Economic Impact of the COVID-19 Pandemic on New Zealand's International Trade in Dairy Products: An Empirical Investigation

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Abstract

The New Zealand dairy industry typically accounts for 30% of the global dairy exports. These exports contribute approximately $20 billion annually to the New Zealand economy. However, the outbreak of COVID-19 in 2020 led to the closure of international borders and the implementation of restrictive measures, adversely impacting New Zealand's exports and imports of dairy goods, which has hitherto not been studied empirically. This study contributes empirically to the literature by investigating the extent to which COVID-19 impacted New Zealand's dairy exports and imports in 2020, whether the COVID-19 impact had been uniform or heterogeneous across the categories of dairy goods and over the months following the outbreak of COVID-19, and whether the existing regional trade agreements (RTAs) had alleviated this impact. To this end, we analyse, by applying the Poisson Pseudo Maximum Likelihood (PPML) method to the gravity model of international trade, the monthly bilateral trade data of dairy goods traded between New Zealand and 155 trading partners from January 2019 to December 2020.

The findings of our research can be summarised as follows. First, except for whey and milk constituents, we find that COVID-19 significantly reduced the growth rates of New Zealand's dairy exports and imports in 2020. However, the reduction was more severe in the most traded product categories and the product categories most exposed to China's market. As China continues to pursue its zero COVID-19 approach, it is most likely that the exports of these product categories may continue to be adversely affected. Thus, this study emphasises (i) a diversification of New Zealand risks in terms of export markets and (ii) government support for the industry. Second, the economic impact of COVID-19 on New Zealand's dairy exports and imports was different each month for most product categories. The effect was relatively stronger during the months associated with stricter COVID-19 containment measures, such as January to April 2020, when China locked down the Hubei province and 19 other provinces/regions. Third, RTAs helped mitigate the negative economic impact of COVID-19 on New Zealand's dairy exports and imports, but New Zealand's dairy imports benefited more than exports. This unequal impact of RTAs on New Zealand's dairy exports and imports was partly due to the fact that New Zealand Dairy exporters face significant barriers in the form of high compliance costs of non-tariff measures (NTMs) – such as the 59 sanitary and phytosanitary (SPS) measures imposed by China on dairy imports from New Zealand (TRAINS, n.d.) – which may not have been addressed even as part an RTA.

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AANZFTA	ASEAN-Australia-New Zealand Free Trade Agreement
ANZTEC	The Agreement between New Zealand and the Separate Customs Territory of Taiwan, Penghu, Kinmen, and Matsu on Economic Cooperation
APEC	Asia-Pacific Economic Cooperation
ASEAN	Association of Southeast Asian Nations
A2M	a2 Milk Company
CEP	Closer Economic Partnership
CER	Closer Economic Relations
COVID-19	Coronavirus disease 2019
CPTPP	Comprehensive and Progressive Agreement for Trans-Pacific Partnership
DCANZ	Dairy Companies Association of New Zealand
DIRA	Dairy Industry Restructuring Act 2001
EU	European Union
FTA	Free Trade Agreement
GDP	Gross Domestic Product
GVC	Global value chain
IFMAA	Infant Formula Manufacturers' Association of Australia
IHS	Inverse hyperbolic sine
INC	Infant Nutrition Council
MAST	Multi-Agency Support Team
MFAT	Ministry of Foreign Affairs and Trade
NZ	New Zealand
NZDB	New Zealand Dairy Board
NZDG	New Zealand Dairy Group
NZIFMA	New Zealand Infant Formula Marketers' Association

NZTE	New Zealand Trade and Enterprises
NTM	Non-tariff measures
OCD	Oceania Dairy
OLS	Ordinary Least Squares
PMI	Purchasing Manager Index
PPML	Poisson Pseudo Maximum Likelihood
P4	Trans-Pacific Strategic Economic Partnership
RTA	Regional Trade Agreement
RoO	Rules of origin
SPS	Sanitary and phytosanitary
TBT	Technical barriers to trade
TRAINS	Trade Analysis Information System
UAE	United Arab Emirates
UK	United Kingdom of Great Britain and Northern Ireland
UNGA	United Nations General Assembly
USA	United States of America
WHO	World Health Organisation
WTO	World Trade Organisation

Attestation of authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

Fylgessio Deng

Chapter 1: Introduction

The spread of coronavirus disease 2019 (COVID-19) precipitated unprecedented disruptions to global trading activities in 2020. Although it began as a health crisis, the bold and drastic measures that governments initiated to curb its spread rendered the COVID-19 pandemic an economic crisis as well. One after another, countries closed their borders to international travellers and imposed strict domestic restrictions as soon as the World Health Organisation (WHO) "declared COVID-19 a pandemic on March 11, 2020" (Hayakawa & Mukunoki, 2021, p.1). These COVID-19 containment measures adversely impacted international trade through demand and supply shocks.

Production generally became constrained as people observed COVID-19 containment measures, including social distancing at workplaces and COVID-19 isolation requirements. This, in turn, had a significant knock-on impact on global supply chains and international trade. For instance, as the production of upstream products reduced due to COVID-19, economies and manufacturers that depend on these products for ingredients experienced supply shortages (Hayakawa & Mukunoki, 2021; Das & Sen, 2022).

New Zealand was one of the first countries to implement COVID-19 containment measures, and the New Zealand borders remained closed to international travellers beyond December 2020. Nevertheless, there is no evidence of an empirical investigation of how New Zealand goods exports and imports were affected by the COVID-19 pandemic in 2020. Therefore, we have chosen to conduct this study. Specifically, we investigate the impact of the COVID-19 pandemic on New Zealand's dairy exports and imports in 2020. We do this because the dairy trade is one of the most important economic activities in the New Zealand economy. According to Ballingall and Pambudi (2017),

> The dairy sector exports twice as much as the meat sector, almost four times as much as the wood and wood products sector and nine times as much as the wine sector. It generates almost four times as much export revenue as export education. (p.i).

Given the significance of the dairy trade to New Zealand, this research seeks to reveal the extent to which it has been negatively affected by COVID-19 and whether this impact is uniform across all types of dairy products exported and imported.

1.1 Motivation

All existing literature on the economic impact of COVID-19 on international trade in goods, including dairy goods, originates from offshore studies (Buchel et al., 2020; Friedt & Zhang, 2020; Meier & Pinto, 2020; Hayakawa & Mukunoki, 2021). These studies indicate that COVID-19 has adversely impacted international trade in goods. They also indicate that the effect is varied across countries, industries, products, and time. In light of this adverse and heterogeneous COVID-19 impact, conducting a New Zealand-focused study is crucial. Specifically, it is essential to take a closer look at how the dairy industry, the leading exporting industry in New Zealand, has performed during the pandemic. This will enable us to shed light on the impact of COVID-19 on the New Zealand dairy trade. Since the New Zealand Trade and Enterprises (NZTE) and other government agencies provide a range of support to New Zealand exporters, including dairy exporters, affected by the COVID-19 pandemic, our findings may assist these agencies in providing bespoke and targeted support to any struggling dairy exporters.

Furthermore, New Zealand is a party to several regional trade agreements (RTAs). These RTAs aim to facilitate trade between New Zealand and the concerned trading partners. The COVID-19 pandemic delivers a substantial test of this RTA-trade facilitation. Thus, by analysing the role played by the RTAs during the COVID-19 pandemic, including the agreement in 2020 by New Zealand and many of its RTA partners to keep open and connected supply chains (MFAT, 2020)[1], this research will contribute to the debate on the significance of RTAs.

1.2 Objectives

This study has three objectives. First, we investigate the extent of the economic impact of COVID-19 on the New Zealand dairy trade. New Zealand is both an exporter and importer of many dairy products. According to Davis and Hahn (2016), New Zealand is the world's largest dairy exporter, accounting for about a third of global dairy exports. These dairy exports contribute $20 billion annually to New Zealand's gross domestic product (GDP) (DairyNZ, 2021).[2]

Second, this research investigates whether the COVID-19 economic impact has been heterogeneous across the categories of dairy products and over the months following the

[1] These RTA partners include Australia, Brunei Darussalam, Canada, Chile, China, Laos, Myanmar, and Singapore.

[2] Unless otherwise specifically stated, the currency used in our research is the New Zealand Dollar.

COVID-19 outbreak. According to the World Trade Organisation (WTO) classification, dairy products are categorised into six categories. These categories are fresh milk and cream; milk powder; yoghurt, buttermilk and kephir; whey and milk constituents; butter and dairy spreads; and cheese and curd. Overseas evidence indicates that different periods and products experienced heterogeneous COVID-19 impacts in 2020 (Buchel et al., 2020; Friedt & Zhang, 2020; Meier & Pinto, 2020; Hayakawa & Mukunoki, 2021). Our study analyses if this has also been the case across these six categories of dairy products.

Finally, we assess whether RTAs have mitigated some of the negative economic impacts of COVID-19 on the New Zealand dairy trade. As the name implies, "RTAs are designed to facilitate trade and increase economic integration between countries" (Khalid et al., 2022, p.1393). New Zealand has fourteen enforced agreements (MFAT, n.d.). However, only eleven of the fourteen agreements relate to our research.[3] We examine if these eleven agreements have helped alleviate some of the adverse economic effects of COVID-19 on the New Zealand dairy trade.

1.3 Approach

To complete this study, we examine the monthly bilateral trade data (disaggregated along the product categories) of dairy trade between New Zealand and 155 trading partners from January 2019 to December 2020. This data set has a large proportion of zero-trade values.[4] Additionally, "It is well known that trade data are plagued by heteroscedasticity" (Yotov et al., 2016, p.20). The Ordinary Least Squares (OLS) method performs poorly in data sets with a non-negligible proportion of zero trade values, such as ours, and in the presence of heteroskedasticity. So, we employ the Poisson Pseudo Maximum Likelihood (PPML) method for our analysis. This estimation method is generally well-behaved (even in the presence of heteroskedasticity), and "the fact that the dependent variable has a large proportion of zeros does not affect the performance of the estimator" (Silva & Tenreyro, 2006, p.222). Moreover, we use three fixed effect controls to account for the standard gravity variables, observable and unobservable country-specific characteristics, and idiosyncratic shocks.[5]

[3] These agreements are listed in Table 7, including the year in which each agreement came into force.
[4] See Table 8 for the exact proportions of zero trade values in all six categories of dairy products.
[5] The relevant references are provided in chapters 4 and 5. Also, these three fixed effect controls are named and described in greater detail in chapter 4.

1.4 Paper organisation

We structure the remainder of the paper as follows. Chapter 2 presents trends and background information on the New Zealand dairy trade. Chapter 3 reviews previous relevant literature. Chapter 4 describes our data and discusses the methodology used. Our empirical results follow in chapter 5, and the paper concludes in chapter 6.

Chapter 2: Background and recent trends of the New Zealand dairy trade

The New Zealand dairy industry has long played a salient role in the New Zealand economy (Barry & Pattullo, 2020) and also in the global economy, "exporting for over 170 years and to more than 140 different markets" (DCANZ, n.d.). The first dairy export, a consignment of cheese to Sydney, Australia, occurred in 1845 (Fonterra, n.d.). By 1920, the share of dairy exports had grown to 22% of New Zealand exports, rising to 42% in 1930 (Raworth, 2013; Te Ara, n.d.).

Then, as a way to enhance competition in "distant and difficult marketplaces" (Te Ara, n.d.), the New Zealand Dairy Board (NZDB) was formed in 1961 (Raworth, 2013) and functioned as a sole exporter of New Zealand dairy goods for the next four decades. Through legislation, "NZDB's pricing behaviour was exempt from the Commerce Act, 1986 and only co-operatives were able to hold shares in the NZDB" (Barry & Pattullo, 2020, p.6). However, these statutory marketing privileges of the NZDB hampered innovation and restricted competition at home.

Thus, the New Zealand government passed the Dairy Industry Restructuring Act (DIRA) in 2001. DIRA established Fonterra by amalgamating the NZDB, New Zealand Dairy Group (NZDG) and Kiwi Co-operative Dairies Limited (Fonterra, n.d.; Raworth, 2013). More importantly, "DIRA also established an environment that facilitated innovation, allowing firms like the a2 Milk Company (A2M), Synlait and OCD to enter the market and compete on the international stage" (Barry & Pattullo, 2020, p.4).

Currently, although the New Zealand dairy industry produces a mere 3% of the total global milk production (Barry & Pattullo, 2020; Dairy Farms NZ Limited, n.d.), it accounts for the largest share (approximately 30%) of the cross-border dairy trade (Dairy Farms NZ Limited, n.d.; Raworth, 2013; Davis & Hahn, 2016) as it exports 95% of what it produces (DCANZ, n.d.) while most other countries produce dairy mainly for domestic consumption (Te Ara, n.d.). The industry also accounts for 29% of New Zealand's total goods exports, the largest by any export sector in New Zealand, and for approximately 3.5% of New Zealand's GDP (Ballingall & Pambudi, 2017). Apart from these direct impacts, the dairy industry is also intwined with the rest of the New Zealand economy.

> This includes the jobs it delivers, the income that these workers earn, its links to supply firms, the effects of rural economic growth on urban centres, the tax revenue it provides

> and the public services that can be funded from this tax revenue. (Schilling et al., 2010, p.C).

New Zealand's dairy exports are, however, heavily negatively affected by non-tariff measures (NTMs). NTMs are policy tools, other than tariffs, that can have economic impacts on trade in goods (Ballingall & Pambudi, 2016; MFAT, 2022). They include sanitary and phytosanitary (SPS) measures, technical barriers to trade (TBT), contingent trade protection measures, subsidies, and quotas. Among the different types of NTMs, SPS and TBT measures are the most prevalent, with SPS measures being more prevalent in agricultural products than TBT measures, however, on the whole, the latter is more prevalent than the former (Jacob & Mikic, n.d.).

SPS measures are quarantine and biosecurity measures which are applied to protect humans, animals or plants from risks arising from the introduction, establishment and spread of pests and diseases and from risks arising from additives, toxins and contaminants in food and feed (Australian Government Department of Agriculture, Fisheries and Forestry, n.d.). These include, *inter alia*, "all conformity-assessment measures related to food safety, such as certification, testing and inspection, and quarantine" (MAST group, 2019, p.viii).

On the other hand, TBT measures are "mandatory technical regulations and voluntary standards that define specific characteristics that a product should have, such as its size, shape, design, labelling / marking / packaging, functionality or performance" (European Commission, n.d.). These include, *inter alia*, "all conformity-assessment measures related to technical requirements, such as certification, testing and inspection" (MAST group, 2019, p.viii).

Even though SPS and TBT measures are quintessentially used for *bona fide* public policy reasons, all NTMs impose compliance costs on businesses. Currently, New Zealand exports of dairy goods face the highest compliance costs from NTMs. These costs amount to approximately $5.4 billion annually (MFAT, 2022), half of which comes from the Asia-Pacific Economic Cooperation (APEC) region alone (Ballingall & Pambudi, 2016). These compliance costs may increase because, as tariffs have been trending downwards in the recent decades (negotiated down through multilateral, regional or bilateral trade agreements), NTMs have increasingly become a prominent part of trade policy (Ballingall & Pambudi, 2016; MFAT, 2022).

However, this research does not consider NTMs because NTMs data are complex and extensive. Currently, there are 16 distinct classifications of NTMs and each classification is further divided into different categories, for example, SPS measures alone have 34 categories (MAST group, 2019). If we were to consider NTMs in this research we would collect data on all existing categories of NTMs. However, the time period involved in our research does not allow us to do this. Hence their exclusion.

The main objective of this chapter is to analyse New Zealand's dairy trade data to establish significant trends before and during the COVID-19 crisis. Thus, we structure the remainder of this chapter as follows. Section 2.1 discusses the pre-COVID-19 trends in the New Zealand dairy trade. In this section, we cover the period from 2015 to 2019. We then look at the New Zealand dairy trade during the COVID-19 pandemic in section 2.2. In particular, we discuss the trade performance in 2020, from January to December. Finally, section 2.3 summarises the chapter.

2.1 Pre-pandemic trends

To conduct this analysis, we disaggregate New Zealand's dairy trade data along the categories of dairy products and trading partners. The analysis mainly focuses on New Zealand's top ten trading partners. Furthermore, we utilise the WTO classification of dairy products, which categorises dairy products into fresh milk and cream; milk powder; yoghurt, buttermilk and kephir; whey and milk constituents; butter and dairy spreads; and cheese and curd. Table 1 below shows the New Zealand dairy trade between 2015 and 2019 along these two dimensions. We choose the period 2015 to 2019 to provide a snapshot of the New Zealand dairy trade before the outbreak of COVID-19.

In 2019, New Zealand's dairy exports amounted to $15,760 million, while its dairy imports totalled $323 million. Over the five years before COVID-19, New Zealand's dairy exports grew by approximately 37% (from $11,760 million to $15,760 million), and its dairy imports by roughly 35% (from $240 million to $323 million). On the export side, China contributed significantly towards the growth. Between 2015 and 2019, China increased its export share from 21% to 33.4%. China was also the leading trading partner (in total dairy trade). On the import side, the growth was primarily driven by the non-top ten trading partners, which increased their import share from 48.6% in 2015 to 63.7% in 2019.

Regarding the main trading partners, New Zealand primarily trades with the Asia-Pacific and European countries. In 2019, most dairy trade occurred with China (32.8%), followed by Australia (5.3%), the Philippines (3.9%), the United States of America (USA) (3.8%), Malaysia (3.7%), and Japan (3.5%). The Philippines and Malaysia are members of the Association of Southeast Asian Nations (ASEAN), an economic community established in 1967.[6] Furthermore, all these countries, except for the USA, are RTA trading partners of New Zealand. This suggests that trade with ASEAN countries and within RTAs significantly affects New Zealand's dairy exports and imports. This is to be expected given that "trade within RTAs often benefits from better trade conditions and lower trade costs relative to trade outside RTAs" (Nicita & Saygili, 2021, p.3).

As for the trade by product category, while milk powder dominated between 2015 and 2019, butter and dairy spreads, and whey and milk constituents experienced an increase in their trade shares. The trade share of butter and dairy spreads rose from 19.9% in 2015 to 21.8% in 2019, and whey and milk constituents saw its share grow from 2.7% to 4.6%. These share increases were driven by the gains from the export side, as exports accounted for the largest proportion of the overall trade values. On the losing side, the trade shares of cheese and curd, fresh milk and cream, and yoghurt, buttermilk and kephir slid between 2015 and 2019.

[6]Association of Southeast Asian Nations. (n.d.). *About ASEAN*. https://asean.org/about-asean. The full list of the ASEAN members can be found here.

Table 1: Main dairy trading partners, dairy product categories, and trends

	Total trade		Imports		Exports	
	2015	**2019**	**2015**	**2019**	**2015**	**2019**
Total (in millions of NZD)	11,760	16,083	240	323	11,520	15,760
Trading partner (share in %)						
China	20.6	32.8	0.0	0.1	21.0	33.4
Australia	4.3	5.3	31.8	21.5	3.7	5.0
Philippines	3.9	3.9	0.0	0.1	4.0	3.9
USA	5.2	3.8	18.0	14.4	4.9	3.6
Malaysia	4.5	3.7	0.3	0.2	4.6	3.8
Japan	3.4	3.5	1.3	0.0	3.4	3.6
UAE	5.2	3.4	0.0	0.0	5.3	3.4
Indonesia	3.0	3.2	0.0	0.0	3.0	3.3
Saudi Arabia	3.2	2.9	0.0	0.0	3.3	2.9
Algeria	4.2	2.8	0.0	0.0	4.3	2.8
Others	42.4	34.8	48.6	63.7	42.3	34.2
Product category (share in %)						
Milk powder	54.8	53.7	32.6	25.7	55.2	54.2
Butter and dairy spreads	19.9	21.8	2.6	2.5	20.2	22.1
Cheese and curd	14.6	13.2	25.0	33.1	14.4	12.8
Fresh milk and cream	6.5	5.8	2.4	3.7	5.9	5.8
Whey and milk constituents	2.7	4.6	36.7	34.1	2.7	4.0
Yoghurt, buttermilk and kephir	1.5	1.1	0.7	0.9	1.5	1.1

Notes: UAE = United Arab Emirates, USA = the United States of America
Source: Author's calculations based on data from Statistics New Zealand. https://infoshare.stats.govt.nz/ (retrieved 15 July 2022).

2.2 New Zealand's dairy trade during COVID-19

In this section, we present the performance of the New Zealand dairy trade during the COVID-19 pandemic. Specifically, subsection 2.2.1 analyses New Zealand dairy exports and subsection 2.2.2 looks at New Zealand dairy imports.

2.2.1 Performance of the New Zealand dairy exports during COVID-19

Table 2 shows the export values, shares, and growths for each category of dairy products. The table presents these figures for 2019 and 2020 for comparative statics.

Table 2: Export values, shares, and growths

	Exports					
	Value (in millions of NZD)		Share (%)		Growth (%)	
Product category	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**
Fresh milk and cream	920	977	5.8	6.2	23.6	6.2
Milk powder	8,545	9,013	54.2	57.0	19.4	5.5
Yoghurt, buttermilk and kephir	166	169	1.1	1.1	23.2	1.8
Whey and milk constituents	629	722	4.0	4.6	11.8	14.8
Butter and dairy spreads	3,490	2,915	22.1	18.4	-7.1	-16.5
Cheese and curd	2,010	2,029	12.8	12.8	5.9	0.9
Total (or average for growth)	**15,760**	**15,825**	**100**	**100**	**10.6**	**0.4**

Source: Author's calculations based on data from Statistics New Zealand. https://infoshare.stats.govt.nz/ (retrieved 15 July 2022).

Looking at the 2020 growth column, we can see that, except for whey and milk constituents, all the other product categories have experienced marked reductions in growth in 2020. The most affected product category was yoghurt, buttermilk and kephir (from 23.2% in 2019 to 1.8% in 2020), followed by fresh milk and cream, milk powder, butter and dairy spreads, and cheese and curd. The decline in export growth in 2020 for fresh milk and cream, milk powder, butter and dairy spreads, and cheese and curd is easy to explain. In Table 1, these categories are the top four most traded categories and so were the most exposed to the impact of COVID-19 in 2020. Furthermore, the top export destination for these categories in 2020 was China (see Figure 1 on page 21 and table A1 in the appendices). Therefore, the drop in the growth rates for the exports of these categories is also consistent with the finding that sectors with high exposure to China's market contracted more compared to less exposed sectors in 2020 (Meier & Pinto, 2020). As for yogurt, buttermilk and kephir, it is the least traded product category (see Table 1). However, about 67.75% of its exports were exported to the ASEAN countries in 2020. The ASEAN countries are highly economically interconnected with China.[7] China, therefore, had an indirect influence on the exports of yoghurt, buttermilk and kephir in 2020 through its interconnection with the ASEAN countries. Hence, the significant reduction in the export growth of yoghurt, buttermilk and kephir, although this product category is least traded.

[7] China has been ASEAN's largest trading partner since 2019, with trade between China and ASEAN more than doubled since 2010 (ASEAN, n.d.).

2.2.2 Performance of the New Zealand dairy imports during COVID-19

Table 3 below shows the import values, shares, and growths for each category of dairy products. As previously stated, we present these figures for 2019 and 2020 for comparative statics.

Table 3: Import values, shares and growths

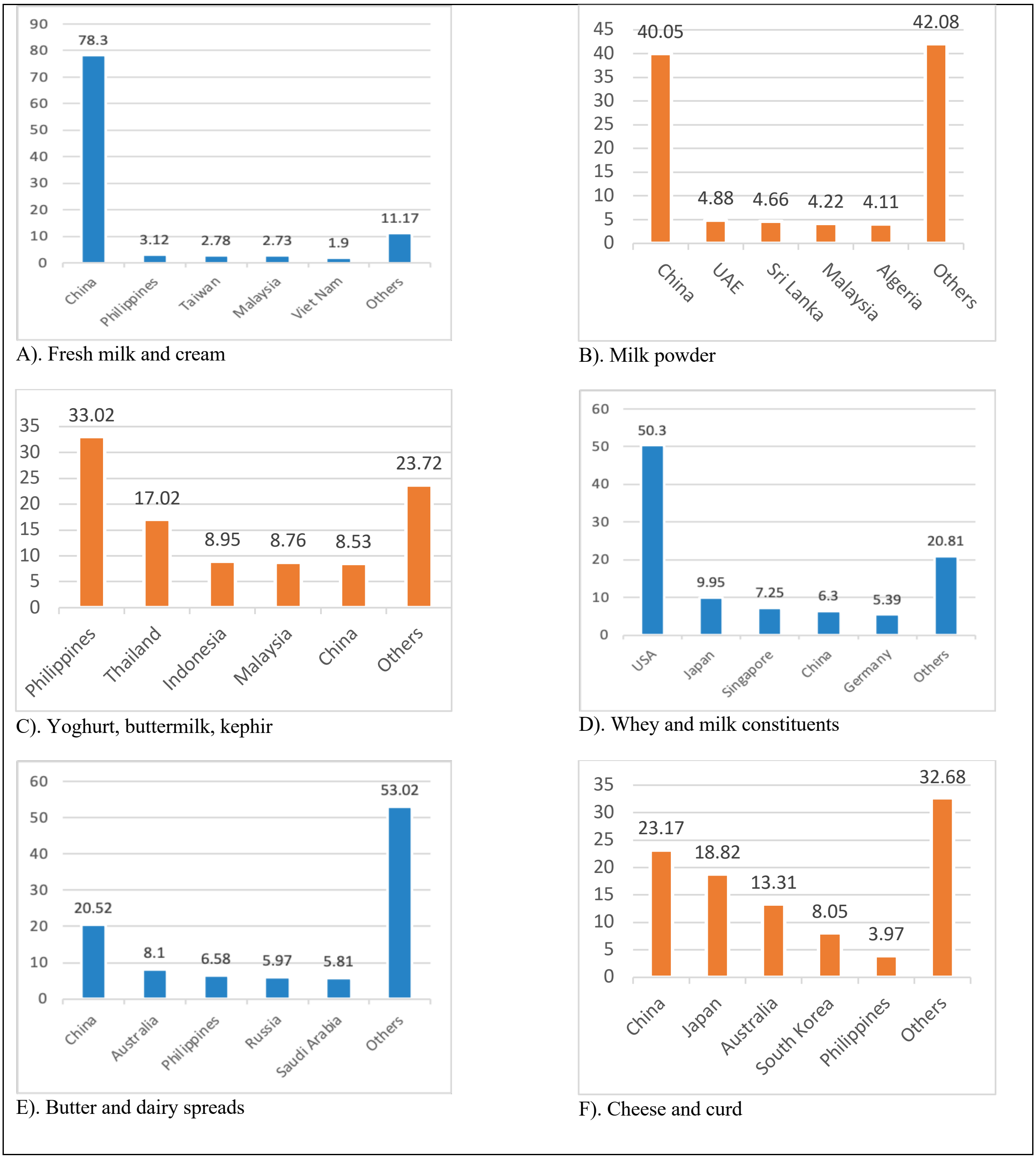
	Imports					
	Value (in millions of NZD)		**Share (%)**		**Growth (%)**	
Product category	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**
Fresh milk and cream	12	13	3.7	4.0	20.0	8.3
Milk powder	83	77	25.7	25.0	118.4	-7.2
Yoghurt, buttermilk and kephir	3	3	0.9	1.0	0.0	0.0
Whey and milk constituents	110	121	34.1	9.0	-1.8	10
Butter and dairy spreads	8	7	2.5	2.0	14.3	-12.5
Cheese and curd	107	92	33.1	29.0	15.1	-14.0
Total (or overall growth)	**323**	**313**	**100**	**100**	**22.8**	**-3.1**

Source: Author's calculations based on data from Statistics New Zealand. https://infoshare.stats.govt.nz/ (retrieved 15 July 2022).

In Table 3, we observe that the import growth of whey and milk constituents increased from -1.8% in 2019 to 10% in 2020, while the import growth of yoghurt, buttermilk and kephir was unaffected in 2020. On the other hand, the other four product categories saw a significant drop in growth in 2020, with the worst impacted category being milk powder (from 118.4% in 2019 to -7.2% in 2020), followed by cheese and curd, butter and dairy spreads, and fresh milk and cream. This information is consistent with the picture in table 1 *vis-a-vis* the trade shares of the product categories. Yoghurt, buttermilk and kephir, and whey and milk constituents are the two least traded categories, while the other four categories are the most traded and were thus most exposed to the adverse effect of the pandemic.

Furthermore, yoghurt, buttermilk and kephir, and fresh milk and cream are the top two categories that saw nearly all imports come from the top five import origins in 2020 (see Figure 2 on page 22 and Table A2 in the appendices). This also most likely helped mitigate the negative impact of COVID-19 on the imports of these categories, as the imports came from a narrow pool of countries.

Figure 1: Export shares by country



A). Fresh milk and cream

B). Milk powder

C). Yoghurt, buttermilk, kephir

D). Whey and milk constituents

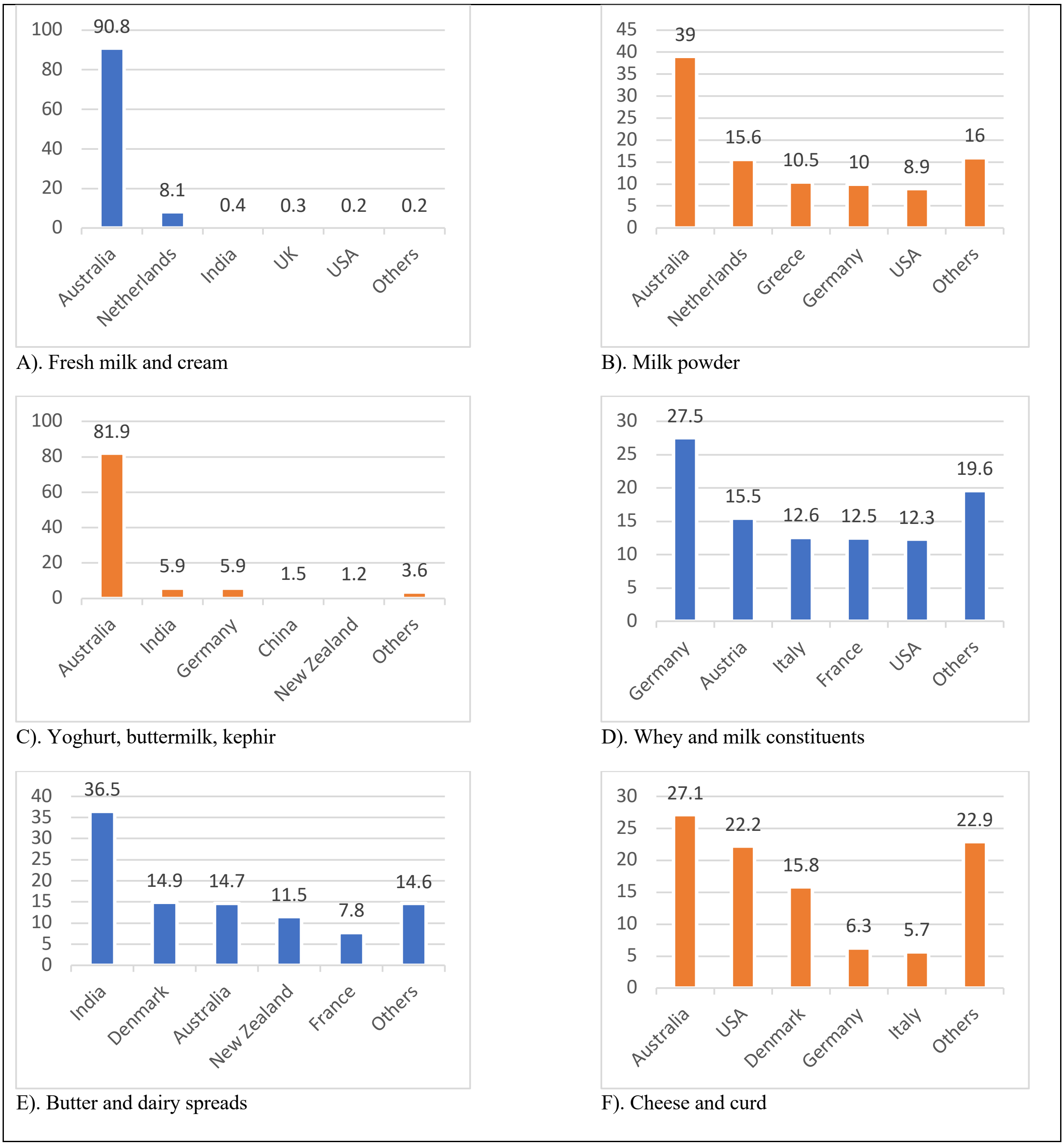
E). Butter and dairy spreads

F). Cheese and curd

Notes: USA = the United States of America

Source: Author's calculations based on data from Statistics New Zealand. https://infoshare.stats.govt.nz/ (retrieved 15 July 2022).

Figure 2: Import shares by country



Notes: USA = the United States of America
Source: Author's calculations based on data from Statistics New Zealand. https://infoshare.stats.govt.nz/ (retrieved 15 July 2022).

2.3 Chapter summary

This chapter presented the history of the New Zealand dairy trade, looked at the New Zealand dairy exports and imports trends between 2015 and 2019, and analysed the New Zealand dairy trade during the COVID-19 crisis. New Zealand has a long history of dairy trade, going as far back as 1845. This history includes a forty-year period (1961-2001) during which the NZDB was the monopoly exporter of New Zealand dairy goods. However, this monopolistic arrangement limited innovation and competition at home. Thus, the New Zealand government enacted DIRA in 2001. DIRA created an environment that enhanced innovation and competition, leading to more dairy firms entering the market and helping the industry become a dominant player in the global dairy trade.

Section 2.1 showed that New Zealand dairy exports and imports grew by 37% and 35%, respectively, between 2015 and 2019. We also observed that China was the leading trading partner - followed by the ASEAN - and milk powder was the most traded product category during this period.

We then looked at the data for New Zealand’s dairy trade during the COVID-19 crisis. This analysis demonstrated that, except for whey and milk constituents, COVID-19 had an adverse effect that was different in magnitude across the product categories. This heterogeneous impact primarily arose from a category's exposure to China's market and its share of the total dairy trade. We expect our empirical analysis to support this and indicate how much trade with and without China was impacted by COVID-19.

Chapter 3: Literature review

In this chapter, we review past literature pertinent to our research. We begin with a review of the theoretical and empirical literature on the economic impact of COVID-19 on international trade and RTAs in section 3.1. We follow this with a review of the literature on the gravity model, a methodology utilised in this research, in section 3.2. Finally, we summarise the key points in this chapter in section 3.3.

3.1 Review of the literature on RTAs the impact of COVID-19 on international trade

Our study contributes to the literature on RTAs and the economic impact of COVID-19 on international trade in goods. Currently, the literature on the economic impact of COVID-19 on international trade in goods consists predominantly of overseas studies (Buchel et al., 2020; Friedt & Zhang, 2020; Meier & Pinto, 2020; Hayakawa & Mukunoki, 2021). Hayakawa and Mukunoki (2021) study the effects of COVID-19 on international trade in goods only, from January to August 2020. The authors estimate the gravity equation (more details on the gravity equation in the next section) using monthly trade data from 34 exporting countries and 173 export destinations, four different measures of COVID-19 incidence, and three fixed effect controls (see Table 4).[8] Their findings indicate that there were significantly negative effects of COVID-19 on international trade of both exporting and importing countries, but different industries and periods were affected differently.

Buchel et al. (2020) investigate the impact of COVID-19 on the Swiss goods trade between January to July 2020. By comparing the Swiss trade flows between January to July 2020 with the corresponding trade flows in 2019, Buchel et al. (2020) have found that, although the Swiss trade generally fell by 11% in 2020 compared to 2019, some sectors were more adversely affected than others. Furthermore, using linear regression models (with the controls and variables shown in Table 4), they have also found that the decline in Swiss exports was correlated with the number of confirmed COVID-19 cases in an importing country, while Swiss imports were more strongly affected by the stringency index countermeasures implemented in an exporting country.

[8] We list the fixed effect controls in Table 4 without explaining what they are and why they are used in the paper. We reserve this for Section 3.2.

Moreover, Friedt and Zhang (2020) analyse the impact of COVID-19 on China's goods exports. Like Hayakawa and Mukunoki (2021), these authors use the gravity model (albeit estimated differently) with a set of fixed effect controls. They have found that a 1% increase in the domestic and foreign COVID-19 cases led to 2.5% to 4.6% drop in Chinese exports. They have also found that COVID-19 affected products and Chinese provinces differently.

Finally, Hayakawa and Imai (2022) examine the impact of COVID-19 on the exports of medical goods. The authors use the same time period and follow a similar methodology as in the study by Hayakawa and Mukunoki (2021). However, they extend the methodology by adding four bilateral linkages. These linkages include political ties (proxied by voting similarity in the United Nations General Assembly (UNGA)) and economic ties (proxied by the presence of RTAs). By incorporating these four linkages, Hayakawa and Imai (2022) show that the adverse impact of COVID-19 on the exports of medical goods was lower when exporting to countries with political, economic or geographical ties.

Table 4: Previous studies on COVID-19 effects on international trade in goods.

Study	**Methodology**	**Explanatory variables**	**Period**	**Key findings**
Buchel, Legge, Pochon and Wegmuller (2020). *Swiss trade during the COVID-19 pandemic: an early appraisal.*	• Compared aggregated weekly Swiss goods trade flows between January and July 2017, 2018, 2019, and 2020. • Compared disaggregated (across trading partners and products) monthly and quarterly Swiss goods trade flows between	Consumer confidence, Purchasing Manager Indices (PMI), COVID-19 cases per a thousand people, stringency index countermeasures, trading partner fixed effects, time period fixed effects, and exchange rates.	January to July 2017, 2018, 2019, and 2020.	• Swiss trade during the COVID-19 pandemic dropped by 11% compared to 2019. • Some sectors were more negatively affected than others. • The contraction in Swiss exports was correlated with an importing country's number of confirmed COVID-19 cases, while Swiss imports were more strongly associated with an exporting country's stringency index countermeasures.

	January and July 2019 and 2020. • Used linear regression models, estimated using the OLS method.			
Friedt and Zhang (2020). *The triple effect of Covid-19 on Chinese exports: first evidence of the export supply, import demand and GVC contagion effects.*	Estimated the gravity model using the OLS method.	Inverse hyperbolic sine (IHS) transformed Chinese provinces' COVID-19 cases and trading partners' COVID-19 cases, a GVC contagion measure, province-to-country effect, commodity fixed effect, and time fixed effect.	January 2019 to June 2020.	• For every 1% rise in new domestic and international Coronavirus cases Chinese exports fell by 2.5% to 4.6%. • While exports of pharmaceutical products significantly rose with the intensity of the Coronavirus outbreak, products that are typically air freighted suffered significant reductions in exports due to the collapse of international air travel. • Not all provinces suffered the same fate in terms of their exports.
Meier and Pinto (2020). *COVID-19 supply chain disruptions.*	Used an empirical technique which exploited differences in the sector-specific exposure to intermediate goods imported from a region or country.	Constructed sector-specific China's exposure measures.	January 2019 to July 2020.	• US sectors that were highly exposed to Chinese imports contracted more than other sectors. • The heterogeneous effects of COVID-19 on US sectors were relatively short

				and dissipated by July 2020.
Hayakawa and Mukunoki (2021). *The impact of COVID-19 on international trade: Evidence from the first shock.*	Estimated the gravity model using the PPML method.	Four measures of the COVID-19 damage, including the numbers of exporter and importer's monthly COVID-19 cases and deaths, a vector of dummy variables used to analyse the monthly changes in the coefficients for the COVID-19 measures, country-pair year fixed effects, country-pair month fixed effects, and year-month fixed effects.	January to August of 2019 and 2020.	• There were significantly negative effects of COVID-19 on international trade of both exporting and importing countries. • The negative effects, particularly the effects of COVID-19 on importing countries, became insignificant after July 2020. • Different industries were affected differently.
Hayakawa and Imai (2022). *Who sends me face masks? Evidence for the impacts of COVID-19 on international trade in medical goods.*	Estimated the gravity model using the PPML method.	Exporter and importer's monthly COVID-19 cases and deaths, United Nations General Assembly's (UNGA) 2019 Voting Similarity Index to indicate strategic relationships, geographical distance, a vector of dummy	January to August of 2019 and 2020.	An increase in COVID-19 incidence decreases exports of medical goods, but such a decrease is lower when exporting to countries with political, economic or geographical ties.

		variables used to analyse the monthly changes in the coefficients for the COVID-19 measures, country-pair fixed effect, year-flow fixed effect, and an RTA dummy variable, which takes the value of 1 if both countries i and j are members of an enforced RTA.		

Reviewing the above studies, although all have analysed the impacts of COVID-19 on international trade, our study relates more closely to Hayakawa and Imai (2022). In both papers, focus is on the impacts of COVID-19 on trade in just one class of goods, these being medical goods in Hayakawa and Imai (2022) and dairy goods in our paper. Furthermore, unlike the other papers, Hayakawa and Imai (2022) have also analysed the influence of RTAs on trade during COVID-19. Also, for the reasons discussed in the following section, we apply their methodology in our analysis.

However, our paper distinguishes itself from all above studies in that it focuses specifically on the exports and imports of dairy products between New Zealand and the rest of the world. To our knowledge, this is the first paper to do this. It will thus shed light on the impact of COVID-19 on the New Zealand dairy trade – including whether the impact has been uniform or heterogenous across the categories of dairy products and over the months following the outbreak of COVID-19 – and the role played by RTAs between New Zealand and its trading partners. This is our main contribution.

By definition, RTAs are types of free trade agreements (FTAs) between two or more countries that enhance their ability to trade between themselves, by breaking down the existing trade barriers. Thus, RTAs facilitate trade and increase economic integration between trading partners (Khalid et al., 2022). Traded goods are the most common subject of RTAs, where duties are reduced or eliminated, and import quotas are increased or removed. However, some sectors, such as the dairy sector, are seen as sensitive and are treated differently in the terms of an RTA (Howard, 2011). While import duties on the vast majority of goods are usually eliminated at entry into force of an RTA, import tariffs on goods from the more sensitive sectors are phased out over a specified period of time to allow these sectors to adjust to tariff reductions (Howard, 2011).

Many RTAs include provisions on NTMs. According to Gubarev et al. (2020, p.1),

> "In Regional Trade Agreements (RTAs) regulations on human, animal or plant health, protection of the environment, animal welfare etc. are progressively gaining more weight. The number of RTAs has increased in the past 20 years as has the share of RTAs that include provisions on NTMs."

RTAs often also cover a host of other considerations, such as trade diversion.[9] However, for the purposes of this literature, we are not looking at these considerations. Rather, in the following paragraphs, we evaluate a few empirical studies that have examined the impacts of RTAs on trade during the COVID-19 crisis.

One of these papers is Nicita and Saygili (2021). This paper has investigated the impact of RTAs on mitigating the downturn during the COVID-19 pandemic. Using a simple cross-section econometric approach with a set of fixed effects controls, Nicita and Saygili (2021) have found that trade within RTAs decreased significantly less than under no agreements during the pandemic.

Das and Sen (2022) have examined the role of trade facilitation and cooperation for the Asian economies. Although they focus on only 29 economies, Das and Sen (2022) have also found that the adverse effect of COVID-19 was lower in economies engaged in RTAs. Hayakawa and Imai (2022), who motivate our paper, have concluded the same.

[9] See the following for the descriptions and analyses of these considerations: Bhagwati & Panagariya (1996), Frankel (1997), LeClair (1997), Bhagwati (2008), Australian Productivity Commission (2010), Howard (2011).

3.2 Review of the literature on the gravity model

The equations that we use in our analysis draw from the fundamentals of the gravity model of international trade. The gravity model is an "ex post econometric technique" (Australian Productivity Commission, 2010, p.47) which originated from Newton's Law of Universal Gravitation (Shuai, 2010; Yotov et al., 2016). It states that bilateral trade flows between any two countries are directly proportional to the product of their economic sizes – usually expressed in terms of GDP – and inversely proportional to the distance between them (Yotov et al., 2016). The concept of distance in the model does not only subsume the geographical distance between two countries but also other determinants of trade frictions, such as the presence of a shared colonial history. Thus, the model generally predicts that countries with larger economic sizes trade more but countries that are further apart trade less because of higher trade costs (Muganyi & Chen, 2016).

Anderson and van Wincoop (2003), who were the first researchers to theoretically specify the gravity model with multilateral resistances, and Yotov et al. (2016) provide the simplest form of the gravity model as:

$$X_{ij} = \frac{Y_i E_j}{Y}\left(\frac{t_{ij}}{\Pi_i P_j}\right)^{1-\sigma} \quad (1)$$

Where X_{ij} is trade flows from country i to country j, Y_i is the nominal national income of country i, E_j is the aggregate expenditure of country j on goods from different countries (including country j), Y is the global output, t_{ij} denotes bilateral trade costs between country i and country j, σ denotes the elasticity of substitution among different goods from different countries, and Π_i and P_j represent the multilateral resistances in country i and country j, respectively. Π_i is an outward multilateral resistance that indicates the ease of market access for country i and P_j is an inward multilateral resistance that denotes the ease of market access for country j (Anderson & van Wincoop, 2003; Yotov et al., 2016).

Because equation (1) is multiplicative in nature, it can be log-linearised so that:

$$\ln X_{ij} = lnY_i + \ln E_j + (1-\sigma)t_{ij} - (1-\sigma)\Pi_i - (1-\sigma)P_j + \varepsilon_{ij} \ (2)$$

Specification (2) is the 'most popular version' of the gravity model. It has been widely utilized to evaluate trade factors, identify effects of trading groups, analyse trade models, and estimate the marginal cost of trade tariffs (Shuai, 2010). For example, Boisso and Ferrantino (1997) have used it to estimate the effects of economic distance, cultural distance, and openness on international trade.

Notwithstanding its popularity, specification (2) is subject to several challenges. One of these challenges is the issue of possible endogeneity between regional trade agreements and tariffs. Tariffs are part of the bilateral trade costs. It is more likely that a country will form a trade agreement with a major trading partner to reduce or remove tariffs. Thus, RTA variables may be correlated with unobserved trade costs, leading to the generation of unreliable estimates (Yotov et al., 2016).

As a solution, international trade scholars have proposed using country-pair fixed effects as a convenient way to account for the unobservable correlation between RTA variables and the error term (Baier & Bergstrand, 2007; Agnosteva et al., 2014). As an added advantage, country-pair fixed effects absorb the standard gravity time-invariant trade-cost variables, such as geographical distance, and all other observable and unobservable country-specific time-invariant characteristics. In fact, Agnosteva et al. (2014) and Egger and Nigai (2015) have demonstrated that country-pair fixed effects provide a better fit for the bilateral trade costs than the traditional gravity variables. Thus, country-pair fixed effects serve a dual purpose of (i) allowing for a more reliable estimation of the impact of a bilateral trade policy through accounting for the endogeneity problem and (ii) absorbing the standard gravity time-invariant variables, such as distance.

A second challenge that the model faces is that the OLS method, which is the most used method of estimating the model, cannot account for the zero trade flows. Zero trade flows exist simply because no trade occurred between some pairs of countries in a given period, or because of rounding errors, or because missing observations may have been erroneously recorded as zeroes (Silva & Tenreyro, 2006). Whatever the reason for their presence, if the OLS method is used, such observations are discarded from an estimation sample during the transformation of the trade values into logarithmic forms (Yotov et al., 2016). We would therefore delete all observations with zero trade flows in our data set if we used the OLS method. However, our data set contains a significantly large proportion of these observations (see Table 8 in the next chapter for the actual share of the observations with zero trade values in each product category).

To overcome this challenge of zero trade values, the PPML method has been proposed as an appropriate approach to handle the problem. According to Silva and Tenreyro (2006, 2011), the PPML method provides a natural way to deal with zeros in trade data – even when the proportion of zeros is substantial – and is also robust to different patterns of heteroskedasticity. Because of these advantages, the PPML method is increasingly being used in international trade studies (Hayakawa & Mukunoki, 2021; Das & Sen, 2022; Hayakawa & Imai, 2022).

A third problem with estimating the gravity model is that the "multilateral resistance terms P_j and Π_i are theoretical constructs" that are unobservable to the researchers (Yotov et al., 2016). However, Anderson and van Wincoop (2003) have demonstrated that the terms can be approximated by the "remoteness indexes" which require intra-national trade estimates. However, intra-national trade estimates are often unavailable or hard to obtain. Alternatively, Olivero and Yotov (2012) and Feenstra (2016) have shown that exporter-time and importer-time fixed effects account for the multilateral resistance terms P_j and Π_i. The authors also maintain that exporter-time and importer-time fixed effects also subsume the size variables, E_j and Y_i, and observable and unobservable country-specific dynamic characteristics, such as exchange rates.

3.3 Chapter summary

This chapter reviewed the relevant literature on the economic impact of COVID-19 on international trade in goods, on the role of RTAs in alleviating the adverse effect of COVID-19 on international trade, and on the gravity model. Regarding the COVID-19 literature reviewed, two studies (Buchel et al. 2021; Hayakawa & Mukunoki, 2021) analyse both exports and imports, two (Fried & Zhang, 2020; Hayakawa & Imai, 2022) study exports only, and one (Meier and Pinto (2020)) examines imports only. We noted, however, that all five papers have found that, on average, COVID-19 has had an adverse effect on trade. On the other hand, existing RTAs have been shown to have helped mitigate this adverse effect (Nicita & Saygili, 2021; Das & Sen, 2022; Hayakawa & Imai, 2022).

While existing literature does suggest RTAs have played an active role in mitigating negative impacts of COVID-19, there is no systematic analysis of the same in the case of New Zealand and its dairy industry. This is what we attempt in the following chapter.

Chapter 4: Methodology

This chapter presents and describes the data and quantitative methods that we use to complete our research on the extent of the economic impact of COVID-19 on New Zealand's dairy trade, whether this impact has been been uniform or heterogeneous across the categories of dairy goods and over the months following the outbreak of COVID-19, and whether the existing RTAs have mitigated this impact. We first present and describe all the data we use in section 4.1. These data cover the period from January 2019 to December 2020 and come from three sources, which we provide in the following section. We then provide and discuss the methodology we utilise for our analysis in section 4.2. This methodology is motivated by Hayakawa and Imai (2022), who use the PPML method.

4.1 Data sources

This research uses data on New Zealand's dairy trade, regional trade agreements, and COVID-19 cases and deaths. We collect data on monthly dairy trade values from Statistics New Zealand. We initially start with 251 countries and territories. Then we delete 96 countries and territories because there are no COVID-19 data, the countries or territories are either defunct or duplicates, or zero trade values exist for both imports and exports across the entire study period. These deleted countries and territories are presented with the reasons for their deletion in table 5 below.

Table 5: Deleted countries and territories

	Countries/territories	**Reason for deletion**
Group One	American Samoa, Antarctica, Antarctica (USA), British Indian Territory, Christmas Island, Destination Unknown (EU), Destination Unknown (Non-EU), French Guiana, French Southern Territories, Gaza Strip/Palestine/West Bank, Guadeloupe, Martinique, Mayotte, Norfolk Island, Reunion, South Georgia and the South Sandwich Islands, United States Minor Outlying Islands, and Western Sahara	No COVID-19 data
Group Two	Czechoslovakia, Democratic Republic of Yemen, East Timor, Netherlands Antilles, Union of Soviet Socialist Republics, Yugoslavia, and Zaire	Defunct or duplicate

Group Three	Afghanistan, Albania, Andorra, Anguilla, Belarus, Benin, Bhutan, Bosnia and Herzegovina, Botswana, British Virgin Islands, Burkina Faso, Burundi, Cabo Verde, Cayman Islands, Central African Republic, Chad, Croatia, Democratic People's Republic of Korea, Dominica, Equatorial Guinea, Eritrea, Estonia, Eswatini, Ethiopia, Faroe Islands, Falkland Islands, Finland, Gibraltar, Greenland, Guinea, Guinea-Bissau, Iceland, Kazakhstan, Kyrgyzstan, Laos, Lesotho, Liberia, Liechtenstein, Luxembourg, Malawi, Mali, Malta, Moldova, Monaco, Montenegro, Montserrat, Morocco, Namibia, Nepal, Niger, Paraguay, Pitcairn, Puerto Rico, Romania, Rwanda, San Marino, Sao Tome and Principe, South Sudan, St Kitts and Nevis, St Pierre and Miquelon, Tokelau, Turkmenistan, Turks and Caicos Islands, Uganda, US Virgin Islands, Uzbekistan, Vatican City, Zambia, and Zimbabwe	Zero trade values for both imports and exports across the entire period.

Notes: EU = the European Union, USA = the United States of America

After the deletion of the above countries and territories, our revised data set consists of the data covering the bilateral dairy trade between New Zealand and 155 trading partners from January 2019 to December 2020. The data are collected at the Harmonized System (HS) four-digit level according to the WHO classification of dairy products, which comprises six categories. Table 6 presents these six categories.

Table 6: Categories of dairy goods.

4-digit HS Code	Category description
0401	Fresh milk and cream
0402	Milk powder
0403	Yoghurt, buttermilk and kephir
0404	Whey and milk constituents
0405	Butter and dairy spreads
0406	Cheese and curd

Our data on RTAs come from New Zealand's Ministry of Foreign Affairs and Trade (MFAT). Currently, fourteen agreements are in force. However, only eleven of the fourteen agreements relate to the time frame mentioned above. Table 7 provides the details of these agreements, including the year each agreement came into force. Note that all these RTAs include market access commitments on dairy products with specified rules of origin (RoO).[10]

Table 7: The relevant RTAs

Agreement	Year entered into force
New Zealand-Australia Closer Economic Relations (CER)	1983
New Zealand-Singapore Closer Economic Partnership (CEP)	2001
New Zealand-Thailand CEP	2005
The Trans-Pacific Strategic Economic Partnership (P4)	2006
New Zealand-China Free Trade Agreement (FTA)	2008
New Zealand-Malaysia FTA	2010
New Zealand-Hong Kong, China CEP	2011
ASEAN-Australia-New Zealand FTA (AANZFTA)	2012
The Agreement between New Zealand and the Separate Customs Territory of Taiwan, Penghu, Kinmen, and Matsu on Economic Cooperation (ANZTEC)	2013
New Zealand-Korea FTA	2015
Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP)	2018

Sources: MFAT. https://www.mfat.govt.nz/en/trade/free-trade-agreements/free-trade-agreements-in-force/ (retrieved 31 July 2022).
MFAT's New Zealand Treaties Online. https://www.treaties.mfat.govt.nz/search/details/t/3795/c_1 (retrieved 31 July 2022).

It is worth mentioning that some trading partners are members of two or more of the above agreements. For example, Malaysia is a party to the New Zealand-Malaysia FTA, AANZFTA, and CPTPP. However, our research does not investigate the separate effects of a specific RTA on the dairy trade between New Zealand and such a trading partner.[11]

Finally, we extract data on COVID-19 incidence from the Our-World-in-Data website. COVID-19 incidence is measured as the aggregate of confirmed cases or deaths each month from January to December 2020. We use both COVID-19 cases and deaths in separate regressions to check for the robustness of our estimation models, following Hayakawa and Imai (2022).

[10] Rules of origin are procedures and regulations that identify "the economic nationality of a product" (Staples, 2011, p.2). They are used to establish if specific products are eligible for tariff preferences under a specific trade agreement. For example, a New Zealand dairy exporter exporting to Taiwan can use RoO under ANZTEC to claim tariff preferences under this agreement.
[11] Furthermore, bilateral dairy trade between New Zealand and the Pacific countries, particularly regarding dairy exports from New Zealand, generates millions of dollars annually for the New Zealand economy. For example, dairy exports to the Pacific countries totalled $141.3 million in 2019 (author's calculations). However, the regional trade agreement – the Pacific Agreement on Closer Economic Relations (PACER) Plus – which connects New Zealand with most Pacific countries came into force on 13 December 2020 (MFAT, n.d.). This agreement falls in the final month of our research time frame and adds little value to our research. Therefore, we have excluded it.

4.2 Estimations and model specifications

Motivated by the solutions proposed to the challenges to the standard gravity model that we covered in the previous chapter and by Hayakawa and Imai (2022), we specify our baseline model as follows:

$$Trade_{ijym} = exp\{\alpha_1 COVID_{iym} + \beta_1 COVID_{jym} + \delta_{ijy} + \delta_{ijm} + \delta_{ymf}\} * \in_{ijym} \quad (3)$$

$Trade_{ijym}$ is the export value of a specific dairy product category from New Zealand (or country i) to country j (or New Zealand) in month m in year y. $\mathrm{COVID_{iym}}$ is the level of Covid-19 burden in exporting country i − including New Zealand − in month m in year y, and $\mathrm{COVID_{jym}}$ is the level of COVID-19 burden in importing country j − including New Zealand − in month m in year y. The numbers for $\mathrm{COVID_{iym}}$ and $\mathrm{COVID_{jym}}$ are set to zero for 2019, and we add one to these numbers before taking their logs. Coefficients α_1 and β_1 indicate the effects of COVID-19 on trade in the exporting and importing countries, respectively. We expect α_1 and β_1 to be negative and positive, respectively. $\in_{ijym}$ is the error term. δ_{ijy}, δ_{ijm}, and δ_{ymf} are fixed effect controls. δ_{ijy} is a country-pair year fixed effect, which controls for standard gravity variables such as geographical distance (Hayakawa & Mukunoki, 2021; Hayakawa & Imai, 2022) and all other observable and unobservable country-specific characteristics. δ_{ijm} is a country-pair month fixed effect, which controls for the seasonality in trade between New Zealand and each of its trading partners. Finally, δ_{ymf} is a year-month-flow fixed effect, which controls for (i) variations in world income and (ii) the difference in the trade value between the export and import statistics. We estimate equation (3) for each of the six categories of dairy products using the PPML method. The PPML method allows us to use the observations with zero trade values in our equation (Silva & Tenreyro, 2006, 2011). As shown in Table 8, each dairy product category contains a substantial proportion of these observations.

Table 8: Share of observations with zero trade values.

Product category	Share of zero trade values (%)
Fresh milk and cream	67.0
Milk powder	65.5
Yoghurt, buttermilk and kephir	70.5
Whey and milk constituents	67.4
Butter and dairy spreads	68.3
Cheese and curd	62.5

Source: Author's calculations based on data from Statistics New Zealand. https://infoshare.stats.govt.nz/ (retrieved 15 July 2022).

Equation (3) does not provide information concerning whether the impact of COVID-19 has been heterogeneous over the specified period, nor does it account for RTA influences. So, we extend the equation by introducing monthly dummies to estimate the time-series changes in the coefficients for the COVID-19 variables. In this extended equation, **D** includes dummy variables that represent months.

$$Trade_{ijym} = exp\{COVID_{iym}\mathbf{D}'\alpha + COVID_{jym}\mathbf{D}'\beta + \delta_{ijy} + \delta_{ijm} + \delta_{ymf}\} * \in_{ijym} \quad (4)$$

We also extend equation (3) by introducing the interaction terms of COVID-19 variables with the RTA variable.

$$Trade_{ijym} = exp\{\alpha_1 COVID_{iym} + \alpha_2 COVID_{iym} * RTA_{ij} + \beta_1 COVID_{jym} + \beta_2 COVID_{jym} * RTA_{ij} + \delta_{ijy} + \delta_{ijm} + \delta_{ymf}\} * \in_{ijym} \quad (5)$$

RTA_{ij} is a dummy variable which takes the value of 1 if both countries i and j are members of an RTA, or zero if otherwise. Coefficients α_2 and β_2 indicate the effects of RTA on trade in the exporting and importing countries, respectively, given the incidence of COVID-19.[12]

4.3 Chapter summary

This chapter looked at our data and analysed the empirical models that we use to examine the extent of the economic impact of COVID-19 on New Zealand's dairy trade, whether this impact has been been uniform or heterogeneous across the categories of dairy goods and over the months following the outbreak of COVID-19, and whether the existing RTAs have mitigated this impact. Our raw data, which comprised 251 countries and territories, needed cleaning first because some countries and territories were found to have zero COVID-19 data, others had zero trade values for both imports and exports across the whole study period, and a few others were found to be defunct or duplicate. This cleaning narrowed down the number of countries and territories to 155. Thus, we collected our final dairy trade, COVID-19, and RTA data on these remaining countries and territories.

Although we removed the countries and territories with zero trade values both for exports and imports across the study period, we noted that our data set still contains a significant

[12] For example, New Zealand-China bilateral trade values take on the value of 1 because the pair have an enforced FTA between them; however, New Zealand-India bilateral trade values take on the value of zero because there is no enforced FTA between the two countries at present.

proportion of the observations of with zero trade values. At least 62.5% of the total observations in each product category are zero trade values. This is not surprising due to the disaggregated nature of our data. However, the presence of such a significant proportion of zero-value observations is believed to badly affect the usefulness of the OLS method as an estimation technique for the gravity equation (Silva & Tenreyro, 2006 & 2011; Yotov et al., 2016).

Therefore, following the empirical trade literature, especially Hayakawa and Imai (2022), we chose the PPML method to estimate our three empirical equations. Our first equation is a baseline equation. This equation allows us to analyse the extent of the economic impact of COVID-19 on trade in each dairy product category. The second and third equations extend on the baseline equation and are used to help us understand the presence of heterogeneous temporal impacts on trade in each dairy product category and the presence of trade-enhancing effects of the existing RTAs, respectively.

The next chapter presents and analyses the empirical results produced by these three equations. In this chapter, we also look at how these results relate to the pandemic trends that we analysed in Chapter 2.

Chapter 5: Empirical results and discussions

5.1 Introduction

In chapter 4, we presented the data and analysed the estimation method and models we utilise in this research. Specifically, we discussed and analysed the PPML method. Since our trade data set contains a significant proportion of zero-trade values, the PPML method is preferred over the traditional OLS method for our estimation. It is also noted that the PPML method provides the added benefit of accounting for heteroskedasticity. Furthermore, we add three fixed effect controls – country-pair year fixed effect, country-pair month fixed effect, and year-month-flow fixed effect – to account for the standard gravity variables, observable and unobservable country-specific characteristics, and idiosyncratic shocks (Baier & Bergstrand, 2007; Agnosteva et al., 2014; Egger & Nigai, 2015; Yotov et al., 2016; Hayakawa & Mukunoki, 2021; Hayakawa & Imai, 2022).

In this chapter, we present and analyse our estimation results. We begin with the estimation results for the baseline equation in section 5.2. We follow this with the analysis of equation (4) results in section 5.3. Equation (4) looks at the possibility of the temporal heterogeneous impact of COVID-19. Section 5.4 analyses the results for equation (5), which assesses the RTA impact, and section 5.5 summarises the chapter. Note that we cluster the standard errors by country pairs in all estimations.

5.2.1 Baseline Model Estimation Results

Tables 9a and 9b report the estimation results for equation (3) for the logs of COVID-19 cases and deaths, respectively. The results are reported for all six categories of dairy products. We first look at the pseudo R^2 associated with the regression output for each product category. The pseudo R^2 is crucial because it provides the proportion of the total variation in the dependent variable that is accounted for by the independent variables. In Tables 9a and 9b, and, of course, in the following tables, this value is very low for each product category. However, this is not unexpected because the PPML method generates large pseudo R^2 values in large samples; our samples are not. Next, we analyse the coefficients of the COVID-19 variables: the exporter COVID-19 and the importer COVID-19. These coefficients are interpreted as the elasticities of dairy exports with respect to COVID-19 incidence because COVID-19 cases and deaths are logged.

Except for whey and milk constituents, the coefficient for the exporter COVID-19 effect is negatively significant for the other product categories for both COVID-19 cases and deaths. This negative exporter COVID-19 effect implies that the incidence of COVID-19 severity diminished the scale of production and export supply of the New Zealand dairy industry in 2020. This is to be expected given social distancing and other stringent COVID-19 restriction measures observed in 2020. The effect was, however, heterogeneous across the product categories. In terms of cases (Table 9a), the impact was particularly strongest for butter and dairy spreads (-0.198), followed by milk powder (-0.175), cheese and curd (-0.152), fresh milk and cream (-0.127), yoghurt, buttermilk and kephir (-0.099), and whey and milk constituents (the COVID-19 effect is not statistically different from zero for this category). In terms of deaths (Table 9b), the most affected product category was milk powder (-0.371), followed by butter and dairy spreads (-0.314), fresh milk and cream (-0.290), cheese and curd (-0.257), yoghurt, buttermilk and kephir (-0.193), and whey and milk constituents (again, the COVID-19 effect is not statistically different from zero for this category). Notwithstanding some products swapping positions going from Table 9a to Table 9b and vice versa, the results show that the most traded categories and the categories most exposed to China's market were the worst affected – these categories being milk powder, butter and dairy spreads, cheese and curd, and fresh milk and cream. These results are consistent with our observations in Chapter 2 and with Meier and Pinto's (2020) finding that sectors with high exposure to China's market contracted more compared to less exposed sectors in 2020.

Table 9a: Baseline model (CASES)

	Fresh milk and cream	**Milk powder**	**Yoghurt, buttermilk and kephir**	**Whey and milk constituents**	**Butter and dairy spreads**	**Cheese and curd**
Exporter COVID-19	-0.127*** (0.029)	-0.175*** (0.026)	-0.099*** (0.026)	-0.151 (0.093)	-0.198*** (0.023)	-0.152*** (0.029)
Importer COVID-19	0.168*** (0.039)	0.134*** (0.021)	0.167*** (0.038)	0.194** (0.081)	0.191*** (0.021)	0.151*** (0.026)
Pseudo log likelihood	-6.777e+09	-5.102e+10	-8.472e+08	-3.493e+09	-1.450e+10	-1.057e+10
Pseudo R^2	0.003	0.003	0.009	0.066	0.017	0.008
Observations	3,504	5,950	2,832	2,736	5,616	5,040

Notes: These results are produced by the PPML estimation method. ***, ** and * denote 1%, 5% and 10% statistical significance levels, respectively. The standard errors reported in parenthesis are those clustered by country-pair fixed effects. We control for country-pair fixed effects and trade flow-year fixed effects in all specifications. 'COVID-19' indicates the log of confirmed COVID-19 cases.

Table 9b: Baseline model (DEATHS)

	Fresh milk and cream	Milk powder	Yoghurt, buttermilk and kephir	Whey and milk constituents	Butter and dairy spreads	Cheese and curd
Exporter COVID-19	-0.290*** (0.040)	-0.371*** (0.064)	-0.193*** (0.037)	-0.023 (0.058)	-0.314*** (0.034)	-0.257*** (0.073)
Importer COVID-19	0.044 (0.029)	0.040 (0.041)	0.158*** (0.054)	0.200** (0.083)	0.159*** (0.041)	0.095* (0.049)
Pseudo log likelihood	-6.874e+09	-5.110e+10	-8.442e+08	-3.542e+09	-1.459e+10	-1.065e+10
Pseudo R^2	0.002	0.003	0.010	0.059	0.013	0.007
Observations	3,504	5,950	2,832	2,736	5,616	5,040

Notes: These results are produced by the PPML estimation method. ***, ** and * denote 1%, 5% and 10% statistical significance levels, respectively. The standard errors reported in parenthesis are those clustered by country-pair fixed effects. We control for country-pair fixed effects and trade flow-year fixed effects in all specifications. 'COVID-19' indicates the log of confirmed COVID-19 deaths.

In contrast to the exporter COVID-19 effect, the importer COVID-19 effect is positively significant across the six product categories for both COVID-19 cases and deaths. Several reasons could explain this positive COVID-19 effect on an importing country. First, there is what Hayakawa and Mukunoki (2021, p.3) refer to as a “panic purchase.” This arises from people seeking to stock up in preparation for the uncertain future. Panic purchases can generate a positive demand shock on essential products, leading to an increased tendency for imports of such products. Similarly, adverse supply shocks emanating from the imposed COVID-19 restrictions in the home country can make people want to compensate for domestic shortfalls with imports. We note, however, that this positive importer COVID-19 impact was generally smaller, in magnitude, compared to the corresponding negative exporter COVID-19 impact, except in a few cases, such as whey and milk constituents. This implies that, compared to 2019, export and import growths for most dairy product categories were significantly reduced in 2020. Nonetheless, the drop in export and import growths varied across the product categories. These results support the findings of the studies discussed in Chapter 3. They are also consistent with the analysis in chapter 2.

5.2.2 Evaluation of the Baseline Model Estimation Results

China is by far the most important trading partner for New Zealand, accounting for approximately 33% of New Zealand’s dairy trade in 2019 (see Table 1 in Chapter 2). Moreover, China’s impact on fresh milk and cream, milk powder, butter and dairy spreads, cheese and curd – the four most traded dairy product categories – is substantial. Thus, to assess the robustness of our results discussed and analysed in the previous section, we deleted all observations pertaining to China across all six categories and re-estimating equation (3) without these observations. Tables 10a and 10b below show the results from these estimations.

Table 10a: Baseline model: New Zealand's non-China dairy trade (CASES)

	Fresh milk and cream	**Milk powder**	**Yoghurt, buttermilk and kephir**	**Whey and milk constituents**	**Butter and dairy spreads**	**Cheese and curd**
Exporter COVID-19	-0.058** (0.028)	-0.144*** (0.019)	-0.092*** (0.025)	-0.147 (0.102)	-0.186*** (0.023)	-0.131*** (0.030)
Importer COVID-19	0.044 (0.041)	0.123*** (0.024)	0.164*** (0.038)	0.200** (0.085)	0.195*** (0.025)	0.146*** (0.032)
Pseudo log likelihood	-9.784e+08	-2.351e+10	-8.191e+08	-3.412e+09	-1.082e+10	-7.965e+09
Pseudo R^2	0.004	0.010	0.008	0.069	0.024	0.007
Observations	3,456	5,902	2,784	2,688	5,568	4,992

Notes: These results are produced by the PPML estimation method. ***, ** and * denote 1%, 5% and 10% statistical significance levels, respectively. The standard errors reported in parenthesis are those clustered by country-pair fixed effects. We control for country-pair fixed effects and trade flow-year fixed effects in all specifications. 'COVID-19' indicates the log of confirmed COVID-19 cases.

Table 10b: Baseline model: New Zealand's non-China dairy trade (DEATHS)

	Fresh milk and cream	**Milk powder**	**Yoghurt, buttermilk and kephir**	**Whey and milk constituents**	**Butter and dairy spreads**	**Cheese and curd**
Exporter COVID-19	-0.205*** (0.056)	-0.286*** (0.026)	-0.187*** (0.037)	-0.009 (0.061)	-0.293*** (0.031)	-0.194*** (0.059)
Importer COVID-19	0.048 (0.061)	0.092** (0.039)	0.166*** (0.056)	0.215** (0.081)	0.195*** (0.034)	0.134* (0.038)
Pseudo log likelihood	-9.663e+08	-2.342e+10	-8.125e+08	-3.439e+09	-1.073e+10	-7.956e+09
Pseudo R^2	0.008	0.012	0.008	0.065	0.026	0.007
Observations	3,456	5,902	2,784	2,688	5,568	4992

Notes: These results are produced by the PPML estimation likelihood method. ***, ** and * denote 1%, 5% and 10% statistical significance levels, respectively. The standard errors reported in parenthesis are those clustered by country-pair fixed effects. We control for country-pair fixed effects and trade flow-year fixed effects in all specifications. 'COVID-19' indicates the log of confirmed COVID-19 deaths.

In Tables 10a and 10b, the coefficient for the exporter COVID-19 for each product category is still negative but smaller, in absolute terms, than the corresponding coefficient in Tables 9a and 9b. This represents a positive change in the coefficient for the exporter COVID-19 for each product category (see Table 11 on the next page). The product category with the largest positive change in coefficient is fresh milk and cream (0.069 for COVID-19 cases and 0.085 for COVID-19 deaths), followed by milk powder, cheese and curd, butter and dairy spreads, yoghurt, buttermilk and kephir, and whey and milk constituents. In terms of exposure to China's market, fresh milk and cream is the most exposed (78.3% of the exports in the category going to China), followed by milk powder (40.05%), cheese and curd (23.17%), butter and dairy spreads (20.52%), yoghurt, buttermilk and kephir (20.52%), and whey and milk constituents (6.3%). It is, therefore, evident that the product category with the highest exposure to China's market has benefited the most, while that with the least exposure has benefited the least from the omission of China's observations.

Table 11: China's import share in each product category and changes in the coefficients of exporter COVID-19

Product category	China's import share (%)	Change in the coefficient of exporter COVID-19 (cases)	Change in the coefficient of exporter COVID-19 (deaths)
Fresh milk and cream	78.3	0.069	0.085
Milk powder	40.05	0.031	0.085
Yoghurt, buttermilk and kephir	8.53	0.007	0.006
Whey and milk constituents	6.3	N/S	N/S
Butter and dairy spreads	20.52	0.012	0.021
Cheese and curd	23.17	0.021	0.063

Notes: change in the coefficient of exporter COVID-19 = the coefficient of exporter COVID-19 in table 10a (or 10b) minus the coefficient of exporter COVID-19 in table 9a (or 9b). N/S = Not statistically significant.

Size of the product category (in terms of the trade shares) still matters. From Tables 10a and 10b, butter and dairy spreads, and milk powder are the worst affected product categories, while whey and milk constituents is the least affected. This is consistent with the results from Tables 9a and 9b. Thus, with or without China, the results show that the pandemic has had a heterogeneous impact on New Zealand dairy exports and imports, with the most traded dairy products being the most affected.

5.3 Monthly economic impact of COVID-19 on the New Zealand dairy trade

In this section, we analyse how the economic impact of COVID-19 differed each month by estimating equation (4) for both COVID-19 cases and deaths. We report the results of this estimation in tables 12a and 12b below for COVID-19 cases and deaths, respectively.

The coefficient for exporter's COVID-19 incidence by cases was negatively significant and decreasing in magnitude from January to February and became insignificant in March 2020 for milk powder, butter and dairy spreads, and cheese and curd. By deaths, the coefficient for exporter's COVID-19 incidence was negatively significant and decreasing in magnitude between February and April 2020 for most product categories. On the importer's side, by cases or deaths, all six product categories were associated with a decreasing (in magnitude) significantly positive COVID-19 impact from January to April 2020. These effects (on the exporter and importer’s sides) are largely consistent with the adverse ramifications of the first lockdown in China. As well as being the epicentre of the infection, China “was the first country to have a COVID-19 lockdown, in Wuhan on 23 January. At its peak, China's quarantine measures were enforced in at least 20 provinces/regions" (Koh, 2020).

Many countries soon followed China in locking down and imposing strict containment measures. We can see the effect of these measures on New Zealand’s monthly dairy trade from May through to December 2020. By cases, the coefficient for exporter’s COVID-19 incidence was negatively significant and varying in magnitude during these months, except for whey and milk constituents. By deaths, a similar picture was also noticeable for the coefficient for exporter’s COVID-19 incidence, reflecting periods of COVID-19 severity in 2020.

On the importer’s side, by cases, the coefficient of the COVID-19 incidence was largely positively significant across all six product categories, implying that imports of the product categories increased with COVID-19 cases. In terms of magnitude, the coefficient of the COVID-19 incidence shows – like on the exporter’s side – a degree of variability across the months. This indicates that the impact of COVID-19 on the imports of the product categories was also heterogeneous across the months, as countries entered and exited lockdowns differently due to deadly waves of COVID-19.

Table 12a: Temporal heterogeneous impacts (CASES)

	Fresh milk and cream	Milk powder	Yoghurt, buttermilk and kephir	Whey and milk constituents	Butter and dairy spreads	Cheese and curd
Exporter COVID-19						
January	-0.840	-1.328**	-0.912	0.009	-4.488***	-0.531*
	(0.557)	(0.658)	(0.624)	(0.252)	(1.389)	(0.287)
February	-0.673	-0.996***	-0.731*	-0.106	-2.943***	-0.334*
	(0.476)	(0.365)	(0.388)	(0.151)	(0.880)	(0.191)
March	0.002	0.017	0.015	-0.137	-0.026	-0.038
	(0.037)	(0.036)	(0.035)	(0.146)	(0.030)	(0.031)
April	0.032	-0.045*	-0.007	-0.320***	-0.080***	-0.055*
	(0.031)	(0.024)	(0.033)	(0.119)	(0.028)	(0.033)
May	-0.088***	-0.255***	-0.110*	-0.109	-0.262***	-0.169***
	(0.027)	(0.030)	(0.064)	(0.099)	(0.046)	(0.031)
June	-0.099***	-0.258***	-0.209***	-0.136	-0.293***	-0.155***
	(0.027)	(0.032)	(0.045)	(0.125)	(0.062)	(0.032)
July	-0.137***	-0.258***	-0.172***	-0.159	-0.321***	-0.195***
	(0.027)	(0.035)	(0.049)	(0.125)	(0.059)	(0.046)
August	-0.059**	-0.213***	-0.142***	-0.076	-0.234***	-0.139***
	(0.026)	(0.034)	(0.054)	(0.114)	(0.037)	(0.042)
September	-0.087***	-0.213***	-0.231***	-0.049	-0.238***	-0.149***
	(0.026)	(0.032)	(0.056)	(0.093)	(0.037)	(0.035)
October	-0.094***	-0.190***	-0.186***	-0.092	-0.209***	-0.144***
	(0.024)	(0.025)	(0.045)	(0.094)	(0.033)	(0.025)
November	-0.078***	-0.119***	-0.137***	-0.175	-0.166***	-0.120***
	(0.024)	(0.022)	(0.039)	(0.120)	(0.035)	(0.024)
December	-0.108***	-0.164***	-0.187***	-0.143	-0.192***	-0.126***
	(0.024)	(0.020)	(0.036)	(0.107)	(0.038)	(0.027)
Importer COVID-19						
January	0.632***	0.525***	0.372***	0.480***	0.507***	0.498***
	(0.064)	(0.042)	(0.046)	(0.123)	(0.048)	(0.066)
February	0.419***	0.394***	0.237***	0.309***	0.373***	0.369***
	(0.041)	(0.025)	(0.047)	(0.074)	(0.028)	(0.032)
March	0.118***	0.062	0.124***	0.246*	0.121***	0.126***
	(0.037)	(0.053)	(0.047)	(0.134)	(0.030)	(0.027)
April	0.114**	0.099***	0.146***	0.390***	0.164***	0.109***
	(0.047)	(0.027)	(0.048)	(0.096)	(0.031)	(0.038)
May	0.174***	0.170***	0.179***	0.197***	0.225***	0.182***
	(0.045)	(0.024)	(0.037)	(0.064)	(0.032)	(0.028)
June	0.160***	0.141***	0.187***	0.222***	0.215***	0.147***
	(0.043)	(0.027)	(0.061)	(0.076)	(0.036)	(0.028)
July	0.154***	0.122***	0.186***	0.208***	0.216***	0.166***
	(0.037)	(0.025)	(0.045)	(0.073)	(0.036)	(0.031)
August	0.113***	0.008	0.089	0.069	0.102***	0.105**
	(0.037)	(0.034)	(0.061)	(0.102)	(0.035)	(0.043)
September	0.113***	0.049*	0.130**	0.071	0.140***	0.071***
	(0.0335)	(0.029)	(0.056)	(0.086)	(0.036)	(0.027)
October	0.132***	0.0934***	0.138***	0.141*	0.164***	0.106***
	(0.030)	(0.024)	(0.052)	(0.082)	(0.033)	(0.027)
November	0.087***	0.098***	0.145***	0.188**	0.157***	0.115***
	(0.025)	(0.021)	(0.043)	(0.091)	(0.036)	(0.035)
December	0.078***	0.090***	0.172***	0.187**	0.159***	0.111***
	(0.026)	(0.029)	(0.040)	(0.082)	(0.038)	(0.032)
Pseudo log likelihood	-6.436e+09	-4.872e+10	-8.286e+08	-3.388e+09	-1.404e+10	-1.028e+10
Pseudo R^2	0.075	0.045	0.017	0.082	0.056	0.034
Observations	3504	5950	2,832	2,736	5,616	5,040

Notes: These results are produced by the PPML estimation method. ***, ** and * denote 1%, 5% and 10% statistical significance levels, respectively. The standard errors reported in parenthesis are those clustered by country-pair fixed effects. We control for country-pair fixed effects and trade flow-year fixed effects in all specifications. 'COVID-19' indicates the log of confirmed COVID-19 cases.

Table 12b: Temporal heterogeneous impacts (DEATHS)

	Fresh milk and cream	Milk powder	Yoghurt, buttermilk and kephir	Whey and milk constituents	Butter and dairy spreads	Cheese and curd
Exporter COVID-19						
February		-7.899***	-2.313*	-0.947*	-8.595***	-0.762
		(1.855)	(1.342)	(0.550)	(1.154)	(0.528)
March	-0.917	-1.370***	-0.820*	0.0687	-2.997***	-0.434***
	(0.609)	(0.500)	(0.496)	(0.109)	(0.709)	(0.161)
April	-0.210**	-0.179**	-0.057	-0.218	-0.186***	-0.144**
	(0.093)	(0.081)	(0.041)	(0.154)	(0.052)	(0.059)
May	0.066	-0.293***	-0.164*	-0.038	-0.322***	-0.213***
	(0.216)	(0.047)	(0.094)	(0.086)	(0.062)	(0.054)
June	-2.678***	-1.275***	-0.923***	-0.008	-1.205***	-0.376***
	(1.021)	(0.382)	(0.333)	(0.092)	(0.397)	(0.136)
July	-1.104*	-0.898**	-0.527***	-0.053	-1.105**	-0.403**
	(0.628)	(0.350)	(0.194)	(0.083)	(0.436)	(0.181)
August	-0.745*	-1.475***	-0.466**	-0.043	-1.003***	-0.340**
	(0.427)	(0.554)	(0.224)	(0.081)	(0.321)	(0.167)
September	-0.092	-0.443***	-0.455***	-0.030	-0.550***	-0.308***
	(0.124)	(0.064)	(0.155)	(0.081)	(0.086)	(0.096)
October	-1.151**	-1.031***	-0.418***	-0.020	-0.986***	-0.411***
	(0.484)	(0.353)	(0.161)	(0.071)	(0.305)	(0.125)
November	-1.171*	-1.234**	-0.640***	-0.074	-2.035***	-0.409***
	(0.614)	(0.522)	(0.248)	(0.077)	(0.629)	(0.131)
December	-6.745***	-0.932**	-0.783***	-0.0230	-1.576**	-0.352**
	(2.138)	(0.423)	(0.276)	(0.070)	(0.643)	(0.140)
Importer COVID-19						
January	0.968***	0.834***	0.538***	0.518***	0.770***	0.696***
	(0.131)	(0.054)	(0.062)	(0.060)	(0.049)	(0.062)
February	0.543***	0.560***	0.318***	0.340***	0.512***	0.499***
	(0.091)	(0.037)	(0.055)	(0.054)	(0.036)	(0.056)
March	0.318***	0.263***	0.268***	0.259***	0.273***	0.251***
	(0.048)	(0.067)	(0.076)	(0.080)	(0.039)	(0.040)
April	0.288***	0.198***	0.210***	0.327***	0.250***	0.158***
	(0.071)	(0.070)	(0.062)	(0.104)	(0.040)	(0.041)
May	-0.938	0.052	0.157***	0.212***	0.200***	0.148**
	(1.335)	(0.087)	(0.058)	(0.076)	(0.055)	(0.074)
June	-0.295	-0.024	0.127	0.243***	0.130**	0.031
	(0.186)	(0.084)	(0.087)	(0.083)	(0.060)	(0.079)
July	-0.238	-0.063	0.142**	0.212**	0.130**	0.069
	(0.199)	(0.096)	(0.059)	(0.085)	(0.059)	(0.062)
August	-0.263	-0.233*	0.019	0.053	-0.002	0.0283
	(0.190)	(0.133)	(0.076)	(0.105)	(0.069)	(0.080)
September	-0.663	-0.168	0.083	0.080	0.110	0.005
	(0.806)	(0.176)	(0.085)	(0.100)	(0.085)	(0.086)
October	-0.249	-0.115	0.073	0.149	0.083	0.015
	(0.179)	(0.124)	(0.068)	(0.092)	(0.070)	(0.073)
November	-0.251	-0.109	0.103*	0.154*	0.073	0.025
	(0.181)	(0.127)	(0.053)	(0.082)	(0.075)	(0.078)
December	-0.367*	-0.121	0.116**	0.186**	0.069	0.007
	(0.221)	(0.136)	(0.055)	(0.083)	(0.079)	(0.083)
Pseudo log likelihood	-6.160e+09	-4.761e+10	-8.231e+08	-3.478e+09	-1.401e+10	-1.034e+10
Pseudo R^2	0.083	0.053	0.017	0.085	0.058	0.035
Observations	3503	5949	2,831	2,735	5,615	5,039

Notes: These results are produced by the PPML estimation method. ***, ** and * denote 1%, 5% and 10% statistical significance levels, respectively. The standard errors reported in parenthesis are those clustered by country-pair fixed effects. We control for country-pair fixed effects and trade flow-year fixed effects in all specifications. 'COVID-19' indicates the log of confirmed COVID-19 deaths.

5.4 RTA effects

Equation (5) estimates the impact of regional trade agreements on the dairy trade between New Zealand and the rest of the world during the COVID-19 pandemic. We report the results of this estimation in Tables 13a and 13b below for COVID-19 cases and deaths, respectively.

Table 13a: Impact of RTAs on New Zealand's dairy trade (CASES)

	Fresh milk and cream	**Milk powder**	**Yoghurt, buttermilk and kephir**	**Whey and milk constituents**	**Butter and dairy spreads**	**Cheese and curd**
Exporter	-0.279*	-0.228***	-0.184***	-0.126	-0.264***	-0.166***
COVID-19	(0.144)	(0.058)	(0.048)	(0.106)	(0.045)	(0.054)
RTA	0.117	0.109*	0.096	-0.139	0.134**	0.029
	(0.136)	(0.066)	(0.066)	(0.110)	(0.060)	(0.062)
Importer	-0.412**	0.012	-0.039	0.182*	0.117**	-0.084
COVID-19	(0.169)	(0.060)	(0.063)	(0.095)	(0.055)	(0.062)
RTA	0.655***	0.227***	0.305***	0.069	0.167***	0.353***
	(174)	(0.070)	(0.066)	(0.100)	(0.053)	(0.067)
Pseudo log likelihood	-5.725e+09	-4.617e+10	-7.301e+08	-3.483e+09	-1.328e+10	-8.934e+09
Pseudo R^2	0.024	0.019	0.065	0.060	0.048	0.061
Observations	3,504	5,950	2,832	2,736	5,616	5,040

Notes: These results are produced by the PPML estimation method. ***, ** and * denote 1%, 5% and 10% statistical significance levels, respectively. The standard errors reported in parenthesis are those clustered by country-pair fixed effects. We control for country-pair fixed effects and trade flow-year fixed effects in all specifications. 'COVID-19' indicates the log of confirmed COVID-19 cases.

Table 13b: Impact of RTAs on New Zealand's dairy trade (DEATHS)

	Fresh milk and cream	**Milk powder**	**Yoghurt, buttermilk and kephir**	**Whey and milk constituents**	**Butter and dairy spreads**	**Cheese and curd**
Exporter	-0.987**	-0.555***	-0.409***	-0.010	-0.529***	-0.352***
COVID-19	(0.458)	(0.175)	(0.127)	(0.063)	(0.119)	(0.134)
RTA	0.878*	0.411**	0.355**	-0.167	0.444***	0.225*
	(0.449)	(0.167)	(0.150)	(0.106)	(0.125)	(0.122)
Importer	-0.976**	-0.096	-0.112	0.202**	0.070	-0.179*
COVID-19	(0.471)	(0.115)	(0.078)	(0.088)	(0.078)	(0.103)
RTA	1.155**	0.293**	0.408***	-0.030	0.213***	0.443***
	(0.470)	(0.117)	(0.095)	(0.108)	(0.068)	(0.102)
Pseudo log likelihood	-6.424e+09	-5.110e+10	-7.668e+08	-3.531e+09	-1.401e+10	-9.804e+09
Pseudo R^2	0.007	0.003	0.040	0.062	0.029	0.028
Observations	3,504	5,950	2,832	2,736	5,616	5,040

Notes: These results are produced by the PPML estimation method. ***, ** and * denote 1%, 5% and 10% statistical significance levels, respectively. The standard errors reported in parenthesis are those clustered by country-pair fixed effects. We control for country-pair fixed effects and trade flow-year fixed effects in all specifications. 'COVID-19' indicates the log of confirmed COVID-19 cases.

It can be seen in Table 13a that, for New Zealand's dairy exports, the RTA coefficient is positively significant for milk powder, and butter and dairy spreads. The RTA coefficient is also positive but not significant for three of other four categories. Whey and milk constituents is the only category whose RTA coefficient is negatively insignificant. On the importer's side, the RTA coefficients for all product categories but whey and milk constituents are positively significant. In Table 13b, we also observe that trade within an RTA generates no positive effect for whey and milk constituents. At the same time, the RTA effect is positively significant for all the other product categories on both the importer and exporter's sides. The above result implies that, for these five categories, New Zealand was more likely to import or export to an RTA partner than a non-RTA partner in 2020. This is consistent with Nicita and Saygili's (2021, p.1) finding that "trade within trade agreements was relatively more resilient against the global trade collapse of 2020."

However, on balance, both Tables 13a and 13b show that New Zealand's dairy imports benefited more than New Zealand's dairy exports in 2020. This suggests that, although tariffs may have been negotiated down or eliminated through RTAs, NTMs most likely weakened the positive effect of RTAs on New Zealand exports. For example, China alone applies about sixty different SPS measures on dairy imports from New Zealand (TRAINS, n.d.). These NTMs induce high transaction costs. While they are thus likely to have adversely affected New Zealand's dairy exports in 2020, NTMs are, however, not modelled in our research due to the reasons discussed in Chapter 2.

To understand why RTAs had no effect on trade in whey and milk constituents in 2020, we divided the exports for each product category into the exports to RTA partners and the exports to non-RTA partners. This enabled us to compute each product category's RTA partner and non-RTA partner shares. These shares are presented in table 14 below.

Table 14 shows that the export share of whey and milk constituents to New Zealand's RTA partners was 30.7% in 2020. This share is about 20% less than the export share to the United States, which is the top export destination for this product category (see Figure 1 in Chapter 2). On the other hand, the export shares of the other five product categories to New Zealand's RTA partner ranged from 65.9% to 95.1% in 2020. This is very informative as it shows us that a plausible cause for the RTAs not mitigating the adverse effect of COVID-19 on trade in whey and milk constituents in 2020 could be the fact that the product category was least traded in

RTAs. Hence, the corresponding insignificant RTA coefficients in Tables 11a and 11b could be attributed to this.

Table 14: Share of exports to RTA partners in each product category

Product category	New Zealand dairy exports					
	RTA partner share (%)			Non-RTA partner share (%)		
	2015	2019	2020	2015	2019	2020
Fresh milk and cream	89.2	93.2	95.1	10.8	6.8	4.9
Milk powder	55.8	68.7	68.1	44.2	31.3	31.9
Yoghurt, buttermilk and kephir	79.6	79.3	87.3	20.4	20.7	12.7
Whey and milk constituents	21.5	27.0	30.7	78.5	73.0	69.3
Butter and dairy spreads	51.9	63.9	65.9	48.1	36.1	34.1
Cheese and curd	72.9	81.6	84.8	27.1	18.4	15.2

Source: Author's calculations based on data from Statistics New Zealand. https://infoshare.stats.govt.nz/ (retrieved 15 July 2022).

5.5 Chapter summary

This chapter analysed the extent of the effect of the COVID-19 pandemic on New Zealand's dairy exports and imports in 2020 (including whether the impact had been different across the product categories and over the months after the outset of COVID-19), and whether the existing RTAs had reduced this effect. The results indicated that COVID-19 substantially reduced the growth rates of New Zealand's exports and imports of most product categories of dairy goods. However, the situation could have been worse had it not been for the positive and trade-enhancing effect of the existing RTAs.

According to Tables 9a and 9b, COVID-19 had no negative effect on the trade in whey and milk constituents. Rather, exports and imports of whey and milk constituents rose during the pandemic. The other five categories could not fare the same, however. In 2020, the growth rates of New Zealand's exports and imports of these categories took a hit. This hit was, however, different across the categories. Milk powder, and butter and dairy spreads were more badly affected than cheese and curd, fresh milk and cream, and yoghurt, buttermilk and kephir. Exposure (direct or indirect) to China's market and how most traded the product category was appeared to be the primary causal factors for this heterogeneity. This was also observed in chapter 2.

Lockdowns and associated stringent containment measures disrupted global supply chains and restricted production capabilities of New Zealand and its dairy trading partners. Lockdown periods were therefore expected to be associated with stronger COVID-19 impacts. Tables 12a and 12b appeared to have borne this out. For example, it was observed that, in the first quarter 2020, the COVID-19 effects were most severe in January and then trended downwards during the quarter. This result, by and large, showed the effects of the first COVID-19 lockdown in China.

Tables 13a and 13b assessed whether the existing RTAs helped New Zealand's dairy exports and imports during the COVID-19 pandemic. All the product categories but whey and milk constituents were predominantly traded within RTAs in 2020. Correspondingly, New Zealand's exports and imports of all the product categories, except for whey and milk constituents, were positively impacted by the existing RTAs. However, the RTA influence was more noticeable in imports than exports.

Chapter 6 concludes our research. In this chapter, we outline the main findings, state the literature contributions, and discuss the limitations and directions for further research.

Chapter 6: Conclusions

This research analysed the extent of the economic impact of the COVID-19 pandemic on New Zealand’s dairy exports and imports in 2020, whether the COVID-19 impact had been uniform or heterogeneous across the categories of dairy goods and over the months following the outbreak of COVID-19, and whether the existing RTAs had alleviated this impact. The results of the study are consistent with the past findings that (i) the COVID-19 pandemic has had heterogeneous impacts across products and time, but, on average, it has negatively impacted international trade, and (ii) trade within RTAs is more resilient than trade without RTAs during the COVID-19 pandemic.

In chapter 2, we looked at New Zealand's dairy trade history, the pre-COVID-19 trends of New Zealand’s dairy exports and imports, and the performance of New Zealand’s dairy exports and imports during the pandemic. New Zealand has traded in dairy for over 170 years. Between 2015 and 2019, New Zealand dairy exports rose by 37%. Over the same period, dairy imports from the rest of the world grew by 35%. However, dairy exports and imports took a significant hit in 2020 due to the COVID-19 crisis. More specifically, except for whey and milk constituents, other five product categories experienced a markedly diminished growth in exports and imports in 2020.

Chapter 3 reviewed previous literature on the economic impact of COVID-19 on international trade in goods, on RTAs, and on the gravity model we used in our estimation process. The literature on the economic impact of COVID-19 on international trade in goods has shown that COVID-19 has generally adversely affected this trade. On the other hand, Nicita and Saygili (2021), Das and Sen, (2022), and Hayakawa and Imai (2022) have found that RTAs have assuaged these adverse effects of COVID-19. Thus, countries have been, by and large, more willing to export and/or import from RTA trading partners than from non-RTA trading partners during the COVID-19 pandemic.

Chapter 4 discussed the empirical models we used in this research. First, we adapted the traditional gravity equation following Hayakawa and Imai (2022). This adapted equation became the baseline model. We then extended the equation to account for the time-series variations in the coefficients of the COVID-19 variables and RTA effects in equations (4) and (5), respectively.

We organise the remainder of this chapter as follows. Section 6.1 presents the main findings of this research. Section 6.2 outlines our literature contributions in section 6.2 and section 6.3 discusses the limitations.

6.1 Main findings

The key findings of our research are as follows. First, we found that, except for whey and milk constituents, COVID-19 significantly reduced the growth rates of New Zealand's dairy exports and imports in 2020. However, the reduction was more severe in the most traded product categories and the product categories most exposed to China's market. With the zero COVID-19 approach still in operation in China, it is most likely that these product categories may continue to be negatively impacted. This dependence on China and its adverse effects on New Zealand’s dairy trade, especially New Zealand’s dairy exports, suggest that New Zealand should diversify its risks *vis-à-vis* export markets. Furthermore, the ongoing war in Ukraine puts additional challenges on New Zealand’s dairy trade to thrive due to supply chain input issues. For instance, a recent Infant Nutrition Council’s (INC) conference pointed out that the war had adversely affected production of sunflower oil, a key ingredient for infant formula, in Ukraine (Gray, 2022).[13]

Second, the economic impact of COVID-19 on New Zealand’s dairy exports and imports was different each month for most product categories. The impact was observed to be stronger during the months when the COVID-19 incidence was more severe. These were also the months associated with strict COVID-19 measures, such as from January to April, when Hubei and 19 other provinces/regions of China were locked down.

Third, while the existing RTAs significantly helped mitigate the negative economic impact of COVID-19 on New Zealand’s exports and imports of the majority of the product categories, the gains from the RTAs accrued more on imports than on exports. This finding is consistent with the negative effects of NTMs, which affect the dairy sector more than any other exporting sector, and the phasing out of tariffs by New Zealand’s RTAs partners, as some RTA partners were still phasing out tariffs in 2020. For example, Myanmar, which is an AANZFTA trading

[13] INC is “an amalgamation of the Infant Formula Manufacturers’ Association of Australia (IFMAA) and the New Zealand Infant Formula Marketers’ Association (NZIFMA)” (Infant Nutrition Council, n.d.). The council represents the vast majority of Australasia’s manufacturers, ingredient suppliers, and marketers of toddler milk and infant formula (Gray, 2022; Infant Nutrition Council, n.d.).

partner was still levying 3% tariff on New Zealand butter in 2020.[14] On the other hand, declining tariff protection, due to the upsurge of RTAs across the globe, has led some countries to make more creative and extensive use of NTMs for protectionist purposes (Ballingall & Pambudi, 2016). Therefore, even if tariffs are lowered, an above-global-average number of NTMs (particularly technical measures) continue to present significant encumbrances to New Zealand dairy exporters (MFAT, 2022).

6.2 Contributions to the existing literature

This study contributes to the existing literature on the international trade-COVID-19 and RTA-COVID-19 nexuses. It also fills the gaps in the examination of the economic impact of COVID-19 on New Zealand's dairy trade. This is especially imperative as the dairy trade is key to New Zealand and the rest of the world.

6.3 Limitations and directions for future research

There are a few limitations that need to be pointed out. First, although the 2021 data are available monthly, we did not consider them because of our research design. So the samples that we obtained and used in our study contained observations that ranged from 2,735 to 5,950. These samples were too small for the PPML method to deliver strong goodness of fit because the method naturally performs very well in large samples. Therefore, we recommend that any other researchers undertaking a similar study employ larger samples.

Second, our research did not consider the RTAs that came into force in or after December 2020. However, some of these RTAs cover markets which are particularly important to New Zealand’s dairy trade, for instance, the Pacific Agreement on Closer Economic Relations (PACER) Plus. We, therefore, believe that our research has not fully captured the significance of RTAs in minimising the adverse effect of COVID-19 on New Zealand’s dairy trade.

Third, New Zealand dairy exporters face considerable barriers in the form of compliance costs of NTMs, which may not have been addressed even as part of an RTA. However, NTMs were not modelled in this research. Therefore, they are a separate area for further research on this topic.

[14] The statistic was collected on 15 October 2022 from MFAT’s Tariff Finder. https://www.tariff-finder.govt.nz/#!272000471|MM

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Appendices

Table A1: Top ten export destinations for each product category

Product category	**Top ten export destinations, value (millions NZ$), and share (%)**					
	2019			**2020**		
	Country	**Value**	**share**	**Country**	**Value**	**Share**
Fresh milk and cream	China	666.88	72.82	China	765.18	78.30
	Philippines	43.47	4.75	Philippines	30.53	3.12
	Malaysia	24.96	2.73	Taiwan	27.13	2.78
	Taiwan	22.93	2.50	Malaysia	26.69	2.73
	Vietnam	22.4	2.45	Viet Nam	18.53	1.90
	South Korea	15.62	2.71	Australia	11.76	1.20
	Thailand	14.86	1.62	Hong Kong	10.7	1.09
	Australia	14.76	1.61	South Korea	10.69	1.09
	Hong Kong	10.66	1.16	Indonesia	10.49	1.07
	Indonesia	9.81	1.07	Thailand	10.4	1.06
Powder milk	China	3,490	40.84	China	3,610	40.05
	UAE	420	4.91	UAE	440	4.88
	Sri Lanka	400	4.68	Sri Lanka	420	4.66
	Algeria	390	4.56	Malaysia	380	4.22
	Malaysia	380	4.45	Algeria	370	4.11
	Bangladesh	340	3.98	Indonesia	370	4.11
	Indonesia	310	3.63	Thailand	330	3.66
	Thailand	300	3.51	Bangladesh	300	3.33
	Viet Nam	250	2.93	Taiwan	280	3.11
	Singapore	240	2.81	Australia	270	3.00
Yoghurt, buttermilk and kephir	Philippines	46.64	28.17	Philippines	55.84	33.02
	Thailand	32.9	19.87	Thailand	28.78	17.02
	Malaysia	14.08	8.5	Indonesia	15.13	8.95
	Yemen	12.2	7.37	Malaysia	14.82	8.76
	Peru	8.85	5.35	China	14.42	8.53
	Indonesia	7.73	4.67	Mexico	4.97	2.94
	Australia	7.02	4.24	Australia	4.67	2.76
	China	6.7	4.05	Saudi Arabia	3.76	2.22
	Saudi Arabia	5.04	3.04	Yemen	3.16	1.87
	Nigeria	4.45	2.69	UAE	2.96	1.75
Whey and milk constituents	USA	331.72	52.79	USA	362.89	50.30
	Japan	47.77	7.6	Japan	71.8	9.95

	Singapore	43.74	6.96	Singapore	52.27	7.25
	Germany	27.87	4.44	China	45.46	6.3
	Egypt	26.26	4.18	Germany	38.89	5.39
	China	25.74	4.1	Saudi Arabia	34.38	4.77
	Saudi Arabia	25.27	4.02	Netherlands	15.03	2.08
	Brazil	16.22	2.58	Brazil	13.33	1.85
	Philippines	9.7	1.54	Egypt	11.31	1.57
	Malaysia	8.93	1.42	Malaysia	11.23	1.56
Butter and dairy spreads	China	628.2	18	China	599.08	20.52
	Australia	249.34	7.14	Australia	236.46	8.1
	Philippines	244.75	7.01	Philippines	192.22	6.58
	USA	210.98	6.05	Russia	174.21	5.97
	Russia	175.54	5.03	Saudi Arabia	169.62	5.81
	Mexico	174.43	5	USA	150.43	5.15
	Saudi Arabia	150.91	4.32	Mexico	126.12	4.32
	Viet Nam	138.11	3.96	Egypt	115.19	3.94
	Egypt	121.32	3.48	Malaysia	106.45	3.65
	Malaysia	119.43	3.42	Viet Nam	95.14	3.26
Cheese and curd	China	445.33	22.16	China	470.44	23.17
	Japan	392.12	19.51	Japan	381.96	18.82
	Australia	285.19	14.19	Australia	270.21	13.31
	South Korea	131.3	6.53	South Korea	163.39	8.05
	Saudi Arabia	84.68	4.21	Philippines	80.55	3.97
	Philippines	81.21	4.04	Indonesia	78.33	3.86
	Indonesia	76.29	3.8	Saudi Arabia	72.76	3.58
	Taiwan	49.48	2.46	Taiwan	56.97	2.81
	Trinidad and Tobago	47.42	2.36	Malaysia	56.91	2.8
	Malaysia	45.76	2.28	Chile	44.58	2.2

Notes: UAE = United Arab Emirates, USA = United States of America.
Source: Author's calculations based on data from Statistics New Zealand. https://infoshare.stats.govt.nz/ (retrieved 15 July 2022).

Table A2: Top ten import origins for each product category

Product category	Top ten export destinations, value (millions NZ$), and share (%)					
	2019			**2020**		
	Country	**Value**	**share**	**Country**	**Value**	**Share**
Fresh milk and cream	Australia	8.65	69.57	Australia	11.58	90.84
	Netherlands	2.37	19.06	Netherlands	1.03	8.08
	New Zealand	1.2	9.65	India	0.05	0.39
	UK	0.09	0.72	UK	0.04	0.31
	India	0.07	0.56	USA	0.03	0.24
	Philippines	0.02	0.16	Philippines	0.01	0.08
	Malaysia	0.02	0.16	Germany	0	0
	South Korea	0.01	0.08	Iran	0	0
	Germany	0.01	0.08	UAE	0	0
	Taiwan	0	0	Malaysia	0	0
Powder milk	Australia	20.08	30.09	Australia	29.9	39.01
	Germany	16.1	19.31	Netherlands	11.97	15.62
	Netherlands	9.78	11.73	Greece	8.02	10.46
	Greece	8.42	10.1	Germany	7.7	10.05
	Austria	8.34	10.01	US A	6.81	8.88
	Italy	6.5	7.8	Austria	4.06	5.3
	Slovenia	1.72	2.06	Spain	2.4	3.13
	Spain	1.56	1.87	Italy	2.2	2.87
	Brazil	1.37	1.64	New Zealand	1.16	1.51
	New Zealand	1.02	1.22	Brazil	0.63	0.82
Yoghurt, buttermilk and kephir	Australia	2.41	83.1	Australia	2.76	81.9
	Germany	0.12	4.14	India	0.2	5.93
	New Zealand	0.11	3.79	Germany	0.2	5.93
	China	0.09	3.1	China	0.05	1.48
	USA	0.06	2.07	New Zealand	0.04	1.19
	India	0.05	1.72	Philippines	0.04	1.19
	Philippines	0.04	1.38	USA	0.03	0.89
	Netherlands	0.01	0.34	Netherlands	0.02	0.59
	Latvia	0.01	0.34	South Korea	0.01	0.3
	Malaysia	0.01	0.34	Thailand	0.01	0.3
Whey and milk constituents	Germany	23.82	21.68	Germany	33.32	27.49
	USA	23.49	21.38	Austria	18.84	15.54
	France	18	16.39	Italy	15.25	12.58

	Italy	10.99	10	France	15.11	12.47
	Austria	9.71	8.84	USA	14.9	12.29
	Netherlands	6.16	5.61	UK	10.39	8.57
	UK	5.96	5.43	Ireland	5.38	4.44
	Ireland	5.22	4.75	Netherlands	3.51	2.9
	Denmark	3.36	3.06	Denmark	2.33	1.92
	Australia	2.15	1.96	Australia	1.37	1.13
Butter and dairy spreads	New Zealand	3.41	34.1	India	2.48	24.8
	India	1.9	19	Denmark	1.01	10.1
	Australia	0.82	8.2	Australia	1	10
	Denmark	0.74	7.4	New Zealand	0.78	7.8
	Ireland	0.54	5.4	France	0.53	5.3
	France	0.52	5.2	Ireland	0.35	3.5
	Fiji	0.23	2.3	USA	0.27	2.7
	USA	0.06	0.6	Fiji	0.24	2.4
	Philippines	0.01	0.1	Canada	0.08	0.8
	Italy	0.01	0.1	UAE	0.02	0.2
Cheese and curd	Australia	29.71	27.77	Australia	25.01	27.18
	USA	22.22	20.77	USA	20.46	22.24
	Denmark	13.85	12.94	Denmark	14.62	15.89
	Ireland	10.09	9.43	Germany	5.8	6.3
	Germany	7.3	6.82	Italy	5.28	5.74
	Italy	5.25	4.91	Netherlands	4.77	5.18
	France	4.69	4.38	France	4.47	4.86
	New Zealand	3.05	2.85	Bulgaria	1.91	2.08
	Netherlands	2.91	2.72	Ireland	1.84	2
	Bulgaria	1.71	1.6	New Zealand	1.77	1.92

Notes: UAE = United Arab Emirates, UK = United Kingdom, USA = United States of America.
Source: Author's calculations based on data from Statistics New Zealand. https://infoshare.stats.govt.nz/ (retrieved 15 July 2022).