

Business Intelligence Certificate in Analytics to Support Managerial
Decisions (**MCBI71**)



NEW ZEALAND INTERNATIONAL TRADE

Assessment 3: Factors Impact Two-way Trade and the Future Forecast



DECEMBER 17, 2023

KAGNA EM, 168839446

Table of Content

1.	Introduction	2
2.	Review of EDA.....	2
2.1	Review of Assessement1	2
2.2	Review of Assessment2	4
3.	Statistical Inference.....	6
3.1	Overview.....	6
3.2	Dataset.....	7
3.3	Statistical Analysis Roadmap and Hypothesis	7
4.	Results Evaluation and Insights.....	8
4.1	Pivotalbe and charts	8
4.2	Pearson Correlation and Regression Analysis.....	11
4.3	Time-Serie Analysis.....	12
5.	Conclusions	17
6.	References	19
7.	Appendix	20

1. Introduction

As a small open-economy, New Zealand tends to heavily rely on international trade; two-way trade has shared around 60% of Country's total economic activities (MFAT, 2023). The term two-way trade is used to describe international trade activities, including exports and imports goods and services from and to different countries around the globe (MFAT, 2023). At the first stage, assessment1 aimed at exploring some insight of the NZ trade data focusing on the overall performance of NZ two-way trade in the last five years (2018 to 2022). To do so, the study were conducted using NZ international trade data made available on the Stats NZ's website (Stats NZ, 2023). The dataset is detailed with value of imports and export of goods and services by month, year, and country.

Slightly different from assessment1, assessment 2 looked further into key factors that could possibly impact the value of NZ imports and exports (only goods category was taken this time). The assessment2 used a dataset that combined two datasets together: the existing Stats NZ from assessment1 and OECD's Consumer Price Indices database (OECD, 2023). Doing this was to get Quarterly Consumer Price Index (CPI) inserted into the dataset and to be used as a predictor variable. CPI is used to measure the change in prices of a sample basket of goods and services paid by households in a particular country within a period of time (e.g. quarterly or yearly) compared to a based period (CFI Team, 2023). If CPI value is 110, it means price of the market basket compared to the based period has increased by 10%.

$$CPI = \frac{\text{Cost of the Market Basket in Given Year}}{\text{Cost of the Market Basket in Base Year}} \times 100$$

Not quite different from assessment2, assessmen3 still focuses a key factor (i.e. CPI) that could possibly impact the value of NZ imports and exports; however, the dataset and the research questions are slightly different. CPI is still used as a predictor variable given the following reasons. First is there were limitation in the assessment2 when combining Stats NZ and OECD datasets together due to considerable lose in number of country. Second is that Annual CPI is calculated not by summing quarterly CPI. Different methodology might vary result and give room for further study. Having said that, assessment 3 uses the same dataset from the Stat NZ in combination with Annual CPI data from IMF Online Database (IMF, 2023) instead. This time the collation of the two datasets can incorporate greater number of countries compared to the dataset in the assessment2. This assessment 3 has three main objectives/questions:

- Overview of key countries in NZ exports and imports compared to their CPI
- *Does Annual CPI value of the partner countries impact NZ Exports and Imports?*
- What will the future projection be like for NZ two-way trade?

2. Review of EDA

This section reviews key insight learned from the two previous assessments.

2.1 Review of Assessement1

Assessment1's main objectives were to understand the overview of NZ international trade and key players (partner countries) in the sector. The study found that New Zealand's two-way trade has increased significantly during the last five year except 2020. Exports deceased by almost 10% while imports went down around 15% in that particular year; this could possibly be the impact of Covid-19 lockdown and border closure. In 2022, the trade were rapidly rose by almost 20% to \$182 billion, comprising of \$100 billion in import and \$82 billion in export as shown in figure 1 and 2. The term two-way trade includes both goods and services; however, almost 80% of the total trade value two-way trade is made up of goods as visualized in figure 3. Regardless those particular events, the key

players in this sector are the countries from Asia (mainly China) and Oceania (mainly Australia) as shown in figure4.

Figure 1. Annual Import and Export

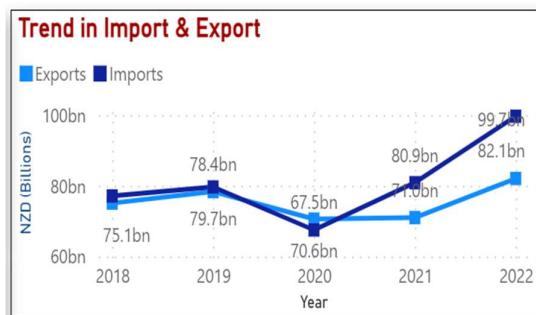


Figure 2. Change in Import and Export

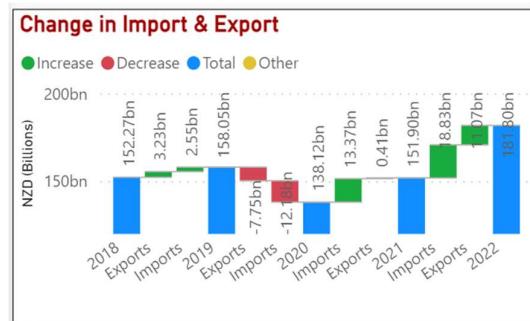


Figure 3. Total share of Goods and Services in Total Exports and Imports

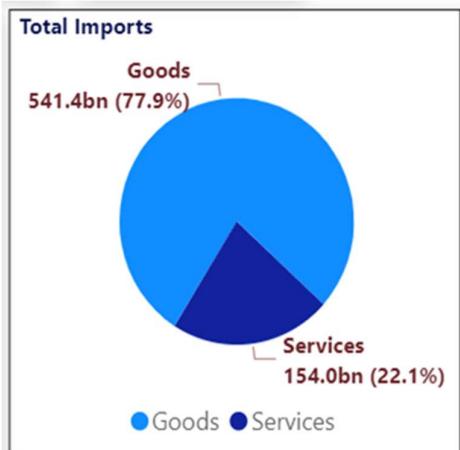
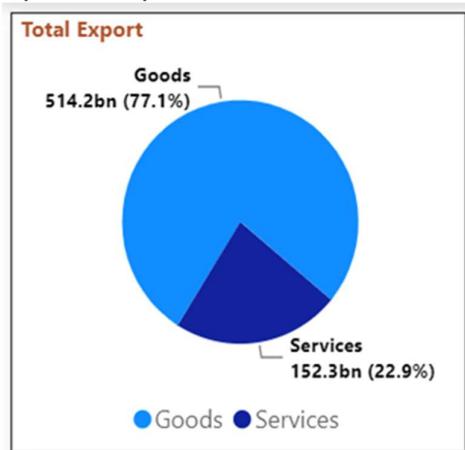


Figure 4. Top 10 Countries in Exports and Imports

Continent	Exports	Imports	Total
Asia	151.33bn	159.53bn	310.86bn
Oceania	64.70bn	64.28bn	128.98bn
North America	46.87bn	45.79bn	92.66bn
Europe	18.88bn	31.30bn	50.18bn
Total	281.78bn	300.89bn	582.67bn

Top 10 Import & Export Countries

	Exports	Imports	Countries
28.7bn	21.6bn	China, People's Republ...	
17.0bn	17.0bn	Australia	
11.9bn	12.6bn	United States of America	
4.8bn	5.7bn	Japan	
2.6bn	6.3bn	Singapore	
2.9bn	4.4bn	Korea, Republic of	
1.5bn	4.9bn	Germany	
2.8bn	3.5bn	United Kingdom	
1.5bn	3.7bn	Thailand	
1.6bn	2.7bn	Malaysia	

2.2 Review of Assessment2

Assessment2 studied factors that could possibly impact the value of NZ goods exports and imports. It is said that inflation is one of the key factors impacting level of imports or exports of a country. Given the reason that CPI has always been used by Economists to predict inflation, the study believed CPI could be a key predictor of NZ exports and imports. Assessment2 used quarterly data from assessment1 combined with quarterly data from OECD. Combining the datasets offered another predictor variable for inferential statistic analysis. In total, there are five predictor variables: Year, Quarter, Country, Region, and quarterly CPI. The assessment2 focused on answering three below questions:

- Q1. Does CPI value of the partner countries impact NZ Exports and Imports from those countries?*
- Q2. Is there a significant difference between Exports and Imports of different quarters?*
- Q3. Does region impact value of Exports and Imports?*

Figure 5. NZ Exports and Imports by Country

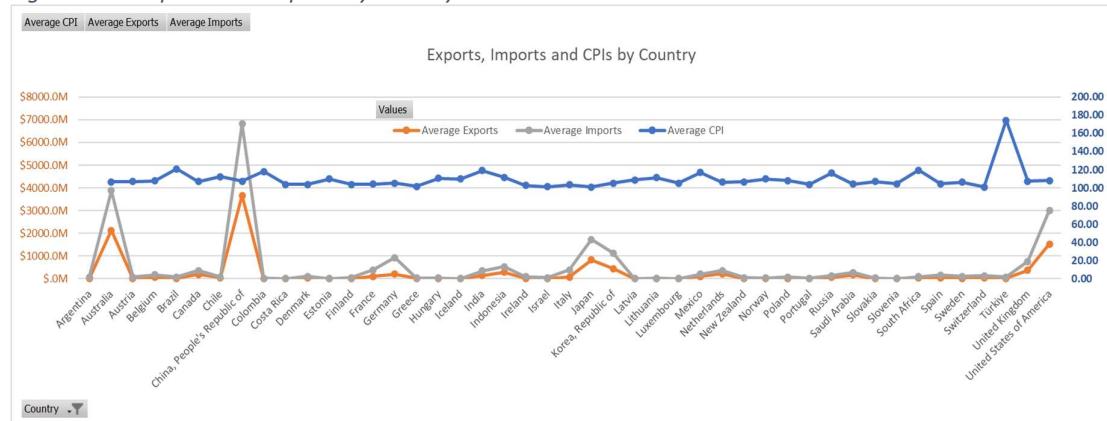


Figure 6. Pearson Correlation among Exports, Imports and CPI

	Exports	Imports	CPI
Exports	1		
Imports	0.961461	1	
CPI	-0.02998	-0.03462	1

As shown in figure 5, it seems that when CPI goes up, exports and imports fall down slightly; However, Pearson Correlation (figure6) and Regression Analysis (figure 7 and 8) found no significant negative correlation among these variables. That means quarterly CPI does not significantly impact the value of exports and imports.

Figure 7. Regression output of Exports and CPI

Regression Statistics	
Multiple R	0.005104304
R Square	2.60539E-05
Adjusted R Squar	-0.000679644
Standard Error	677559622.3
Observations	1419

Figure 8. Regression output of Imports and CPI

Regression Statistics	
Multiple R	0.000849228
R Square	7.21188E-07
Adjusted R Squar	-0.000704995
Standard Error	587747575.5
Observations	1419

Figure 9. Exports by Quarter



Figure 10. Imports by Quarter

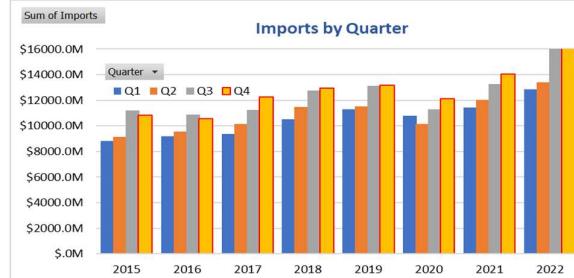


Figure 11. Exports, Imports and CPI by Region and Year

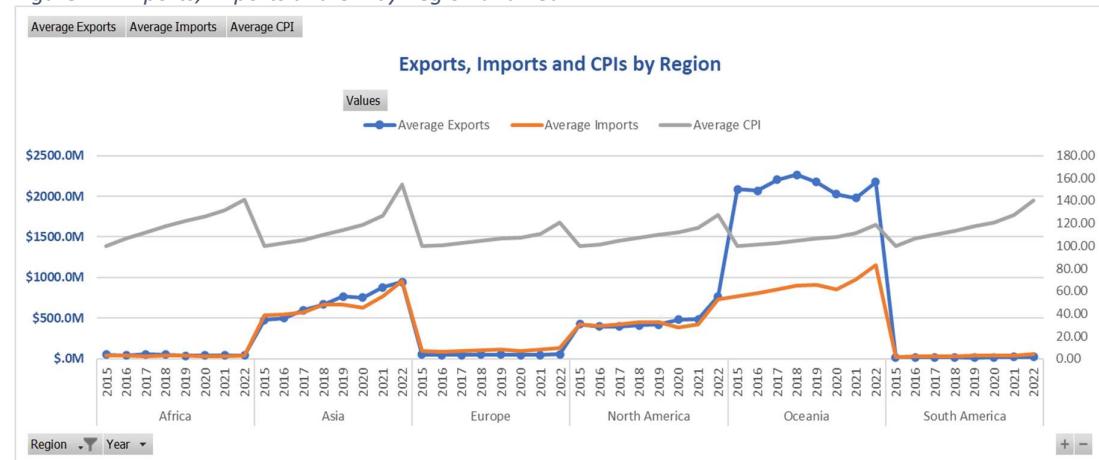


Figure 9 and 10 show the values of exports and imports by quarter while figure 11 presents the pattern of exports, imports, and CPI according to regions. For question 2 and 3, Quarter and Region were used as predictors respectively. However, only Region was confirmed as the key factor influencing the value of NZ exports and imports. To back up this claim, ANOVA Single-factor analysis were used. This was interpreted by comparing F and F Crit values from the ANOVA tables in figure 12, 13, 14, and 15 accordingly.

Figure 12. ANOVA SINGLE FACTOR FOR EXPORTS BY QUARTER

SUMMARY						
Groups	Count	Sum	Average	Variance		
Q1	356	82147.0M	230.75M	382848006.33B		
Q2	355	91454.39M	257.62M	482768458.47B		
Q3	354	79300.05M	224.01M	376221050.19B		
Q4	354	91134.79M	257.44M	596588796.53B		

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	330335005.94B	3	110111668.65B	0.239626126	0.868738	2.611191
Within Groups	650212952436.54B	1415	459514454.02B			
Total	650543287442.48B	1418				

Figure 13. ANOVA SINGLE FACTOR FOR IMPORTS BY QUARTER

SUMMARY							
Groups	Count	Sum	Average	Variance			
Q1	356	84285.16M	236.76M	267138949.82B			
Q2	355	87411.02M	246.23M	279393931.06B			
Q3	354	99900.17M	282.20M	397713139.08B			
Q4	354	102788.13M	290.36M	438036532.38B			

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	739640397.56B	3	246546799.19B	0.713773918	0.5437711	2.611191
Within Groups	488759412777.33B	1415	345413012.56B			
Total	489499053174.89B	1418				

Figure 14. ANOVA SINGLE FACTOR FOR EXPORTS BY REGION

SUMMARY OF EXPORTS BY REGION							
Groups	Count	Sum	Average	Variance			
Europe	829	41448.49M	50.0M	7512644.07B			
Asia	250	173276.50M	693.11M	1538595048.01B			
North America	124	57575.06M	464.31M	412220015.44B			
South America	120	2330.96M	19.42M	283789.80B			
Africa	32	1504.43M	47.01M	60709.30B			
Oceania	64	67900.79M	1060.95M	1155965036.93B			

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	137648138996.20B	5	27529627799.24B	75.84272185	1.579E-70	2.220432
Within Groups	512895148446.28B	1413	362983119.92B			
Total	650543287442.48B	1418				

Figure 15. ANOVA SINGLE FACTOR FOR IMPORTS BY REGION

SUMMARY							
Groups	Count	Sum	Average	Variance			
Africa	32	1163.41M	36.36M	45298.20B			
Asia	250	165948.32M	663.79M	1085787804.87B			
Europe	829	88705.87M	107.0M	26927683.59B			
North America	124	56432.26M	455.10M	394989765.46B			
Oceania	64	57793.02M	903.02M	781485283.32B			
South America	120	4341.60M	36.18M	694204.68B			

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	98940439144.06B	5	19788087828.81B	71.59122113	6.759E-67	2.220432
Within Groups	390558614030.50B	1413	276403831.59B			
Total	489499053174.56B	1418				

3. Statistical Inference

3.1 Overview

Assessment3 uses descriptive, inferential, and predictive statistics in data analysis. Descriptive statistics help summarize and identify trends and patterns of the data while inferential statistics helps draw conclusion over the population based on hypothesis testing (Pritha, 2020; SimpliLearn,

2023). Outcome prediction could be done properly with the help of predictive analysis (LinkedIn, 2023).

3.2 Dataset

As mentioned in the introduction, assessment 3's dataset was slightly different from assessment2's. The value of exports and imports are yearly aggregated while Annual CPI is the CPI taken from IMF database instead. The dataset of this assessment embraces greater number of countries compared to the assessment2; however, it still has some limitation. First, it only selects goods (exclude services) from the exports and imports. Second, not all countries from Stat NZ's dataset are included due to the collation process. Therefore, the result from this study could not represent the whole picture of NZ international trade. Figure 16 shows how the final dataset of this assessment3 look like, and figure 17 presents the list of variable of the dataset.

Figure 16. Assessment3 dataset

ID	Year	Country_Cod	Country	Continent	Annual Export	Annual Import	Annual CP
1	2015 AE	United Arab E	Asia		832.99M	425.57M	97.52
2	2015 AF	Afghanistan	Asia		.40M	.11M	101.30
3	2015 AG	Antigua and B	North America		2.60M	.02M	96.56
4	2015 AI	Anguilla	North America		.08M	.19M	106.13
5	2015 AL	Albania	Europe		.14M	.37M	92.44
6	2015 AM	Armenia	Asia		15.16M	.08M	124.23
7	2015 AO	Angola	Africa		31.80M	.0M	31.11
8	2015 AT	Austria	Europe		21.24M	190.62M	92.48
9	2015 AU	Australia	Oceania		8339.52M	5952.38M	107.68
10	2015 AW	Aruba	North America		.99M	.02M	93.73
11	2015 AZ	Azerbaijan	Asia		80.06M	.08M	117.73
12	2015 BA	Bosnia and He	Europe		.27M	1.76M	102.01
13	2015 BB	Barbados	North America		24.05M	.30M	77.53
14	2015 BD	Bangladesh	Asia		213.39M	87.81M	69.53
15	2015 BE	Belgium	Europe		240.92M	307.76M	100.90
16	2015 BF	Burkina Faso	Africa		.83M	.0M	101.65
17	2015 BG	Bulgaria	Europe		8.24M	41.73M	6550.41
18	2015 BH	Bahrain	Asia		78.09M	5.98M	92.97

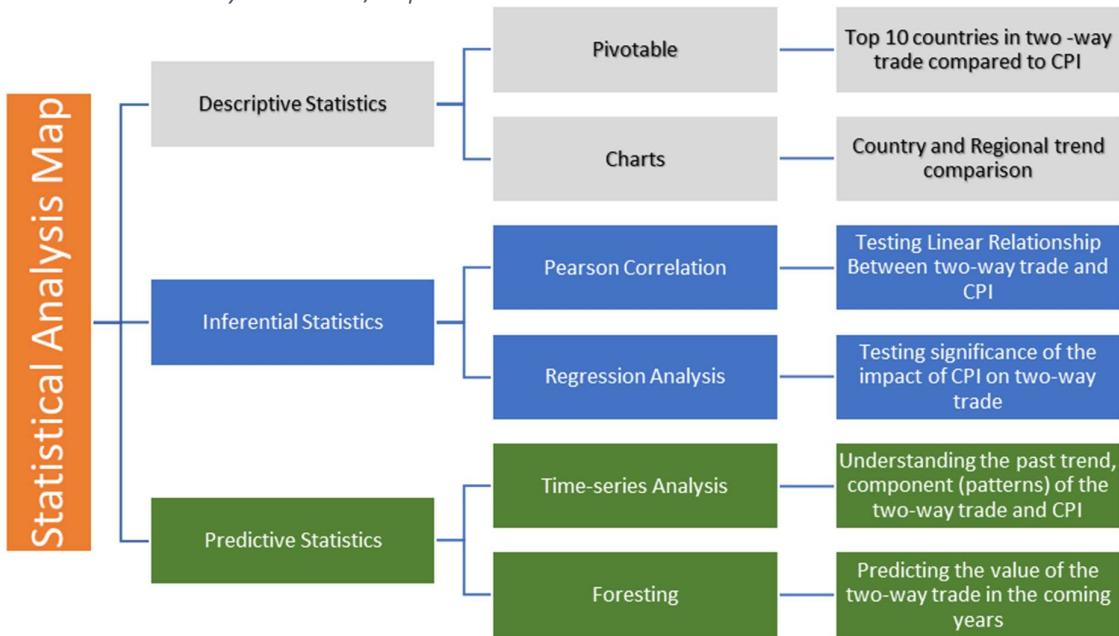
Figure 17. Assessment3's List of Variables

Variable Name	Description	Data Type
Country_Code	Country Code (NZ standard 2 digits)	Categorical, Norminal
Country	Country Name	Categorical, Norminal
Region	Name of the region each country locates in	Categorical, Norminal
Year	Year of trade	Categorical, Ordinal
Annual Imports	Yearly Import Value (NZD)	Continuous
Annual Exports	Yearly Export Value (NZD)	Continuous
Annual CPI	Yearly Consumer Price Index	Continuous

3.3 Statistical Analysis Roadmap and Hypothesis

The below map provides an overview of how the study will perform statistical analysis. There is no application of hypothesis testing for Question 1 and 3. For Question1, only crosstabulation and graphing are needed. For Question3, time-series analysis and forecasting are to be done.

Figure 18. Statistical Analysis Overview/Map



Two sets of Null hypotheses (H_0) and Alternative Hypotheses (H_a) are written to correspond to

Question2: Does Annual CPI value of the partner countries impact NZ Exports and Imports?

H_0 : There is no significant negative correlation between Annual Exports and Annual CPI

H_a : There is significant negative correlation between Annual Exports and Annual CPI

H_0 : There is no significant negative correlation between Annual Imports and Annual CPI

H_a : There is significant negative correlation between Annual Imports and Annual CPI

4. Results Evaluation and Insights

4.1 Pivotal and charts

Figure 19. Top 10 Countries by Total Value of Two-Way Trade (Goods only 2015 to 2022)

Top 10 Countries	Total Two-Way Trade	Total Exports	Total Imports	Average CPI
China, People's Republic of	\$218.18B	\$117.30B	\$100.88B	96.27
Australia	\$124.15B	\$67.90B	\$56.25B	114.89
United States of America	\$96.24B	\$48.64B	\$47.60B	117.59
Japan	\$58.20B	\$27.44B	\$30.76B	99.56
Korea, Republic of	\$36.15B	\$14.37B	\$21.79B	99.63
Germany	\$29.70B	\$6.41B	\$23.29B	99.80
Thailand	\$28.37B	\$7.83B	\$20.54B	99.82
Singapore	\$25.81B	\$9.91B	\$15.90B	100.77
United Kingdom	\$24.46B	\$12.0B	\$12.46B	107.41
Malaysia	\$22.61B	\$8.30B	\$14.30B	120.02

Figure 20. Yearly Comparison between Regional Two-way Trade and CPI

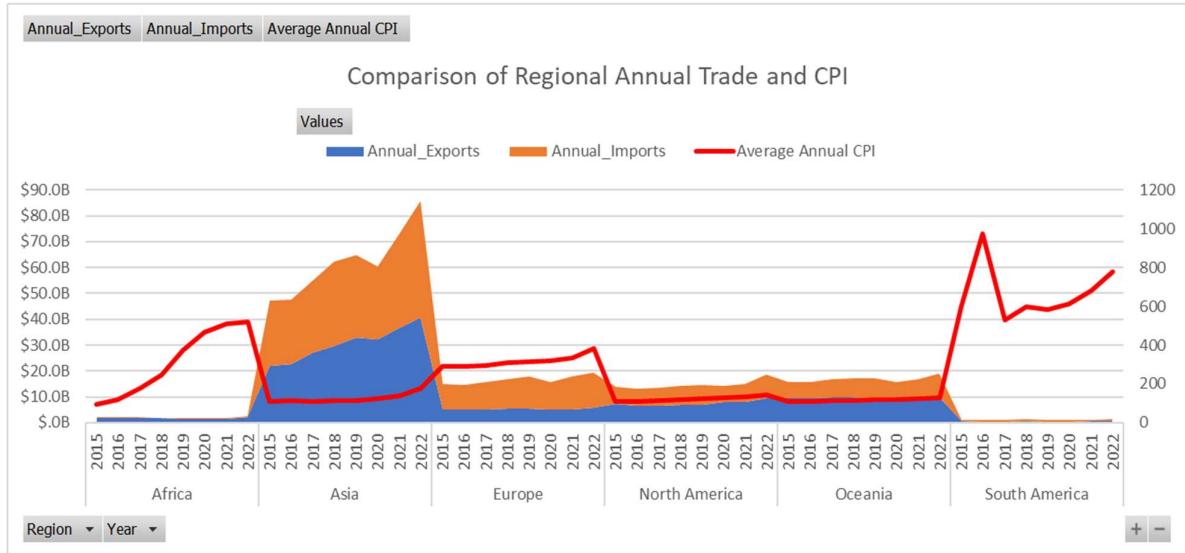


Figure 21. 5 Years Comparison between Top 10 Countries' Two-way Trade and CPI

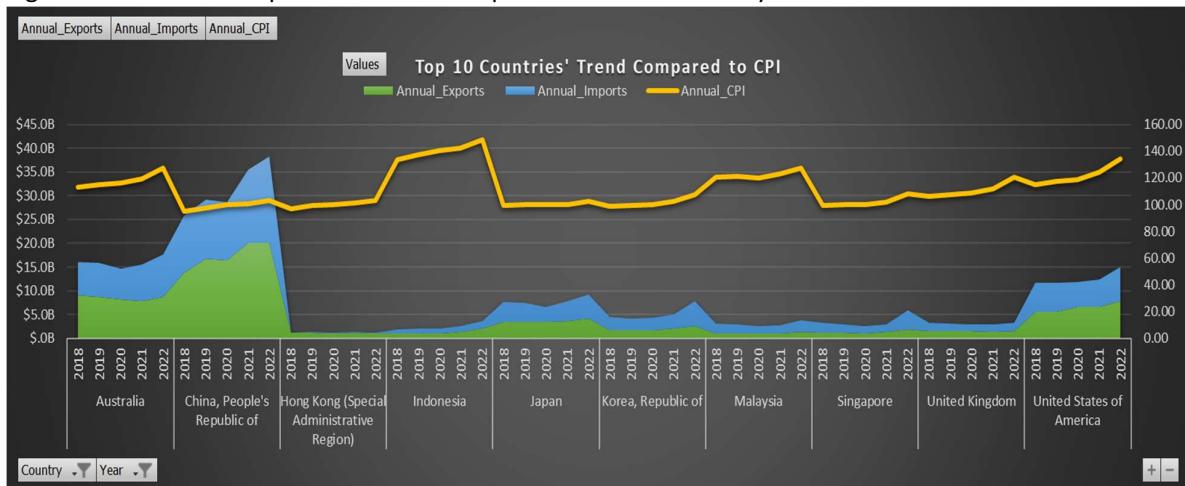


Figure 22. Yearly Comparison between Top 5 Countries' Two-way Trade and CPI

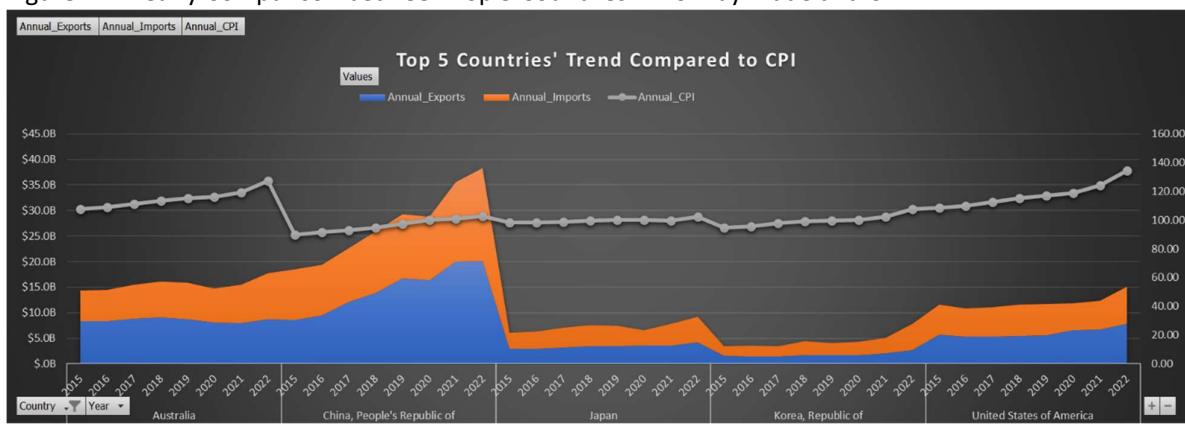
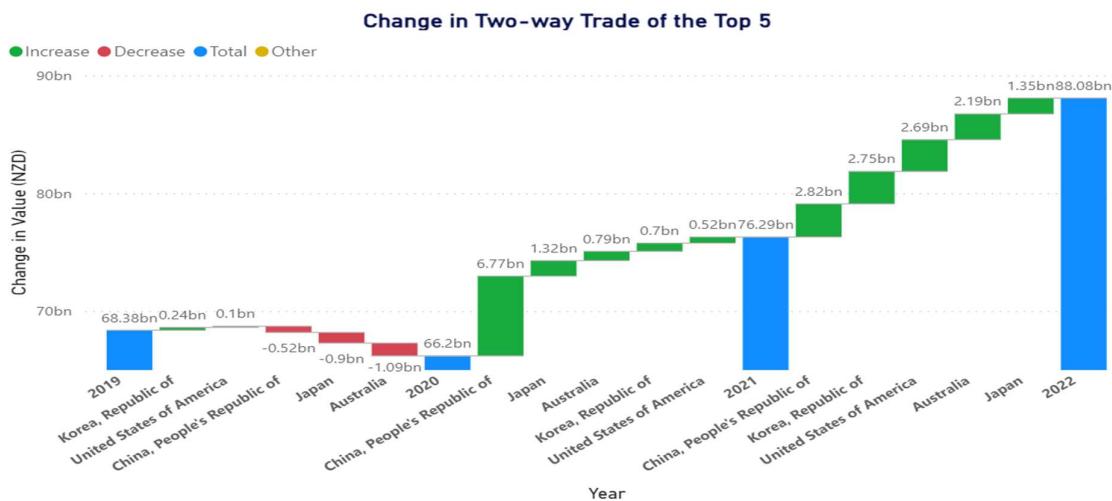


Figure 19 and 20 indicate significant role of the countries in Asia (mainly China) and Oceania (predominantly Australia) in NZ international trade sector. They are the key players in the top 10 and also the major share in this sector. By comparing total annual exports and imports with average annual CPI across regions (figure 20), top 10 countries (figure 21) and top5 (figure 22), the patterns or story line seems to be the same. When CPIs go up, the value of trade tend to go down. CPI has been steadily increased through out the years in every country regardless the Covid pandemic, while there was a decline in the two-way trade in those countries. Figure 22 helps zoom in the trend of top 5 countries since 2015.

Figure 23. Changes in Trade of the Top 5 Countries



To see changes in those countries, waterfall chart (figure 23) and the Change table (figure 24) help visualizing the changes in total value of two-way trade since the pandemic year. In 2020, China, Japan and Australia experienced a decline in two-way trade by 2%, 12% and 7% respectively; however, the other 2 America and Korea seemed to be not impacted by this pandemic. After the 2020 pandemic, there was a sharp increase in all the top 5 countries, and more interestingly there was a double increase in trade value from Korea. Based on this trend, it seems that NZ international trade seem to be not heavily impacted by the so-called Covid Pandemic.

Figure 24. Changes in Two-way Trade (Annual Total) of the Top 5 Countries

Top 5 Countries	Year	Annual Trade	Change in %	Change in Value
Australia	2019	\$15.84B		
	2020	\$14.75B	-7%	-\$1.09B
	2021	\$15.53B	5%	\$.79B
	2022	\$17.72B	14%	\$2.19B
China	2019	\$29.24B		
	2020	\$28.72B	-2%	-\$52B
	2021	\$35.49B	24%	\$6.77B
	2022	\$38.30B	8%	\$2.82B
Japan	2019	\$7.45B		
	2020	\$6.55B	-12%	-\$90B
	2021	\$7.87B	20%	\$1.32B
	2022	\$9.21B	17%	\$1.35B
Korea, Republic of	2019	\$4.10B		
	2020	\$4.34B	6%	\$.24B
	2021	\$5.04B	16%	\$.70B
	2022	\$7.79B	55%	\$2.75B
United States of America	2019	\$11.75B		
	2020	\$11.85B	1%	\$.10B
	2021	\$12.37B	4%	\$.52B
	2022	\$15.06B	22%	\$2.69B

4.2 Pearson Correlation and Regression Analysis

For question2, the study uses Pearson Correlation in combination with Regression Analysis to test the correlation between response variables (Annual Exports and Annual Imports) and predictor variable (Annual CPI). From the Regression output, the interpretation is mainly based on Multiple R and Significance F. While Multiple R represents multiple correlation between those variables, Significance F (or P-value) could tell whether or not the regression model is statistically significant.

Figure 25. Pearson Correlation Among Exports, Imports and CPI

	Exports	Imports	CPI
Exports	1		
Imports	0.960212524	1	
CPI	-0.02378054	-0.028028	1

Figure 26. Regression Output for Exports and CPI

Regression Statistics						
Multiple R	0.02378054					
R Square	0.000565514					
Adjusted R Sq	-0.000162937					
Standard Erro	1437477995					
Observations	1374					
ANOVA						
	df	SS	MS	F	Significance F	
Regression	1	1.6042E+18	1.6E+18	0.776324	0.378421966	
Residual	1372	2.835E+21	2.07E+18			
Total	1373	2.8366E+21				
	Coefficients	standard Erro	t Stat	P-value	Lower 95%	Upper 95%
Intercept	327508653.7	39814361.8	8.225892	4.45E-16	249405037.4	4.06E+08
CPI	-32248.53622	36600.6166	-0.88109	0.378422	-104047.7661	39550.69
					-104048	39550.69

Figure 27. Regression Output for Imports and CPI

Regression Statistics						
Multiple R	0.028027968					
R Square	0.000785567					
Adjusted R Sq	5.72766E-05					
Standard Erro	1307932396					
Observations	1374					
ANOVA						
	df	SS	MS	F	Significance F	
Regression	1	1.8452E+18	1.85E+18	1.078645	0.299183812	
Residual	1372	2.3471E+21	1.71E+18			
Total	1373	2.3489E+21				
	Coefficients	standard Erro	t Stat	P-value	Lower 95%	Upper 95%
Intercept	348711189.6	36226289.2	9.625915	2.87E-21	277646275.7	4.2E+08
CPI	-34586.91401	33302.1669	-1.03858	0.299184	-99915.59323	30741.77
					-99915.6	30741.77

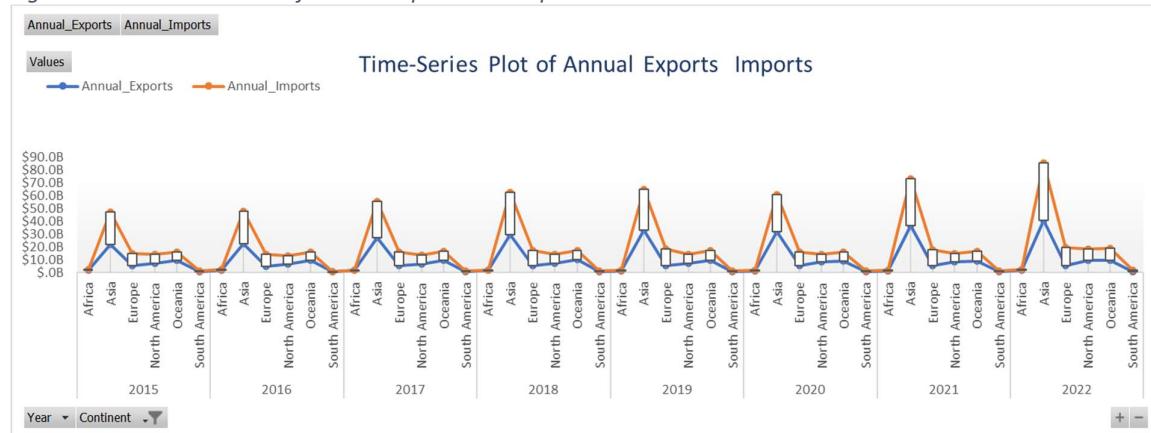
The Pearson correlation in Figure 25 shows there is a weak negative correlation between CPI and Exports and also a weak negative correlation between CPI and Imports. In figure 26 and 27, the value of both Multiple Rs are almost 0 meaning there is almost no linear relationship between the two pairs: Exports vs CPI and Imports vs CPI. Significance F (or P-value) of both regression outputs

are larger than the significant level (0.05) which is not good enough to reject null hypothesis H₀1 and H₀2. In short, it is proven that: (i) *there is no significant negative correlation between Annual Exports and Annual CPI* and (ii) *there is no significant negative correlation between Annual Imports and Annual CPI*.

4.3 Time-Serie Analysis

Time-series analysis is used to establish the trend of Exports and Imports over years and across regions. Visualizing pattern of the dataset helps inform proper or ideal forecasting model. Figure 28 presents time-series plot of Annual Exports and Imports from 2015 to 2022 across 6 regions.

Figure 28. Time-Series Plot of Annual Exports and Imports



There are two possibilities in forecasting the value of exports and imports using time-series analysis. First is using Auto forecasting method which already built in Ms Excel. Second is doing manual forecasting applying any appropriate forecasting methods that well fit with the dataset. Auto-forecasting automatically generate Annual figure for Exports and Imports in 2023 and 2024 while also provide the figure of lower bound and upper bound. The lower and upper bounds give 95% confidents that the forecast will lie within these range.

Figure 29. Auto-Forecasting NZ Annual Exports by 2024

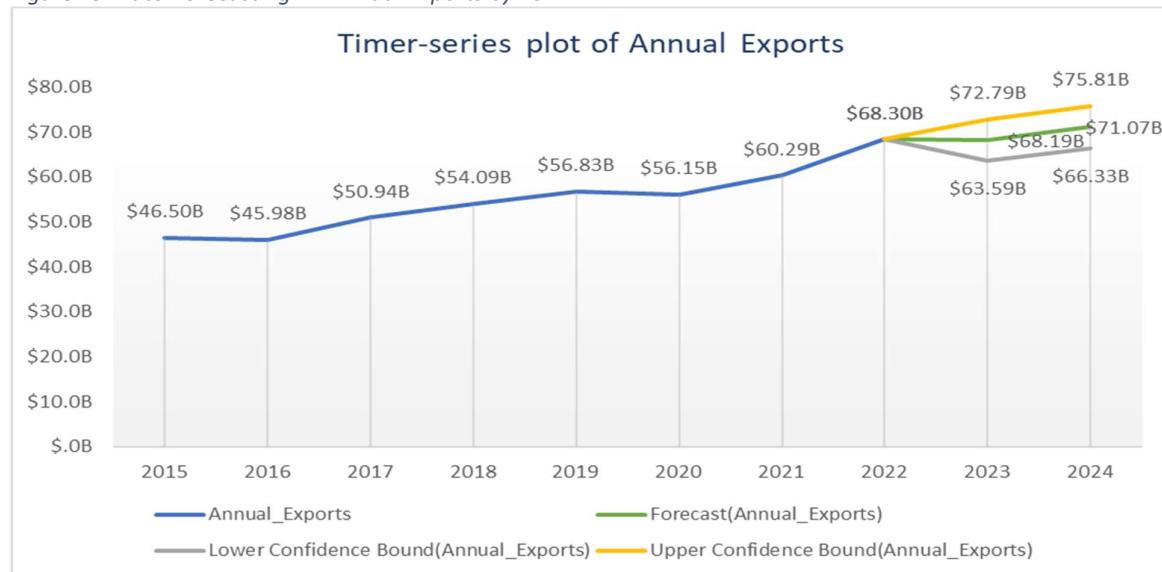


Figure 30. Auto-Forecasting NZ Annual Imports by 2024

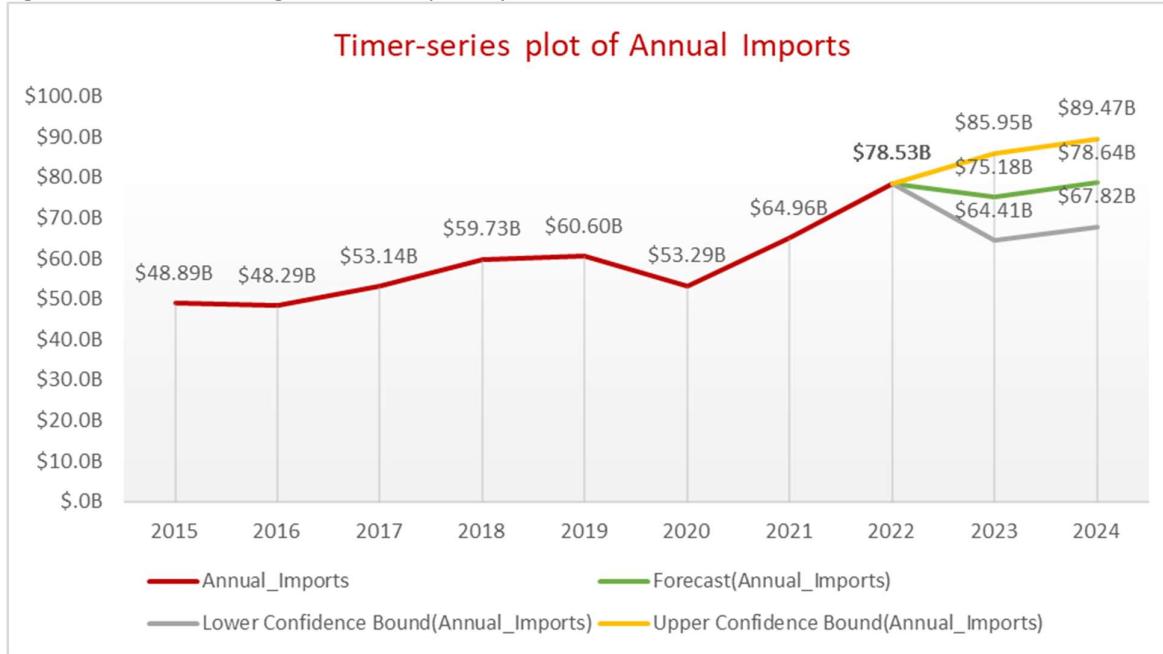


Figure 29 and 30 are the forecast of NZ annual goods exports and imports for the year 2023 and 2024. Based on this forecast, it could tell that exports' value will be slightly dropped in 2023 and go up around 4% in 2024. For the imports, there will 4% increase in 2023 and around 5% in 2024.

A limitation of using auto-forecasting technique is that it can only perform univariate forecasting which is not enough for this study. As the paper seeks to predict annual exports and imports by year and region, manual forecasting helps doing the job. The component (pattern) of the datasets is a combination of Level and Seasonal, and it is dominantly horizontal. In theory, Moving Average, Simple Exponential Smoothing (SES) or Winter Smoothing should give an ideal result in prediction. However, in practice, those methods do not produce a sound prediction as shown in figure 31,32,33. The ideal one is utilizing Average (or Mean) Method as shown in figure 34 and 35. Figure 36 and 37 show how Average model were calculated. The calculation of forecasting error using other models were also attached in the appendix.

Figure 31. Forecasting NZ Annual Exports using Moving Average (MA)

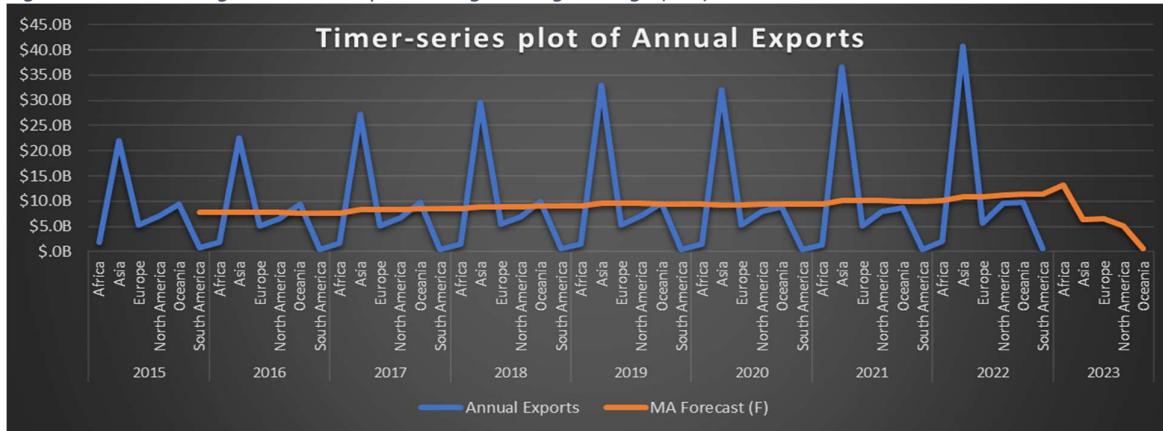


Figure 32. Forecasting NZ Annual Exports using Simple Exponential Smoothing(SES)

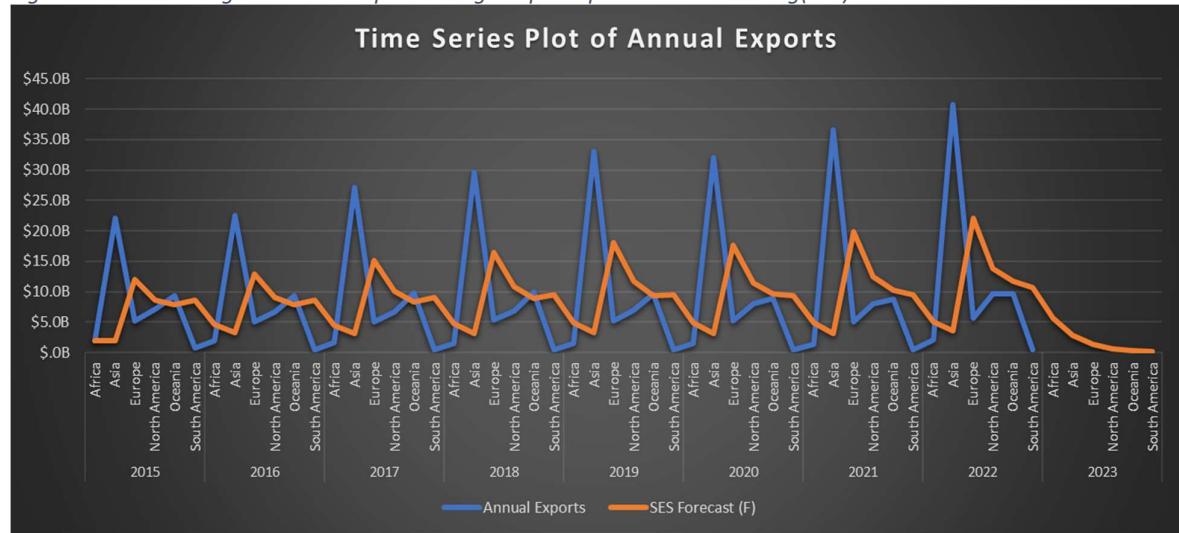


Figure 33. Forecasting NZ Annual Exports using Winter Smoothing (WS)

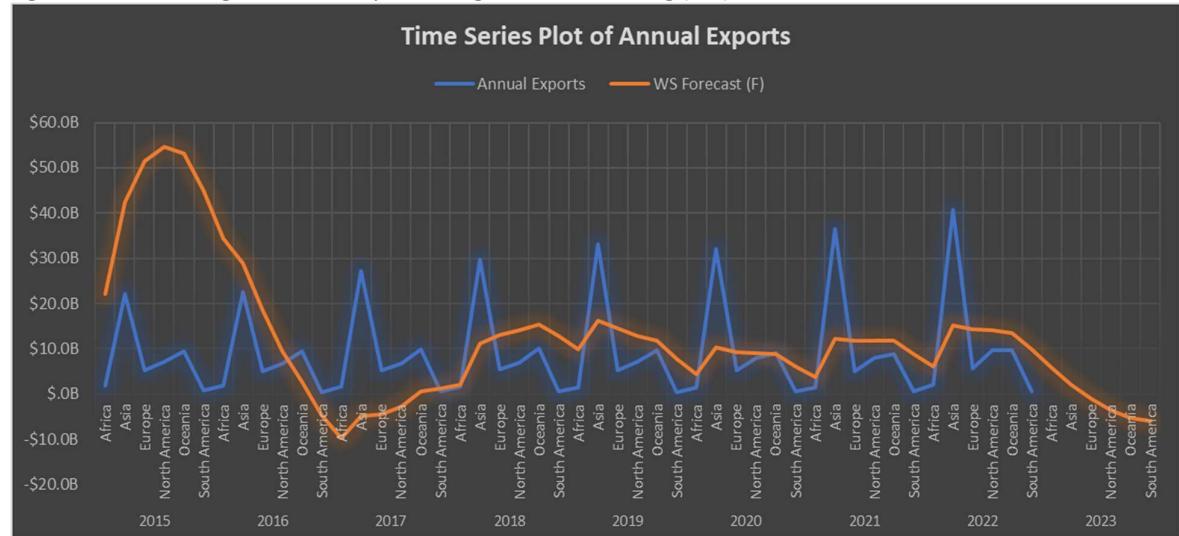


Figure 34. Manual Forecasting of NZ Annual Exports using Average Method

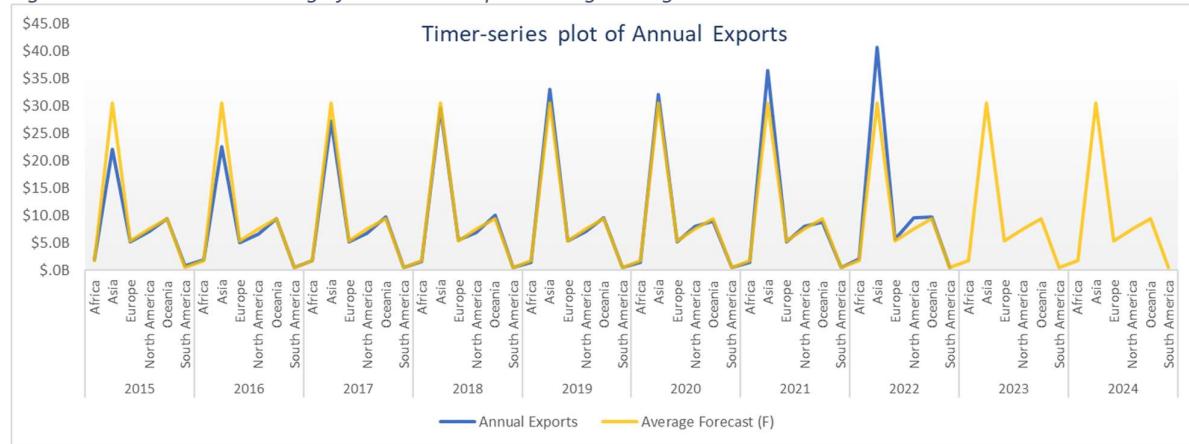


Figure 35. Manual Forecasting of NZ Annual Imports using Average Method

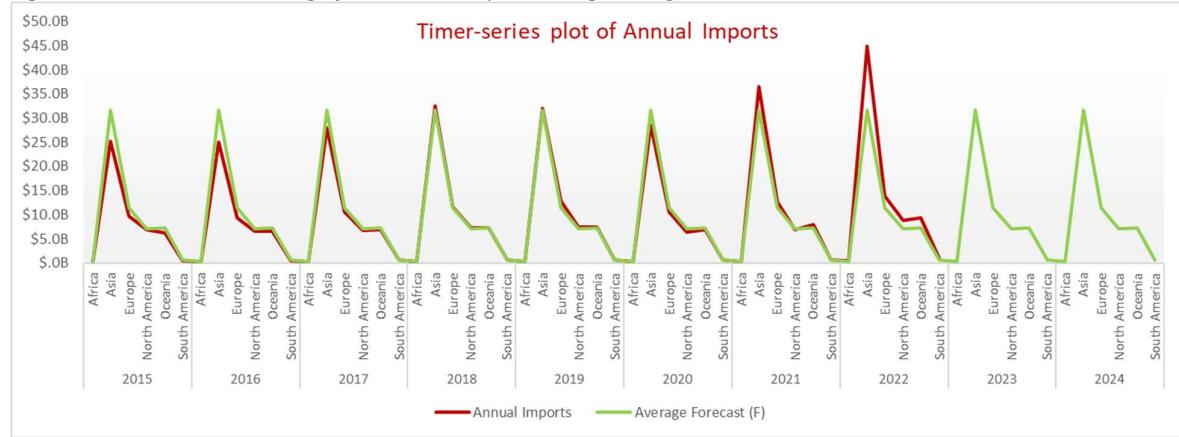


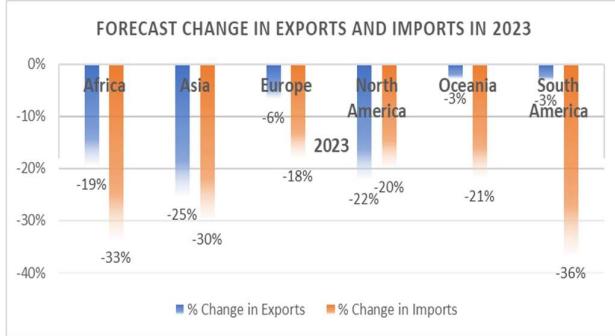
Figure 36. Annual Exports' Forecasting using Average Method

Time	Year	Regions	Annual Exports	Average Forecast (F)	Error (e) = Y - F	Absolute Error	Squared Error
1	2015	Africa	1.93B	1.70B	.23B	.23B	54856287.73B
2		Asia	22.11B	30.48B	-8.37B	8.37B	70041279437.10B
3		Europe	5.23B	5.25B	-.02B	.02B	316073.48B
4		North America	7.11B	7.50B	-.39B	.39B	155275568.49B
5		Oceania	9.40B	9.44B	-.05B	.05B	2137364.62B
6		South America	.72B	.51B	.21B	.21B	43647407.73B
7	2016	Africa	1.91B	1.70B	.21B	.21B	45600655.98B
8		Asia	22.59B	30.48B	-7.88B	7.88B	62163807605.98B
9		Europe	5.06B	5.25B	-.19B	.19B	34858785.59B
10		North America	6.63B	7.50B	-.88B	.88B	767099626.96B
11		Oceania	9.37B	9.44B	-.08B	.08B	5739995.63B
12		South America	.42B	.51B	-.09B	.09B	8287579.29B
13	2017	Africa	1.73B	1.70B	.03B	.03B	885640.40B
14		Asia	27.19B	30.48B	-3.29B	3.29B	10835465443.81B
15		Europe	5.12B	5.25B	-.14B	.14B	18418713.63B
16		North America	6.66B	7.50B	-.84B	.84B	704815501.31B
17		Oceania	9.78B	9.44B	.33B	.33B	109724113.35B
18		South America	.47B	.51B	-.04B	.04B	1804898.90B
19	2018	Africa	1.59B	1.70B	-.11B	.11B	11106157.57B
20		Asia	29.65B	30.48B	-.83B	.83B	680686986.83B
21		Europe	5.41B	5.25B	.16B	.16B	25816836.59B
22		North America	6.89B	7.50B	-.61B	.61B	377435642.35B
23		Oceania	10.01B	9.44B	.56B	.56B	316883631.47B
24		South America	.54B	.51B	.03B	.03B	748829.01B
25	2019	Africa	1.46B	1.70B	-.23B	.23B	54501033.92B
26		Asia	32.99B	30.48B	2.52B	2.52B	6330813583.45B
27		Europe	5.27B	5.25B	.02B	.02B	377704.71B
28		North America	7.04B	7.50B	-.46B	.46B	214623012.76B
29		Oceania	9.62B	9.44B	.18B	.18B	31917238.19B
30		South America	.44B	.51B	-.07B	.07B	4612768.84B
31	2020	Africa	1.47B	1.70B	-.23B	.23B	52090622.27B
32		Asia	32.06B	30.48B	1.58B	1.58B	2505160426.82B
33		Europe	5.21B	5.25B	-.04B	.04B	1874945.64B
34		North America	8.03B	7.50B	.52B	.52B	275540572.16B
35		Oceania	8.92B	9.44B	-.53B	.53B	278374641.87B
36		South America	.46B	.51B	-.05B	.05B	2251771.91B
37	2021	Africa	1.38B	1.70B	-.32B	.32B	100921140.25B
38		Asia	36.52B	30.48B	6.04B	6.04B	36522292868.30B
39		Europe	5.09B	5.25B	-.16B	.16B	25786259.33B
40		North America	8.05B	7.50B	.54B	.54B	292794784.84B
41		Oceania	8.74B	9.44B	-.70B	.70B	492121579.11B
42		South America	.51B	.51B	.08B	.08B	18598.79B
43	2022	Africa	2.10B	1.70B	.41B	.41B	165842703.94B
44		Asia	40.71B	30.48B	10.23B	10.23B	104611690875.57B
45		Europe	5.61B	5.25B	.36B	.36B	132474109.58B
46		North America	9.63B	7.50B	2.12B	2.12B	4498779966.34B
47		Oceania	9.72B	9.44B	.28B	.28B	77448630.19B
48		South America	.53B	.51B	.02B	.02B	286243.16B
49	2023	Africa		1.70B	-.1.70B	1.70B	2878282143.41B
50		Asia		30.48B	-30.48B	30.48B	928872355481.32B
51		Europe		5.25B	-.5.25B	5.25B	27572242388.0B
52		North America		7.50B	-.7.50B	7.50B	56312990469.17B
53		Oceania		9.44B	-.9.44B	9.44B	89202374728.73B
54		South America		.51B	-.51B	.51B	261532166.95B
55	2024	Africa		1.70B	-.1.70B	1.70B	2878282143.41B
56		Asia		30.48B	-30.48B	30.48B	928872355481.32B
57		Europe		5.25B	-.5.25B	5.25B	27572242388.0B
58		North America		7.50B	-.7.50B	7.50B	56312990469.17B
59		Oceania		9.44B	-.9.44B	9.44B	89202374728.73B
60		South America		.51B	-.51B	.51B	261532166.95B

Figure 37. Annual Imports' Forecasting using Average Method

Time	Year	Regions	Annual Imports	Average Forecast (F)	Error (e) = Y - F	Absolute Error	Squared Error
1	2015	Africa	.30B	.32B	-.01B	.01B	186053.37B
2		Asia	25.27B	31.58B	-6.31B	6.31B	39859358637.65B
3		Europe	9.78B	11.41B	-1.63B	1.63B	2651399852.51B
4		North America	6.87B	7.13B	-.27B	.27B	70893076.54B
5		Oceania	6.27B	7.32B	-1.05B	1.05B	1110605058.80B
6		South America	.41B	.67B	-.26B	.26B	67280474.15B
7	2016	Africa	.29B	.32B	-.03B	.03B	742042.56B
8		Asia	25.08B	31.58B	-6.50B	6.50B	42266122756.58B
9		Europe	9.41B	11.41B	-2.0B	2.0B	3981086710.54B
10		North America	6.56B	7.13B	-.57B	.57B	325258446.41B
11		Oceania	6.51B	7.32B	-.82B	.82B	666481384.52B
12		South America	.44B	.67B	-.23B	.23B	52489618.52B
13	2017	Africa	.28B	.32B	-.04B	.04B	1669969.65B
14		Asia	27.91B	31.58B	-3.68B	3.68B	13513415805.73B
15		Europe	10.63B	11.41B	-.77B	.77B	597861314.25B
16		North America	6.78B	7.13B	-.35B	.35B	124032954.94B
17		Oceania	6.92B	7.32B	-.41B	.41B	166351995.40B
18		South America	.63B	.67B	-.04B	.04B	1484353.49B
19	2018	Africa	.32B	.32B	.0B	.0B	5800.11B
20		Asia	32.54B	31.58B	.95B	.95B	910356865.16B
21		Europe	11.56B	11.41B	.15B	.15B	23623163.08B
22		North America	7.33B	7.13B	.20B	.20B	40515718.05B
23		Oceania	7.30B	7.32B	-.02B	.02B	510460.84B
24		South America	.68B	.67B	.02B	.02B	362100.54B
25	2019	Africa	.33B	.32B	.01B	.01B	125321.42B
26		Asia	31.97B	31.58B	.39B	.39B	152383162.66B
27		Europe	12.78B	11.41B	1.38B	1.38B	1894742501.30B
28		North America	7.40B	7.13B	.27B	.27B	70287842.90B
29		Oceania	7.42B	7.32B	.09B	.09B	8424602.54B
30		South America	.70B	.67B	.04B	.04B	1538334.35B
31	2020	Africa	.23B	.32B	-.09B	.09B	7453225.12B
32		Asia	28.50B	31.58B	-3.08B	3.08B	9516723519.80B
33		Europe	10.57B	11.41B	-.84B	.84B	702740968.47B
34		North America	6.32B	7.13B	-.81B	.81B	662853472.04B
35		Oceania	6.95B	7.32B	-.38B	.38B	140677565.93B
36		South America	.72B	.67B	.06B	.06B	3338357.68B
37	2021	Africa	.32B	.32B	.0B	.0B	18.03B
38		Asia	36.46B	31.58B	4.88B	4.88B	23822894780.48B
39		Europe	12.66B	11.41B	1.25B	1.25B	1567680759.53B
40		North America	6.92B	7.13B	-.22B	.22B	46598040.59B
41		Oceania	7.90B	7.32B	.58B	.58B	334801069.26B
42		South America	.70B	.67B	.03B	.03B	1032542.20B
43	2022	Africa	.48B	.32B	.16B	.16B	25331038.78B
44		Asia	44.93B	31.58B	13.35B	13.35B	178230139198.83B
45		Europe	13.86B	11.41B	2.45B	2.45B	6016346040.40B
46		North America	8.89B	7.13B	1.75B	1.75B	3070818925.69B
47		Oceania	9.33B	7.32B	2.01B	2.01B	4021453370.75B
48		South America	1.04B	.67B	.38B	.38B	143531849.51B
49	2023	Africa		.32B	-.32B	.32B	101348715.46B
50		Asia		31.58B	-31.58B	31.58B	997413848388.17B
51		Europe		11.41B	-11.41B	11.41B	130088123128.15B
52		North America		7.13B	-7.13B	7.13B	50882901440.05B
53		Oceania		7.32B	-7.32B	7.32B	53631199789.68B
54		South America		.67B	-.67B	.67B	442753834.84B
55	2024	Africa		.32B	-.32B	.32B	101348715.46B
56		Asia		31.58B	-31.58B	31.58B	997413848388.17B
57		Europe		11.41B	-11.41B	11.41B	130088123128.15B
58		North America		7.13B	-7.13B	7.13B	50882901440.05B
59		Oceania		7.32B	-7.32B	7.32B	53631199789.68B
60		South America		.67B	-.67B	.67B	442753834.84B

Figure 38. Forecast Change in 2023



Based on the Average method, the value of NZ goods exports and imports is predicted to go down in every region By 2023; there will be considerable decrease in exports to Asia, North America and Africa regions. Also the imports will be greatly dropped by at least 18 per cent across regions in 2023. Because Average method was deployed, the forecast value of the 2024 will be the same as 2023.

Figure 39. Annual Exports' Forecasting Error using Average Method

Mean Absolute Error (MAE)	2.72B
Mean Squared Error (MSE)	41887980827.01B
Root Mean Squared Error (RMSE)	6.47B

Figure 40. Imports' Forecasting Error using Average Method

Mean Absolute Error (MAE)	2.96B
Mean Squared Error (MSE)	46699906028.57B
Root Mean Squared Error (RMSE)	6.83B

The figures on the left (39 and 40) are the result from calculating Forecasting Error by using Average method. Theoretically, the Root Mean Squared Error (RMSE) is an indicator to estimate how well a model is in time-series forecasting because it measures the variation between actual and the predicted values (SAP, 2023) and (Andrés, 2023). It is said that the less RMSE the better, meaning a perfect model is having RMSE value of 0. However, for this particular case, the theory is not applicable due to the large value in annual exports and imports.

While Auto-forecasting predicts that there will be around 4% or less decrease in 2023's two-way trade, manual forecasting found there will considerably drop in all region. However, this drop still lies within the lower-bound range of Auto-forecasting. The forecast of 2024 solely depends on Auto-forecasting because the Average method could just produce the same figure for both 2023 and 2024. Therefore, this study can assume that NZ two-way trade will go down in 2023 and then go slightly back up in 2024.

5. Conclusions

All in all, this paper focuses on New Zealand international trade; it is the combination of review work of previous assessments and the generation of relevant insight for future forecasting. The assessment1 provides some descriptive insight on trade overview for the period of 5 years; assessment2 was more into inferential statistics explaining key factors influencing the value of exports and imports. Last but not least, assessment3 seeks to achieve three more objectives. First is to understand overview and patterns of NZ goods export and imports compared to CPI. Second is to check whether there is a significant correlation between annual CPI and annual two-way trade value. And third is to forecast the trends of the two-way trade.

This study uses a combination of statistical analysis, including descriptive, inferential and predictive analysis. Some key points could be learned from question1. First is that NZ international trade sector is heavily influenced by Countries in Asia are Oceania. Second is that though there was a significant drop in the trade value in 2020, it seems that two-way trade from those key players (top 10 countries) were not heavily impacted by the 2020 phenomenon. Third, the value of two-way

trade tends to go up or down in an opposite direction to CPI, meaning CPI could negatively influence the international trade value.

It is not enough to claim that Annual CPI impact the value of the two-way trade by just relying on the graphs. Proving the claim is based on the 2nd question. Pearson correlation and regression analysis were used to confirm or reject the hypotheses. It was found that it is not significant enough to confirm the correlation. In short, there is no significant negative correlation between Annual CPIs and Annual two-way trades.

Question3 mainly relies on predictive analysis. Time-series analysis is used to understand historical data and patterns of the two-way trade over the years and across countries and regions. While predicting the two-way trade value by years relies on Auto-forecasting, forecasting the value by years and regions requires manual forecasting models. Among various forecasting models, Average method is the most ideal one. Based on both Auto and Manual forecasts, it is to conclude that the value of the two-way trade is more likely to go down in 2023 and might go back up in 2024.

6. References

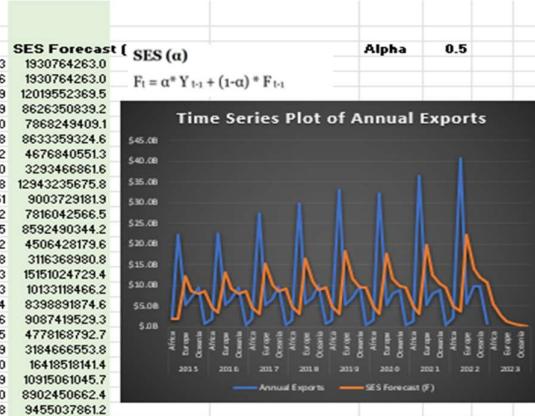
- Andrés, D. (2023, June 22). *Error Metrics for Time Series Forecasting*. Retrieved from Machine Learning Pills: [https://mlpills.dev/time-series/error-metrics-for-time-series-forecasting/#:~:text=Root%20Mean%20Squared%20Error%20\(RMSE\)%20is%20another%20commonly%20used%20metric,differences%20to%20emphasize%20larger%20errors](https://mlpills.dev/time-series/error-metrics-for-time-series-forecasting/#:~:text=Root%20Mean%20Squared%20Error%20(RMSE)%20is%20another%20commonly%20used%20metric,differences%20to%20emphasize%20larger%20errors).
- CFI Team. (2023, November). *What is the Consumer Price Index (CPI)*? Retrieved from CFI Education Inc: <https://corporatefinanceinstitute.com/resources/economics/consumer-price-index-cpi/>
- IMF. (2023, November). *Consumer Price Index*. Retrieved from International Monetary Fund: <https://data.imf.org/?sk=4FFB52B2-3653-409A-B471-D47B46D904B5&slid=1485878855236>
- LinkedIn. (2023, November). *Data Analytics*. Retrieved from LinkedIn community: <https://www.linkedin.com/advice/1/what-some-key-concepts-techniques-descriptive-inferential#:~:text=Descriptive%20Analytics&text=Inferential%20analytics%20draws%20conclusions%20about,learning%20and%20time%20series%20analysis>.
- MFAT. (2023). *New Zealand Foreign Affairs and Trade*. Retrieved from NZ Trade Policy: <https://www.mfat.govt.nz/en/trade/nz-trade-policy>
- MFAT. (2023, November). *NZ economic performance in 2022, and future prospects*. Retrieved from New Zealand Foreign Affairs and Trade: <https://www.mfat.govt.nz/en/trade/mfat-market-reports/nz-economic-performance-in-2022-and-future-prospects/>
- OECD. (2023, October 29). *Main Economic Indicators*. Retrieved from OECD LIBRARY: https://stats.oecd.org/viewhtml.aspx?datasetcode=PRICES_CPI&lang=en
- Pritha, B. (2020, June 22). *Inferential Statistics*. Retrieved from Scribbr: <https://www.scribbr.com/statistics/inferential-statistics/>
- SAP. (2023, December). *Root Mean Squared Error (RMSE)*. Retrieved from Predictive Factory Online Help: https://help.sap.com/docs/SAP_PREDICTIVE_ANALYTICS/41d1a6d4e7574e32b815f1cc87c00f42/5e5198fd4afe4ae5b48fefe0d3161810.html
- SimpliLearn. (2023, November). *Descriptive vs. Inferential Statistics*. Retrieved from SimpliLearn: https://www.simplilearn.com/difference-between-descriptive-inferential-statistics-article#difference_between_descriptive_and_inferential_statistics
- Stats NZ. (2023, November). *Consumers Price Index*. Retrieved from Stats NZ Tatauranga Aotearoa: <https://www.stats.govt.nz/topics/consumers-price-index>
- Stats NZ. (2023, June 02). *New Zealand Internatinoal Trade*. Retrieved from New Zealand Trade Dashboard: https://statisticsnz.shinyapps.io/trade_dashboard/

7. Appendix

Appendix 1. SES Forecasting

SES Forecasting

Time	Year	Regions	Annual Exports	SES Forecast (SES (α)	Alpha	0.5	Error	Absolute E	Squared Error
1	2015	Africa	1930764263	1930764263.0			20.18B	20.18B	407134581829.41B
2		Asia	22108340476	1930764263.0			-6.79B	6.79B	46055266493.22B
3		Europe	5233149309	12019552369.5			-152B	152B	2298871113.39B
4		North A.	710147979	8626350839.2			153B	153B	2341572730.82B
5		Oceania	9398463240	7868249409.1			-7.91B	7.91B	62616163213.26B
6		South A	720321778	8633359324.6			-2.77B	2.77B	7654891060.75B
7		Africa	1910093172	4676840551.3			19.30B	19.30B	372472152668.49B
8		Asia	22593004490	2334668616			-7.88B	7.88B	62078845662.24B
9		Europe	5064222688	12943235675.8			-2.38B	2.38B	5642397986.12B
10	2016	North A	6628355951	90037231819			155B	155B	2411434606.43B
11		Oceania	9368938122	7816042566.5			-8.17B	8.17B	66783616052.35B
12		South A	42036015	8592490344.2			-2.78B	2.78B	7729058304.75B
13		Africa	1726309782	4506428179.6			24.07B	24.07B	579331755948.91B
14		Asia	27185680478	3116368980.8			-10.04B	10.04B	100717533065.12B
15		Europe	5115212203	15151024723.4			-3.47B	3.47B	12002167494.06B
16		North A	6644665283	10123118466.2			-1.38B	1.38B	1896281325.14B
17		Oceania	9775947184	8338891874.6			-8.62B	8.62B	74278567645.28B
18		South A	468918056	9087419523.3			-3.19B	3.19B	101563937540.56B
19	2017	Africa	1591164315	4778168792.7			26.47B	26.47B	700539311369.16B
20		Asia	29652369729	3184666553.8			-11.01B	11.01B	121152160017.12B
21		Europe	54116033950	1641851814.1			-4.03B	4.03B	16202402220.72B
22		North A	68893840279	10915061045.7			-1.1B	1.1B	1221410449.21B
23		Oceania	10007625060	8902450662.4			-8.92B	8.92B	79493887888.79B
24		South A	538766898	94550378612			-3.53B	3.53B	12487791019.82B
25		Africa	14630935506	4936902379.6			29.76B	29.76B	885867072680.89B
26		Asia	32993518101	3223998942.8			-12.84B	12.84B	164301454590.62B
27		Europe	5270362391	18117585219			-4.65B	4.65B	21623769444.90B
28	2018	North A	7040923959	1691060456.4			-2.6B	2.6B	66235526.04B
29		Oceania	9623354843	93659392207.7			-9.05B	9.05B	81924017523.15B
30		South A	443484730	94946737525.4			-3.50B	3.50B	1226524095.61B
31		Africa	1468316370	4969079157.7			28.84B	28.84B	831830933470.68B
32		Asia	32060177155	3218637763.8			-12.43B	12.43B	154549908265.59B
33		Europe	5207627122	17639437459.4			-3.39B	3.39B	11522049897.67B
34		North A	8029117776	11423532290.7			-8.1B	8.1B	654863486.92B
35		Oceania	8917088673	9726325033.4			-8.86B	8.86B	78459868534.28B
36		South A	463949319	9321706853.2			-3.51B	3.51B	12347907102.32B
37	2019	Africa	1378869193	4892828086.1			33.38B	33.38B	139187127453.33B
38		Asia	36520774972	3135848633.5			-14.74B	14.74B	217207613719.88B
39		Europe	5090346759	1982831805.8			-4.41B	4.41B	136498374476.79B
40		North A	8045303341	12459329282.4			-1.51B	1.51B	2277470965.51B
41		Oceania	8743187104	1025231631.7			-8.93B	8.93B	140224357854.51B
42		South A	507089526	9497751707.8			-2.90B	2.90B	8402071239.20B
43		Africa	2103787967	5002420616.9			37.15B	37.15B	142400896043.95B
44		Asia	40705332966	3553104292.0			-16.51B	16.51B	272723786810.31B
45		Europe	5614897634	22129249623.2			-4.25B	4.25B	141861276169.60B
46	2020	North A	9625230943	1387207316.16			-2.03B	2.03B	4103279129.04B
47		Oceania	9722996521	11748652055.3			-10.21B	10.21B	145632128189.22B
48		South A	528320980	10735824438.0			-5.63B	5.63B	31720242436.52B
49		Africa	5632072659.0				-2.82B	2.82B	148550453085.57B
50		Asia	2816036329.5				-141B	141B	1982515152.23B
51		Europe	1408018164.8				-7.0B	7.0B	133841666397.34B
52		North America	7040030824				-3.35B	3.35B	123907197.02B
53		Oceania	3520045412						



Appendix 2. Holt's Winter Smoothing Forecasting

Holt's WinterSmoothing Forecasting							Holt's Exponential Smoothing						
Time	Year	Regions	Annual Exports	WS Forecast (F)	Level (L)	Trend (T)	Alpha	0.2 Error	Absolute Error	Squared Error			
							Beta	0.5					
1	2015	Africa	1930764263	2210340747.6	1930764263.0	20177576213.0	-0.19B	20.18B	40734581929.41B				
2		Asia	22103407476	42285916688.9	22103407476	16472299475	-46.11B	46.11B	2126548344170.90B				
3		Europe	5233149309	51347662687.9	34875362313	12048548004	-47.44B	47.44B	225016953163.44B				
4		North Ar	711047979	54549707750.2	42500159746	12048548004	-43.65B	43.65B	1905468293128.28B				
5		Oceania	938469240	53052842012.2	4551660048	7335254153	-44.17B	44.17B	1950620349613.21B				
6		South A	72032778	44886149627.3	425951817	2300337911	-32.38B	32.38B	104856007872.45B				
7		Africa	191009372	34236706014	36290938336	-199.267735	-6.19B	6.19B	383557095195.65B				
8		Asia	22593004490	28786203033.2	31953537379	-3167334346	-13.44B	13.44B	1005812875162B				
9		Europe	50642274488	24041806964	5539532380		-2.77B	2.77B	768515956.94B				
10	2016	North Ar	6528355951	9400566613.4	1612749057	-672624244	6.70B	6.70B	44954132505.82B				
11		Oceania	9369538122	2664153822.3	9394240915	-6730097093	5.16B	5.16B	2659775997.21B				
12		South A	42036605	-4730963612.8	2215396261	-6594565974	11.48B	11.48B	1379574144.39B				
13		Africa	1726339782	-975326367.9	-3445933734	-6307327934	32.17B	32.17B	1046529003850.16B				
14		Asia	2718568476	-4979566338.3	-236601239	-2615677220	9.68B	9.68B	937138000000.32B				
15	2017	Europe	515212303	-4955362334.3	-2560012326	-2614453360	9.47B	9.47B	69959367137.13B				
16		North Ar	6684658493	-3000767451	-233972625	-4914452.2	9.29B	9.29B	861567500000.63B				
17		Africa	9775247784	4976938387.7	-29846480.5	-723325412	-7.99B	7.99B	526513207.67B				
18		South A	469918056	1204019323.0	488377071	-774046750.9	-5.44B	5.44B	29452343.37B				
19		Africa	15916415	2130767585.7	1326588006	607197095.5	18.48B	18.48B	3406219581.31B				
20		Asia	29652369729	1198424465.2	7637439382	3559895003	7.61B	7.61B	5789713240.52B				
21	2018	Europe	541103050	13019953334.2	10034960362	289050301	-7.27B	7.27B	52675000856.36B				
22		North Ar	6039940279	14161423490.4	11733303771	2367490720	5.28B	5.28B	2782747366.61B				
23		Oceania	100762560	15262778811	13320658604	195120277	-12.27B	12.27B	10624552307.83B				
24		South A	538766988	2811685563.0	12333976485	4777090787.5	8.42B	8.42B	7052540343.59B				
25		Africa	1463095506	988487124.4	1051957552	-65749327.2	16.83B	16.83B	28335737678.49B				
26		Asia	3293591801	16160277840.2	14050557720	165372020	9.28B	9.28B	86056430100.81B				
27	2019	Europe	52702362391	14547023325.9	139822347970	564228575.5	-5.82B	5.82B	3360733264.40B				
28		North Ar	7040923959	128599220814	1304503453	-85981361.1	-2.08B	2.08B	425217445.66B				
29		Oceania	9623345843	1170370557.5	12212608642	-509538086	-7.37B	7.37B	54348919260.48B				
30		South A	4434384790	781565674.0	945153403	-163549663	-2.81B	2.81B	789285134.12B				
31		Africa	1468316370	4275957965.5	6546188666	-2270230700	21.72B	21.72B	47172295337.72B				
32		Asia	3260717755	10340993023.5	983280904	50819129.3	-4.10B	4.10B	16822690666.93B				
33	2020	Europe	520762722	9309174472.3	931439843	-5145730.846	-8.99B	8.99B	793692683.31B				
34		North Ar	802917776	8920012092.6	905316313	-13351040.5	.13B	.13B	1718842.41B				
35		Oceania	8917088673	8785984026.2	8919427409	-133443384.2	-5.69B	5.69B	32398646709.65B				
36		South A	4539345319	15659302316	7121577095	-956646853.2	-2.38B	2.38B	5566291263.70B				
37		Africa	1378869393	3751765063.9	5200518024	-144352957	24.38B	24.38B	594281027960.91B				
38		Asia	3652077497	124128950814	1030987048	1833008033	-3.80B	3.80B	144258517417B				
39	2021	Europe	5093046759	1868013868.2	1073238547	112753201	-2.92B	2.92B	8505666405.94B				
40		North Ar	8045303341	1843441236.3	1109717563	746269673.5	-8.24B	8.24B	6794775348.32B				
41		Oceania	874387104	1659364670.1	1123390410	436244260.3							
42		South A	507089526	875015387.2	9429125641	-679010254.1							

Appendix 3. Moving Average Forecasting

