables Australian agricultural real GDP, Real exchange rate, and government total tariff from agricultural exports as control variables. We have also taken care of time series properties of the fitted model and data. Our finding reveals that global climate change negatively affects the Australian AFF exports. Additional findings of our investigation are that increase of agricultural GDP enhances, and agricultural export tariff and real exchange rate appreciation have negative consequences agricultural exports.

Now, almost one third of Australian export earning is generated by the agricultural exports of the country. However, global climate change caused by the environmental pollution is also directly affecting the agricultural export earnings. If the trend of climate change is continued, Australia may have serious consequences in future as it may fall in crises of macroeconomic imbalances. This study has importance in both theoretical and empirical ground for Australian as well as for the rest of the world. Besides, it has numerous policy implications for agricultural commodity exporting countries. If those countries want to ensure the sustainability of its agricultural export and output growth, they should contemplate to curb the GHGs emissions as early as possible. Otherwise, continuous and higher emissions may bring in fatal consequence for the global agriculture sector and human employment associated with the agriculture sector. Incidence of consequences may hinder the global food security too. Therefore, global community should emphasize for the abatement of carbon emissions in their all future economic planning as well as should bid persuasion and argument in the supranational forums and emission affair dialogues.

Global community should start for gradual withdraw of carbon emitting inefficient energy usage. Since high level emission is deteriorating the natural environment and agriculture sector and it can be mitigated only by efficient energy use, scientific innovations, and quick installation of renewable energy plants, investment and resources mobilization with this intension should be prioritized and strictly overseen by the related government agencies all countries and organization working across the global front. Agriculture sector itself should be attentive for further emission curbing technological innovation so that it can survive and promote growths in the potential hostile global scenario. In this way, sustainability of growth in the long-run can be ensured for the agriculture sector and its export earnings.

We have conducted this research by the aggregate data of Australian agriculture sector. However, all subsectors and each commodity based production process may not be equally affected by the global climate change. Some may be higher and others may be affected in very low scale. So, doing research relying on aggregate data does not beget any clear and detail picture of any issue. So, future researchers may think to investigate with disaggregated subsector or commodity base agricultural data so that which commodity trades are seriously affected can be recognized. Such clearer picture can be helpful in priority action selecting and future policy settings.

REFERENCES

Ali, U. Jing, W., Zhu, J. Zhibek. O., & Fahad, S. (2021). Climate change impacts on agriculture sector: A case study of Pakistan. Ciência Rural, Santa Maria, vol.51, Issue 8.

Atici, C., (2009). Pollution without subsidy? What is the environmental performance index overlooking? Ecological Economics. Vol. 68, PP. 1903–1907.

Bahmani-Oskooee and Kara (2003), Relative responsiveness of trade flows to a change in prices and exchange rate. International Review of Applied Economics, 17, 293-308.

Balogh, J.M. and Jámbor, A. (2020).The Environmental Impacts of Agricultural Trade: A Systematic Literature Review. Sustainability, 12, 1152.

Balogh, J. M. and Mizik, T. (2021) Trade–Climate Nexus: A Systematic Review of the Literature. *Economies* 2021, *9*(3), 99.

Bouchaou, L. Choukr-Allah, R. Hirich, A. Ennasr, M. S. Malki, M. Abahous, H. Bouaakaz, B. and Nghira, A. (2017). Climate change and water valuation in Souss-Massa region: Management and adaptive measures. *European Water,* 60: 203-209, 2017.

Ben-Salha, O. Dachraoui, H. and Sebri, M. (2021). Natural resource rents and economic growth in the top resource-abundant countries: A PMG estimation. Resources Policy Volume 74.

Brenton, P. and Chemutai, V. (2021). The trade and climate change nexus. The urgency and opportunities for the developing countries. A working paper by the staffs of the World Bank Group.

Bourgeon, J.M. and Ollivier, H. (2012). Is bioenergy trade good for the environment? European Economic Reviews. 56, 411–421.

Barrows, G. and Ollivier, H. (2021). Foreign demand, developing country exports, and CO2 emissions: Firm-level evidence from India. Journal of Development Economics, 2021, Vol. 149, issue C

Buckingham, D.E. (1998). Does the World Trade Organization care about ecosystem health? The case of trade in agricultural products. Ecosystem Health, 4, 92–108.

Burke, M. & Emerick, K. (2016) Adaptation to Climate Change: Evidence from US Agriculture. American Economic Journal: Economic Policy Vol. 8, Issue 3, PP. 106–140

Chang, J. Symes, W.S., Lim, F., Carrasco, L.R. (2016). International trade causes large net economic losses in tropical countries via the destruction of ecosystem services. Ambio, 45, 387–397.

Carter, C.A. (1993). Trade, agriculture, and the environment in developing countries: Discussion. American Journal of Agricultural. Economics 75, 801–802.

Chasek, P. S. and Downie, D. L. (2021). Global Environmental Politics. Book, Published by Routledge, Vanderbilt Avenue, New York. NY1007

Costinot, A., Donaldson, D., & Smith, C. (2016). Evolving comparative advantage and the impact of climate change in agricultural markets: Evidence from 1.7 million fields around the world. *Journal of Political Economy*, 124(1), PP. 205-248.

Crowley, G. M. and Murphy, S. A. (2023) Carbon-dioxide-driven increase in foliage projective cover is not the same as increased woody plant density: lessons from an Australian tropical savanna. The Journal of Rangeland. The Commonwealth Scientific and Industrial Research Organisation (CSIRO). Vol. 45(2), PP. 81–95.

Dallmann, I. (2019). Weather variations and international trade. Environmental and Resource Economics, 72(1), PP. 155-206.

Dall'Erba, S., Chen, Z., and Nava, N. J. (2021). U.S. Interstate Trade Will Mitigate the Negative Impact of Climate Change on Crop Profit. American Journal of Agricultural Economics. Volume103, Issue 5, PP 1720 – 1741

Damodaran, A. (2002). Conflict of trade-facilitating environmental regulations with biodiversity concerns: The case of coffee-farming units in India. World Development. 30, 1123–1135.

Dellink R, Hwang H, and Lanzi E, (2017). International trade consequences of climate change.

Doanh, N. K. and Quynh, N. N. and Heo, Y. (2020). Impacts of ecosystem vitality on ASEAN's agricultural exports: A System Generalized Method of Moments approach. International Area Studies Review 2020, Vol. 23(4) 335 – 351.

Dent, C. M. (2022).Neoliberal Environmentalism, Climate Interventionism and the Trade-Climate Nexus. Sustainability Vol. 14, 15804.

Dethier & Effenberger (2012). Agriculture and development: A brief review of the literature. Economic Systems, Volume 36, Issue 2, June 2012, Pages 175-205

DFAT, Australia (2023). Department of Foreign Affairs and Trade. Australia. https://www.dfat.gov.au/trade/organisations/wto/Pages/agricultural-trade

Ervin, D.E. (1993). Trade agreements, agriculture, and the environment in developing countries: Discussion. American Journal of Agricultural Economics. Vol. (75), PP 799 – 800

Fischer T, Byerlee D, Edmeades G (2014). Crop yields and global food security. ACIAR, Canberra, Australia.

Friel, S. Schram, A. and Townsend. B. (2020). The nexus between international trade, food systems, malnutrition and climate change. Nature Food 1: 51–58.

Gouel, C., & Laborde, D. (2021). The crucial role of domestic and international market-mediated adaptation to climate change. Journal of Environmental Economics and Management, 106, 102408.

Griffin, Conor, Diana Hindle Fisher, Ailia Haider, Kamala Dawar, Adam Green, and Gareth Owen. 2019. Climate Change and Trade Agreements Friends or Foes? London: The Economist Intelligence Unit Limited, Available online:

Gupta, D. (2009). Australia's Climate Change Bill – Past and Future. The Climate Club.

Galt, R.E., (2008). Pesticides in export and domestic agriculture: reconsidering market orientation and pesticide use in Costa Rica. Geoforum. Vol. (39). Issue 3. PP.1378 – 1392.

Hansen, L.M. (2022). Australia well positioned to become a CCUS leader. The APPEA Journal 62 S25-S28.

Haq, M. A. Ahmed, A. Khan, I. Gyani, J. Mohamed, A. Attia, E. (2022). Analysis of environmental factors using AI and ML methods. Scientific Reports volume 12, Article number: 13267.

Harle, KJ., Howden, SM., Hunt, LP., Dunlop M. (2009). The potential impact of climate change on the Australian wool industry by 2030. Agricultural Systems. Volume 93, Issues 1–3, Pages 61-89.

Hochman Z, Gobbett D. L, and, Horan H (2017). Climate trends account for stalled wheat yields in Australia since 1990. Global Change Biology, 23 (5): 2071 – 2081.

Hossain & Qian (2018). Climate change and crop farming in Bangladesh: an analysis of economic impacts. International Journal of Climate Change Strategies and Management Vol. 11 No. 3. PP. 424-440.

Huong, N. T. L., Bo, Y. S., & Fahad, S. (2019). Economic impact of climate change on agriculture using Ricardian approach: A case of northwest Vietnam. Journal of the Saudi Society of Agricultural Sciences. Vol. 18, PP. 449 – 457.

Huynh, H. T. L., Thi, L. N. & Hoang, N. D. (2020). Assessing the impact of climate change on agriculture in Quang Nam Province, Viet Nam using modeling approach. International Journal of Climate Change Strategies and Management, Vol. 12, No. 5, PP. 757-771

Heyl, K. Ekardt, F. Roos, P. Stubenrauch, J. and Garske. B. (2021). Free Trade, Environment, Agriculture, and Plurilateral Treaties: The Ambivalent Example of Mercosur, CETA, and the EU–Vietnam Free Trade Agreement. Sustainability 13:31-53.

Iglesias, A and L. Garrote, L. (2017). On the barriers to adapt to less water under climate change in Mediterranean countries. *European Water* 60: 1-8, 2017.

Jansen, K., (1996). Ecological dilemmas of coffee exports and local food production in northwest Honduras. European Review of Latin American and Caribbean Studies. Vol. 60. PP. 7 - 30.

Jayanthakumaran, K. Verma, R. Liu, Y. (2012). CO2 emissions, energy consumption, trade and income: A comparative analysis of China and India. Energy Policy, Vol. 42, PP. 450-460

Jebli, B.M. and Youssef, B.S. (2017). Renewable energy consumption and agriculture: Evidence for co-integration and Granger causality for Tunisian economy. International Journal of Sustainable Development and World Ecology. 24, 149 - 158.

Jorgenson, A.K., (2007). Foreign direct investment and pesticide use intensity in less-developed countries: a quantitative investigation. Social and National Resources. Vol. 20. Issue 1, PP 73 - 83.

Jorgenson, A.K., and Kuykendall, K.A., (2008). Globalization, foreign investment dependence and agriculture production: pesticide and fertilizer use in less-developed countries, 1990 - 2000. Social Forces. Vol. (87). Issue 1. PP. 529 - 560.

Karimi, V., Karami, E., & Keshavarz, M. (2018). Climate change and agriculture: Impacts and adaptive responses in Iran. Journal of Integrative Agriculture, Vol. 17, Issue 1, PP. 1-15

Kashem, MA, Rahman, MM, and Khanam, R. (2022). Improving Australia's trade balance: A case study of agro-forest and fish products. Volume 63, Issue 3, 494-533.

Keenan, R.J. (2015). Climate change impacts and adaptation in forest management: a review. Annals of Forest Science. 72. PP 145-167

Khan, M. K. Teng, J. Z. Khan, M. I. Khan, M. O. (2019). Impact of globalization, economic factors and energy consumption on CO2 emissions in Pakistan. Science of The Total Environment Volume 688, PP. 424-436.

Kinsey, J. (2012). Expectations and Realities of the Food System. Book Name: Natural Resource Management and Policy.

Koneswaran, G. and Nierenberg, N. (2008). Global Farm Animal Production and Global Warming: Impacting and Mitigating Climate Change. Environmental Health Perspective.

Krommyda, V. (2017). Climate change mitigation and adaptation plan for West Athens. *European Water* 59: 207-214, 2017.

Lang J. C. and Ho A. C. (2007). Trade, national competitiveness and the environment-part i: the empirical story. International Journal of Environmental Studies. Volume 53, Issue 3.

Liddle, B. (2017). Consumption-based accounting and the trade-carbon emissions nexus. Energy Economics 69: 71–78.

Liu, Y., Geng, X., Hao, Z., & Zheng, J. (2020) Changes in Climate Extremes in Central Asia under 1.5 and 2.0 Celsius Global Warming and their Impacts on Agricultural Productions. Atmosphere, MDPI. Vol. 11, PP. 76-100.

Leitao, N.C. (2011). Environmental change and agriculture: The role of international trade. African Journal of Agricultural Resources, 6, 4065 – 4068.

Mahmood, H. Tawfik, T. Alkhateeb, Y. and Furqan, M. (2020). Exports, imports, Foreign Direct Investment and CO_2 emissions in North Africa: Spatial analysis. Energy Reports. Volume 6, PP. 2403-2409.

Mania, E. (2020) Export Diversification and CO2 Emissions: An Augmented Environmental Kuznets Curve. Journal of International Development. Vol. 32, Issue 02 PP 168-185.

Meyer, T. (2017). Explaining energy disputes at the World Trade Organization. International Environmental Agreements: Politics, Law and Economics 17: 391–410.

Molua, E.L., (2016). The Economic Impact of Climate Change on Agriculture in Cameroon. World Bank Policy Research Working Paper No. 4364.

Omri, A., Daly, S., Rault, C. and Chaibi A., (2015). Financial development, environmental quality, trade and economic growth: What causes what in MENA countries. Energy Economics, Volume 48, PP 242-252.

Olanipekun, I.O., Olasehinde-Williams, G.O., Alao, R. O. (2019). Agriculture and environmental degradation in Africa: The role of income. Science of the Total Environment Volume 692, PP 60 – 67.

Ouraich, I. Dudu, H. Tyner, W. E. and Cakmak, E. H. (2019). Agriculture, trade, and climate change adaptation: a global CGE analysis for Morocco and Turkey. The Journal of North African Studies, 2019, Vol. 24, No. 6, 961–991.

Porfirio, L. L. Newth, D. Finnigan, J. J. and Cai, Y. (2018) Economic shifts in agricultural production and trade due to climate change. The Commonwealth Scientific and Industrial Research Organisation (CSIRO).

Peres, D.J. Caruso, D. J. and Cancelliere, A. M. F. (2017). Assessment of climate-change impacts on precipitation based on selected RCM projections. *European Water* 59: 9-15, 2017.

Rahman, MM, (2017). Do population density, economic growth, energy use, and exports adversely affect environmental quality in Asian populous countries? Renewable and Sustainable Energy Reviews, Volume 77, PP 506-514.

Rahman MM (2020). Exploring the effects of economic growth, population density and international trade on energy consumption and environmental quality in India. International Journal of Energy Sector Management. Volume 14, Issue 6.

Roger E. K., and Jeanne X. K. (2005). Climate Change, Vulnerability and Social Justice. Book, First Edition, Published by Routledge.

Roobavannan, M. Kandasamy, J. Pande, S. Vigneswaran, S. and Sivapalan, M. (2017). Finding a sustainable balance in the water food nexus - Socio-economic transformation in an agricultural catchment. *European Water* 58: 323-329, 2017.

Santeramo, F., G., Miljkovic, D., and Lamonaca, E. (2021). Agri-food trade and climate change. MPRA Paper No. 106754,

Saunders, C. Wreford, A. Cagatay, S. (2006). Trade liberalization and greenhouse gas emissions: The case of dairying in the European Union and New Zealand. Australian Journal Agriculture Resources Economics. 50, 538 - 555.

Solomon, A. A. Khan, M. Gulagi, A. Ram, M.. Breyer, C. (2020) Current energy policies and possible transition scenarios adopting renewable energy: A case study for Bangladesh. Renewable Energy Vol. 155, PP 899-920.

Shrybman S. (2020). Trade, Agriculture, and Climate Change: How Agricultural Trade Policies Fuel Climate Change. West Coast Environmental Law Association. Institute for Agriculture and Trade Policy, First Avenue South, Minneapolis, Minnesota 55404 USA

Subhadra, B.G. (2010). Sustainability of algal biofuel production using integrated renewable energy park (IREP) and algal Bio-refinery approach. Energy Policy. Volume 38, Issue 10, PP 5892 – 5901.

Ssekibaala, D. S. Ariffin, M. I. and Duasa, J. (2021) Transmission channels and indirect effects in the relationship between institutions and environmental degradation in Sub-Saharan Africa. International Journal of Green Economics, Vol. 15, No. 4.

Thrupp, L.A., Bergeron, G. & Waters, W.F., (1995). Bittersweet harvests for global supermarkets: challenges in Latin America's agricultural export boom. World Resources Institute, Washington, D.C., U.S.A.

Tanure, T. M. D. P., Miyajima, D. N., Magalhães, A. S., Domingues, E. P. & Carvalho, T. S. (2020).The Impacts of Climate Change on Agricultural Production, Land Use and Economy of the Legal Amazon Region Between2030 and 2049. EconomiA, Vol. 21, PP. 73 - 90.

Tsakiris, V. Tigkas, D. and Vangelis, H. (2017). Crop pattern modification for long term mitigation planning against persisting droughts. *European Water* 60: 307-311, 2017.

Treesa, A. Das, J. and Umamahesh, N.V. (2017) Assessment of impact of climate change on river-stream flows using VIC model. *European Water* 59: 61-68, 2017.

UN (2012). Report on Kyoto Protocol - Targets for the first commitment period. Climate Change Report, United Nations.

Weber, E. Li, B. Bo. L. (208) Plant Invasions in China: What Is to Be Expected in the Wake of Economic Development? Bio Science, Vol. 58, Issue 5, PP 437–444.

WTO Report (2020). Trade and Climate Change: Overview of trade policies adopted to address climate change.

Yunfeng, Y, and Yang Laike. (2010). China’s foreign trade and climate change: A case study of CO2 emissions. Energy Policy 38: 350–56.

Yu. X., Luo, H. Wang, H. and Feil, J. (2020). Climate change and agricultural trade in central Asia: evidence from Kazakhstan. Ecosystem Health and Sustainability 2020, Vol. 6, No. 1, 1766380.

Appendix:

Availability of data and materials

All data used in this research is compiled from the publicly available domains. Data sources are as follows:

Name of the Data	Source of the Data
Agro Exports	Department of Foreign Affairs & Trade (DFAT), Australia
CO_2 Emissions	WDI, World Bank Group (Country Australia)
Energy Consumption	WDI, World Bank Group (Country Australia)
Real GDP	WDI, World Bank Group (Country Australia)
Population	WDI, World Bank Group (Country Australia)
Australian Yearly Temperature	Australian Government Bureau of Meteorology
Sector-wise CO_2 emissions level	Australian National Science Agency

Appendix: Table 08: Recent researches on climate effects on trade and their findings

Serial No.	Authors & Years	Data & Region	Method	Research Question	Findings
1	Costinot *et al.* (2016)	Global analysis	DGE Model	Investigate the global income effect by climate catastrophe	Global GDP reduces by 0.26% with adjustment in trade and production patterns
2	Dellink, *et. al.* (2017)	OECD Countries	Dynamic computable general equilibrium (DGE) model	Assessing direct & indirect cost of trade due to climate change.	=> Climate change damages may affect international trade in the coming decades. =>Designing proper climate and trade policies can be helpful to avoid the worst climate damages at least cost.
3	Porfirio, *et. al.* (2018)	Global Analysis	Qualitative Analysis	Measuring structural changes in the global agricultural trade network by the GHGs emissions by Global Gridded Crop (GGC) Model and Earth System Model (ESM) to a global dynamic economic model.	=>Global trade patterns of agricultural commodities may be significantly different from today's reality due to climate change. =>The agricultural export will become more centralized under the high CO2 emissions scenario where a few regions will dominate the global market. =>More regions will turned into as importers of agri-goods. =>Mitigation of CO2 emissions has the benefit of creating a more stable global agricultural trade system that may be better able to reduce food insecurity.
4	Dallmann (2019)	134 countries	Ricardian type trade model	Measuring the trade effect of global climate change on bilateral trade.	=>Bilateral trade is reduced by 3.1% due to an additional degree of temperature (in Celsius) increase in exporting countries.
5	Ouraich, *et. al.* (20219)	Morocco and Turkey	GTAP model	To define the impact of climate change on global agricultural market by 2050	=>If both carbon emissions and liberalization of trade are increased, the global welfare gains by trade will be increased. However, the gains are not large enough to offset the loss from climate change impacts on global agricultural productivity. =>In Morocco, agricultural trade liberalization, would induce additional welfare losses but in Turkey, it would induce net welfare gains.
6	Doanh *et. al*. (2020)	ASEAN Countries	Sys - GMM Model	Impact of ecosystem vitality on agricultural exports	=>the quality of ecosystem vitality (EV) for climate change has the most substantial negative effect on the ASEAN's exports of food and live animals. =>EV has the most potent negative effect on the ASEAN's agricultural exports to high-income countries.

7	WTO (2020)	Global Analysis	Data and Trade Analysis	Looking at the trade policies adopted to address climate change	=>The data presented in this paper shows that climate change-related trade measures are increasingly being adopted by members which provides relevant and useful insights on the evolving interaction between trade and climate policies.
8	Yu, *et. al*. (2020)	Kazakhstan	Gravity Model.	Pay attention to the effect of climate change on cereal trade in Central Asia through the eyes of Kazakhstan.	=>Climatic changes in Kazakhstan, measured by precipitation and temperature, may increase the export of wheat and rice and the import of maize, and decrease the import of wheat. =>As a major crop in Kazakhstan, increasing precipitation by 1 millimeter during the major cropping season (May to August), will significantly enhance export of wheat by 0.7% and reduce the import by 1.7%; => increasing temperature by 1°C during the cropping season will significantly increase export of wheat by 21.9% and reduce the import by 49.4%.
9	Brenton, & Chemutai (2021)	Low and Middle Income Countries	Tabular and Graphical representation. Qualitative and theoretical Analysis	This report explores the ways in which trade and climate change intersect.	=>Trade exacerbates the GHGs emissions and cause global warming and is itself affected by climate change. =>Climate change will re-adjust the present global trade patterns through comparative advantages change and the policy responses.
10	Santeramo, Miljkovic & Lamonaca, (2021).	Global Analysis	Review of existing literatures	Measuring the economic impacts of climate changes on international trade of agriculture and food sectors.	=>The agro based food sector is one of the most affected sector by climate changes. =>These effects do not alter only the agri-food domestic markets but also propagate across countries.
11	Dall'Erba *et al*. (2021)	Among states of the USA	Gravity model	Examining the impact of severe droughts on interstate trade	Yearly 14.5 billion USD worth of trade is expected shrink due to change of climate at the present speed and for its adaptation measures
12	Gouel & Laborde (2021)	Global data based analysis	DGE Model	Assessing the impact of global welfare due to trade reduction by climate change	Production and trade adjustment reduce global welfare losses by 55% and 43%, respectively

CHAPTER 8

8.1. CONCLUSION AND POLICY IMPLICATIONS

This research involves a series of investigations regarding the impact of exchange rate, price level, environmental degradation, climate change, and trading agreements on Australian AFF products exports and trade balances. It was identified totally six research objectives as well as questions reported in chapter one. To this end, this chapter seeks to combine the key findings and policy implications of this research. The findings are assembled under the umbrella of each research question and subsequently all probable policy responses are also grouped accordingly, which are as follows:

8.1.1. *Marshall-Lerner condition and improving Australian AFF trade balance*

The relationship between exchange rate and trade balance is delved by the economists for many years. Empirical strategies of this investigation are highly diversified. Examining the validity of Marshall-Lerner Condition (MLC) is a famous method among them (Marquez, 1990). MLC confirms that if the sum of the import and export price elasticities is more than one, currency depreciation is expected to improve the TB in the long-run. The findings of this research reveals that this condition is valid for the most Australian AFF commodities with major five partners. So if Australian currency depreciates, its AFF trade balance with the major partners would be improved.

After demystifying the time series nature of the data we adopted the ARDL technique for the purpose of estimation. The results of our model show that the MLC notion works for the fitted data and after passing through depreciated RER, the AFF commodities trade balance will be improved. This occurs because of the increase and decrease of the profit margin of Australian AFF exporters and importers, respectively. Since the estimation technique and results are econometrically reliable, we believe any policy based on findings of this paper will be good for the Australian AFF trade balance in the long-run. Besides exchange rate, income also plays an important role in determining the Australian AFF trade balance with the major five AFF trade partners. As an advocate of free market economic management and perfectly floating exchange rate regime, Australia does not have any option to directly manipulate the real exchange rate. So, prudential application of monetary and fiscal policies are the ultimate policy options for intended direction of exchange. So, both Australian central bank and government must have joint and coherent efforts in this regard.

8.1.2. *Orcutt (1950) Hypothesis and Australian AFF Trade Balance*:

Economists have been searching various means to improve a country's trade balance as it is essential for a feasible trading relationship with the rest of the world. Without a positive trade balance, a country cannot foster continued and smooth trading activities. Exchange rates can be used to improve trade balance if Orcutt (1950) hypothesis is valid for a country's trade balance. Nevertheless, though more than 70 years have passed after his proposition, our investigation shows that Orcutt (1950) hypothesis is still an under investigated issue which may have vast policy implications especially when a country wants to use exchange rate as a policy tool for rapid growth of its externally linked sectors. The essence of this hypothesis is that flow of international trade among countries makes response relatively in faster speed to the change of the nominal exchange rate faster than a change in the relative price levels. The findings of this research show that this hypothesis is valid for most imports and exports of Australian AFF sectors with its biggest five partners. In short, the findings of this research means that if Australia wants to improve AFF trade balance instead of domestic price level control, nominal exchange rate manipulation would be a relatively better option. This can help to generate policies for the central bank of Australia in the front of monetary policy formulation and implementation areas. Thus, the results of this research have important policy implications not only for Australia but also for the other countries which have a relatively larger agriculture sector, and for countries with agricultural sectors that have high international linkage (such as USA, Australia. India etc.) than other sectors of the economy. So, this research finding has important policy implications regardless of the development status of the country. As the central bank of Australia is an independent body, if it wants to improve trade balance it may favorably manipulate the exchange rate by crafting a suitable monetary policy. Federal government can use its encouraging fiscal policy to expedite the country's foreign trade. Since AFF commodities are mostly non-durable in nature and Orcutt (1950) hypothesis is supported by greater segments of exports and imports for each of the five biggest AFF trade partners of Australia, it is an indication that this proposition might be encouragingly valid for the data of the countries which are not used in this study. If this is the case, the country should pursue AFF export encouraging nominal exchange rate policies in the future.

8.1.3. ***Environmental consequence of Australian AFF trade: an asymmetric analysis*.**

The link between carbon emissions and trade balance analysis has now entered into a new phase since the world is increasingly interconnected through trading activities and socioeconomic disturbance stemming from the global environmental issues (Ren, *et. al.* 2014). However, it is yet to be investigated in enough level by the researchers in the context of environmental ramifications on international trade flows and agricultural trade balance (ATB) in particular. Moreover, until now asymmetric analysis of this relationship has been totally ignored by prior researchers. By searching research articles in this subject matter, it can be seen that literature on this subject is absent. Thus, across the literature still there is a big research gap on this issue. Therefore, in this part of our research, we have attempted to fill this overdue research gap. With this intention, we have selected to explore the Australian environment and ATB relationship to explore as this country's agricultural sector is one of the highest export oriented sectors in the world with an intensively mechanized production technique. Since the existing literature does not provide any knowledge about asymmetric analysis of this linkage, ours is the first of this kind of research. Australia is a land abundant country and land is intensively used input in agriculture. The country has a high-level involvement in agro-based trading activities with the rest of the world (Weinzettel, 2019). Considering all these facts we believe Australia is one of the best countries to select for such a case study.

We have relied both on linear and non-linear ARDL models in estimation purpose. When the linear ARDL approach suggested by Pesaran *et al.* (2001) is used, we have found short-run support of the impact of ATB on the carbon emissions of Australia but there is no significant impact in the long-run. However, the linear ARDL model cannot deal with the symmetricity of the relationships between variables. Therefore, we resorted to Non-Linear ARDL model suggested by Shin *et. al*.'s (2014). This non-linear ARDL model reveals the asymmetry in both in short- and long-run relationships. Results by the later model imply that the response of Australian carbon emissions is not the same during the cases of improvement and deterioration of the ATB. Non-technically it means that if ATB improves, CO_2 emission increases but if ATB deteriorates CO_2 emission does not decrease. The findings also illustrate that ATB is harmful for the Australian environment both in short- and long-runs. Moreover, empirical findings of the research also support the conventional theoretical predictions of environmental economics. i.e., Australian income, ATB, and CO_2 emissions have the long-run equilibrium relationships for the sample period.

The policy implication of this study are that if the government wants to improve the Australian environmental quality by agricultural commodity import substitution, the policy may not bring immediate positive results for the Australian environment. Thus, the government should concentrate on extending environment friendly technologies for the agricultural production and trade related activities rather than the direct control of agricultural exports and imports of Australia.

8.1.4. *Trading agreements and trade diversion impact on Australian AFF Exports*

In this research we have used an augmented Gravity model (Rahman, 2009) to examine the impact of Australian trading agreements on its AFF exports. For this purpose, we relied on a panel data estimation technique with time specific random effect model. The type of model is selected by the Hausman (1978) test. The model shows that partner countries real GDP, population size, land lockedness, geographical distances, economic openness for the foreign trade, commonness of culture, and trading agreements have significant impact on Australian AFF exports. The model also confirms that along with openness both BTAs and MTAs have given significant impact on bilateral AFF exports. Moreover, graphical investigations show that growth in Australian AFF exports have taken place mostly after conducting trading agreements with its 19 partner countries.

These results have very important policy implications for future policy setting efforts of Australian AFF sector export promotion. Clearly, increased openness stems from tariff reduction and trading agreements have a significantly positive impact on Australian AFF export increase. Likewise, graphical investigations also confirm that trading agreements are the predominant driving force of the Australian AFF exports. Therefore, it is highly possible that bilateral and multilateral trading agreements are the main promoter of the Australian agro exports for the selected data period. So, it means that net export diversion originated by the trading agreements is the root cause of phenomenal growth of Australian AFF exports in the last two decades. Thus, Australian AFF exports now are mostly dependent on the demand of 19 countries only. In other words, the country has ignored the potential demand of the rest of the world. Although the present trend shows a gradual growth, the country may be heading towards a terrific reality. The present force of trade diversion can be disappeared over time as the AFF export market base is overwhelmingly dependent only on a few selected countries. Thus, it is claimed that such utter dependence on trading agreements can be problematic for the sustainability of the Australian AFF export growth in the future.

8.1.5. *Price and exchange rate sensitivity of Australian AFF exports to major destinations*.

In the section of Orcutt (1950) hypothesis we have examined the relative speed of impact on Australian AFF exports. However, this hypothesis cannot forecast the relative importance or degree of impact by price and exchange rate on exports. Therefore, in this section we have shifted our sight to investigating the measurement of impact by price and exchange rate on Australian

AFF exports resorting on their coefficient values (elasticities). Relying on proper exercises of econometric approaches, our findings reveal both agreements and disagreements with conventional theoretical wisdoms of International Economics. The research results confirm that the exporters (Australian) export price index, importers import price indices, and exporter real exchange rate are the main, and significant determinants of Australian AFF exports in its major five destinations. This result has a high coherence with the standard trade theories. However, income and output have no significant impact on the exports of these sectors of Australia which is a disagreement with the common trade theories.

The findings have very important policy implications. Since depreciation of bilateral real exchange rate promotes Australian AFF exports, it means that exchange rate depreciation has an expansionary impact on the AFF sector of Australia. Results also indicate that further openness may bring increased profit for the AFF sectors of Australia as prices are significant determinants. Likewise, as both export and import prices have significant impacts on AFF exports prudential price manipulation of AFF trading goods may incur favorable results in AFF export performances. It also indicates that if input subsidy and/or tax holiday etc. facilities are provided, to the AFF sectors directly or their backward and upward linked sectors, positive results by AFF exports can be expected.

Further, bilateral trade elasticities of the above three significant determinants are more than one (i.e., elastic), and they have an increasing tendency as time periods are increasing after a shock originated from them. So, the results postulate that elasticities of exchange rates and prices are large enough to work as growth factors of Australian AFF exports. Precisely, estimated elasticities indicate that along with price manipulation, real exchange rate depreciation may increase Australian AFF exports. The result of this research further indicates that prices are working as a relatively more important determinant than real exchange rate, i.e., prices are relatively powerful determinants of Australian AFF exports than real exchange rate.

8.1.6. *Impact of Climate Change on the Australian Agricultural Exports*.

Global climate change due to pervasive carbon emissions is creating numerous problems in the present world. On the economic front, this study discovers that climate change is affecting agricultural exports, although the issue fails to catch eyeballs of the researchers and environmental champions much. So, in this research, we focus on uncovering the empirical relationship between climate change and agro exports in the case of Australia. In this regard, we have resorted to a statistical and econometric investigation process. The result reveals that environmental pollution and climate change has significant negative impacts on the Australian agro exports. Additionally, findings show that fossil fuel based energy consumptions, Australian GDP, and population growth are also important abetting factors of environmental degradation or climate change in Australia.

Now, agriculture sector contributes almost one third of Australian export earnings. However, according to this study, climate change by massive GHG emission is damaging this crucial sector of the Australian economy. The findings of this study confirm that these emissions threaten the country's agricultural export earnings. This study has important policy implications for the Australian economy. If the country wants to ensure the sustainability of its agricultural growth and agricultural export earnings, it should contemplate curbing the GHG emissions as early as possible. Otherwise, severe consequences for the growth of the Australian agricultural sector will be seen. Therefore, the country should emphasize carbon emissions in its future economic planning as well as holding adequate discussions in international carbon emission affair dialogues. Australia also needs to improve energy use efficiency and renewable energy generation processes.

8.1.7. *Limitation of this research and future research direction*

This study used commodity level disaggregated data in the first two papers while investigating the validity of the ML condition and Orcutt (1950) hypothesis. However, subsequent issues such as the impact on AFF exports by environmental degradation, trading agreements, price and exchange rates, and global climate change have used aggregate data for empirical investigation. Using aggregate data in empirical purposes can produce misleading results. This claim may be explained as follows:

Firstly, some studies use aggregate data at the highest level of aggregation, that is, trade between one country and rest of the world. Such over aggregation could incur the aggregation bias. The problem is that different sectors or commodity may respond differently to changes in their prices and the exchange rate. Similarly, the trade of different goods of AFF sector can have different types of impact on environment pollution and climate change. Such diversified impacts are flatly ignored if aggregate trade data are used in the analysis. Indeed, arguments against using such an extremely aggregate data set in research is that some individual commodities may experience relatively large changes and at the same time others may not. Aggregation can suppress the details of observations that may appear clearly at the disaggregated levels and hence cause a loss of information too. *Secondly*, aggregate data using studies often give ambiguous or conflicting results or sometimes even no results. As a result, some have criticized the use of this type of data because it can end up obscuring significant results and causing incorrect policy decisions. For example, bilateral trade flow between a countries may show a positive response, while another might show a negative one. When combined, however, such responses might “cancel out” one another and ultimately lead to an insignificant effect. Thus, bilateral aggregate data may give finally a confusing result. *Thirdly*, similar to aggregate trade, aggregate exchange rate can also deliver an incorrect result due to aggregation bias. The aggregate effective exchange rate of a country is always calculated using weighted average methods. In this case, it can be seen that the effective exchange rate would not necessarily reflect the fact that a country’s currency could appreciate against one currency and at the same time depreciate against another currency. These opposite directional changes may not be reflected in the weighted average based calculated aggregate exchange rate. *Fourthly*, a country’s trade balance could improve with one trading partner and at the same time deteriorate with another. But using aggregate data a trend may be seen that the overall trade of that country is improving or worsening. The same limitations can be applicable and true for symmetry or asymmetry analysis and other environmental issues too.

Due to the probability of misleading and confusing research results, our suggestion is that to get more reliable research results, depending on the data availability future researches in the issues incorporated in this thesis should continue only with the product level disaggregated data and including all trade distorting factors in the model. For clear and proper research result, and reliable policy suggestions, segregation of the data should be done as much as possible.

8.2. REFERENCES

Ren, S. Yuan, B. Ma, X. & Chen. X. (2014). The impact of international trade on Chinas' industrial carbon emissions since its entry into WTO. Energy Policy. Vol. 69, PP 624-634.

Marquez, J. (1990). Bilateral trade elasticities. The Review of Economics and Statistics (1990)

Orcutt (1950). Measurement of price elasticities in international trade. The Review of Economics and Statistics, 1950 - JSTOR.

Pesaran, M. H., Y. Shin, & Smith, R. J. (2001) "Bounds Testing Approaches to the Analysis of Level Relationships," Journal of Applied Econometrics, 16, 289-326.

Shin, Y, Yu, B., & Greenwood-Nimmo, M. (2014) Modelling Asymmetric Co-integration and Dynamic Multipliers in a Nonlinear ARDL Framework. Festschrift in Honor of Peter Schmidt: Econometric Methods and Applications, eds. by R. Sickels and W. Horrace: Springer, 281-314.

Weinzettel, J. Vackaru, D. & Medkova, H. (2019) Potential net primary production footprint of agriculture: A global trade analysis. Journal of Industrial Ecology. Volume 23, Issue 5. PP 1133-1142.

Rahman, M. M. (2009). Australia's global trade potential: evidence from the gravity model analysis. Proceedings of the 2009 Oxford Business and Economics Conference (OBEC 2009). Oxford, United Kingdom. http://www.facultyforum.com/obec/

Hausman, J. A. & Rudd, P. A. (1987). Specifying and testing econometric models for rank-ordered data. Journal of Econometrics, Volume 34, Issues 1- 2, PP. 83 - 104.