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FTA, Exchange rate pass-through and export price behavior – Lessons from the Australian dairy sector

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The growing number of bilateral and regional free trade agreements (FTAs) alongside exchange rate volatility has raised a question on whether these affect exporters' pricing behaviors, hence competitiveness. This study contributes to this topic by examining Australian dairy export price behavior across eight major markets taking into account the extent of pass-through of exchange rate and tariff as well as FTAs between Australia and its trading partners. Commodity-level dairy trade data from 1996 to 2016 and the feasible generalized least squares methods are employed. The study finds incomplete pass-through at the industry level. The dairy export prices decrease by 1.7% if Australian dollar depreciates by 10%, while 10% tariff reduction is associated with 0.7% export price cut. Results at the commodity level show different pricing behaviors across destination and commodity markets. Overall, apart from the tariff effects, there is minimal evidence of the impacts of FTAs on dairy export prices.

Key words: Australia, dairy, exports, exchange rate, free trade agreement, pricing-to-market, tariff.

1. Introduction

The impacts of economic integration on agricultural trade have been the subject of a long literature. Many studies address the *trade* effects of participation in the World Trade Organization (WTO) and its predecessor the General Agreement on Tariffs and Trade (GATT) (Rose 2004; Grant and Boys 2011; Anderson 2016) as well as those of regional and bilateral free trade agreements (FTAs) (Miljkovic *et al.* 2003; Grant and Boys 2011; Mujahid and Kalkuhl 2016). There has also been an interest in understanding the impacts of FTAs on exporters' *pricing* behaviour. Such understanding is particularly important if industry expansion is reliant on international trade for example due to excess of production and a small or relatively stagnant domestic market. Meanwhile, from a policy perspective, food price volatility in 2007–2008, in which international trade distortions were found to be one of the key drivers (Martin and Anderson 2011; von Braun and Tadesse 2012), raised a question on whether and the extent to which FTAs can contribute to less-distorted markets through access to affordable food, hence food security.

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To identify the link between trade-related aspects and pricing behaviour, some possible explanation can be considered. One important indicator is changes in tariff. Mallick and Marques (2008) consider tariff rate pass-through (TRPT) in explaining changes in India's import prices. Bilateral trade ties between the exporting and importing countries are another possible determinant of the trading prices. Such ties can be influenced by trade policy and the free trade agreements (FTAs) between trading partners, among others. In the case of Russian wheat exports, for example, following the disruption of Russian supplies due to the government's decision to impose high export taxes, Russian exporters saw the need to rebuild confidence among their buyers, hence their behaviours to adjust mark-ups of prices over costs to stabilise local currency prices (Pall *et al*. 2013). Another study finds that while the multilateral trade agreement under GATT has positively influenced US beef export prices, the regional trade bloc NAFTA only shows a little impact (Miljkovic, Brester *et al*. 2003).

Looking at the broader macroeconomic landscape, the exchange rate volatility may also affect the exporters' pricing behaviours. A large number of studies have provided foundations to assess the links between exchange rates and trading prices. Many of these studies consider exchange rate 'pass-through' (ERPT) and pricing-to-market behaviour (Krugman 1986; Krugman 1987; Knetter 1989; Knetter 1993).[1] The latter is introduced by Krugman (1986) who defines a phenomenon in which an exporter with power in multiple markets adopts a price-discriminating behaviour.

One aspect that has not been considered by the existing studies is a possibility of exporters' different responsiveness to exchange rate changes following the start of an FTA. FTAs may encourage closer economic ties between countries where exporters would have more incentives to expand and maintain their reputation and market shares in the destination markets than the pre-FTA period, for example through minimising the price increase when the exporting country's currency appreciates against that of the FTA partner. Only a few studies, however, consider both trade-related aspects and exchange rate changes as well the interaction between the two aspects in the analysis of pricing behaviour.

To fill in that gap in the literature, the main purpose of this study is to examine Australian dairy export price behaviour using data from 1996 to 2016 on three main dairy export commodities, namely whole fresh milk, skimmed dried milk and cheese. Specifically, the study looks at both the impacts of exchange rates by identifying the ERPT and three trade aspects, namely tariff reduction, other FTA effects and different responsiveness to exchange rate changes following the entry into force of an FTA with a trading partner. Focusing on Australia's economic ties with Asia and considering data availability, this study includes trade data between Australia and eight countries, namely China, Indonesia, Japan, Korea, Malaysia, Philippines,

[1] See table 1 for a summary of studies adopting a pricing-to-market approach.

Thailand and Viet Nam. It applies feasible generalised least squares (FGLS) taking into account a possibility of heteroskedascity across panels and autocorrelation within panels. The Australian dairy sector is chosen as a focus in this study given its high reliance on the exports and a concern over a downward trend in the share of total dairy production exported to overseas, from over half of its production in early 2000s to about 30–40% in more recent years. Obtaining an improved understanding of the factors affecting export prices is critical for Australian dairy producers operating in a competitive global market.

Results from the analyses using industry-level and commodity-level data shed light on different dimensions of export pricing behaviour. At the industry level using pooled samples of the three commodities' exports data, the study shows that Australian dairy exports are responsive to both exchange rate fluctuations and tariff reduction. The export price change, however, is less proportional to the change in exchange rate or to the tariff reduction highlighting incomplete pass-through. At the commodity level, the study finds different export pricing behaviours across overseas cheese markets. For the other two commodities, namely whole fresh milk and skimmed dried milk, however, there is not enough evidence of non-competitive pricing in the majority of the export markets. Overall, the study finds that FTA benefits remain confined to tariff effects.

The remainder of this article is organised as follows. Section 2 provides a brief overview of the Australian dairy industry highlighting recent trends and industry challenges. Section 3 reviews existing studies and conceptual frameworks, while data and descriptive statistics are then presented in Section 4. Following the discussions on results from the empirical work in Section 5, the final section provides a summary and discusses possible implications from the findings.

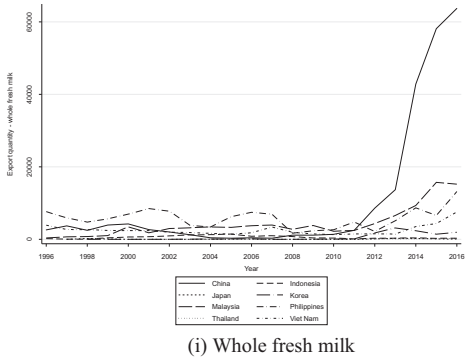
2. The Australian dairy industry

The dairy industry plays a significant role in the Australian economy. According to Dairy Australia, in 2016–2017, the industry was the third largest rural industry in Australia with a value of farm-gate production of A$3.7 billion.[2] Nearly two-thirds of the country's milk production in 2016–2017 was in Victoria, up from 55% in early 1980s. Australia currently has 1.5 million cows with average herd size of 261. The national herd size and production of milk and other dairy products had increased from the 1980s to the early 2000s before declining following the deregulation of the dairy industry in 2000 with the end of the Domestic Market Support Scheme and repeal of state legislation governing the sourcing and pricing of fresh milk. Productivity, however, as indicated by milk yield per cow has continued to improve and more than doubled between early the 1980s and recent years.

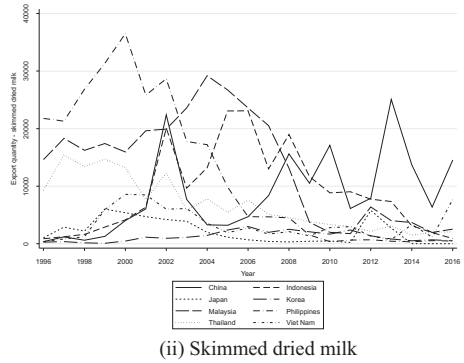
[2] https://www.dairyaustralia.com.au/industry/farm-facts/dairy-at-a-glance

About 37% of Australian milk production is exported providing an export revenue of A$3 billion. Relative to other dairy producing countries, Australia only accounts for 2% of the world's milk production (Appendix S1). This is relatively low compared to other dairy producing countries or regions such as the European Union (26% of the world production), India (26%) and the United States (16%). Between 2010 and 2017, the increase in Australian dairy production was relatively moderate compared to those of Brazil (51%), India (32%), New Zealand (27%) and China (23%). Given the production surplus and its dairy processing activities, however, Australia continues to contribute to the world's exports and has persistently served as one of the top 10 dairy exporting economies.

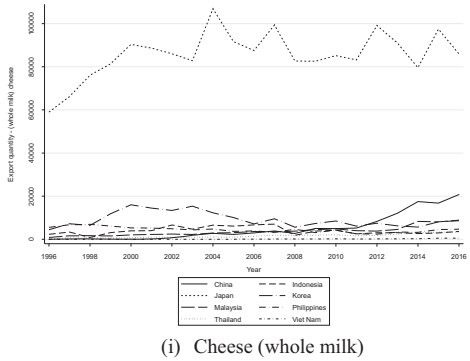
The country exports a wide range of dairy products to the global markets. Figure 1 looks at the trends in the volume of Australian dairy exports. A significant increase is observed in China's imports of whole fresh milk in recent years. This increase has been most likely driven by growing demand for milk quantity as well as safety (Cheng *et al.* 2015). Whole fresh milk exports to other countries such as Malaysia and Viet Nam also experienced a continued increase in the past five years. Meanwhile, demand for cheese has been largely dominated by Japanese consumers with notable increases



(i) Whole fresh milk



(ii) Skimmed dried milk



(i) Cheese (whole milk)

Figure 1 Australian dairy exports by destination country, 1996–2016 (tonnes). *Source*: FAOstats.

observed in cheese exports to China. With regard to skimmed dried milk exports, there are nearly no noticeable increasing trends observed. In fact, exports to countries such as Indonesia and Thailand have been generally declining over the years.

Despite its significant presence in the global dairy market, the Australian dairy industry continues to face challenges. Dairy Australia's Dairy Situation and Outlook June 2018 identifies that dry conditions led to a spike in the culling rate and the lowest cull cow price for the past three years. The Outlook also identifies exchange rates as one of the six key drivers of the Australian dairy industry. It is argued that the weakening of New Zealand dollar and Euro – the currencies of some of Australia's largest dairy competitors – is limiting the price competitiveness benefits offered by the appreciation of US dollar against the Australian dollar.

Figure 2 shows exchange rates dynamics between 1996 and 2016 of the eight importing countries. The Figure shows stark variations in the exchange rate volatility between these importing countries. For instance, the Indonesian Rupiah in the aftermath of the 1997–1998 Asian financial crisis depreciated against the Australian dollar. Meanwhile, other partners such as China tend to have more inflexible exchange rates.

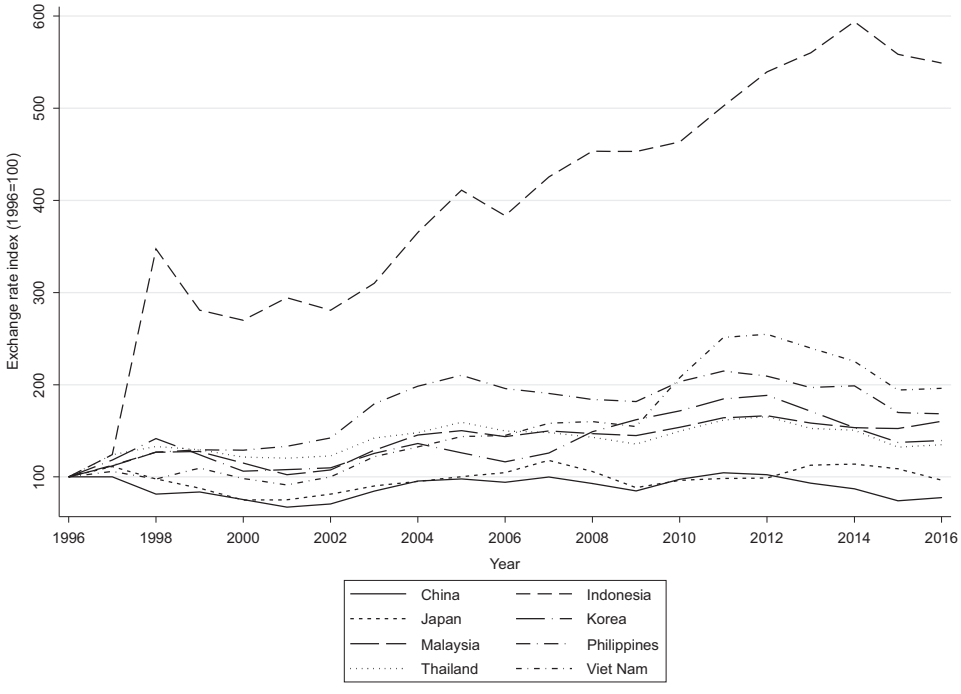


Figure 2 Importing countries' exchange rates against Australian Dollar (1996 = 100), 1996–2016. *Source*: Author's calculation using data from RBA and Passport.

In addition to exchange rates, the context of Australia's FTA engagement becomes an important element in understanding the export behaviour. Twelve bilateral FTAs are currently in effect between Australia and its individual partners. Adding to the earlier list of FTAs with New Zealand (since 1983), Singapore (2003), the US (2005), Thailand (2005), Chile (2009), Malaysia (2013), Korea (2014), Japan (2015) and China (2015), Australia's newest bilateral FTAs with Hong Kong, Peru and Indonesia have entered into force since January, February and July 2020, respectively. Its engagement in trade agreements has also been pursued through various regional trade agreements (RTAs). An FTA between Australia, New Zealand and the Member States of the Association of Southeast Asian Nations (ASEAN) or AANZFTA entered into force in January 2010. Australia is also a party of the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP), which entered into force in 2018 for Australia, and a participating country in the recently concluded negotiations for the Regional Comprehensive Economic Partnership (RCEP) between ASEAN and its FTA partners. An important policy question is whether and the extent of the FTA effects on export prices, hence competitiveness.

3. Previous research and conceptual framework

There is a sizeable body of literature that looks at exporters' price behaviour across different export markets. Following the introduction of the concept by Krugman (1987), some other seminal studies have stimulated further work on the application of the PTM concept (Knetter 1989; Knetter 1994). According to the PTM concept, the depreciation of an exporting country's currency relative to that of the importing country, which essentially reflects a decrease in the production cost of exported products, is not necessarily followed by a proportional decrease in the import prices. Exporters exercising their market power may either maintain or even increase their prices in response to the currency's depreciation. This incomplete exchange rate pass-through implies that prices would differ from marginal cost, and the export prices would comprise of destination-specific 'mark-ups'.

Table 1 lists selected recent studies in the agricultural sector. It can be seen that much focus has been given to the wheat sectors especially those in the US and Canada that are competing in the global wheat markets. Table 1 also suggests that most studies reviewed here suggest evidence of imperfect competition and price discrimination either through country-specific mark-ups or incomplete pass-through. Further to this, there are only a few studies that look at both ERPT and TRPT concepts.

With regard to TRPT, there is not much evidence of complete pass-through. Using data from 46 countries including both agriculture and non-agriculture commodities, a study finds a negative association between the tariff reduction and export prices with the average of TRPT coefficients being 0.727 for RTAs and 0.282 for MFN rates (Hayakawa and Ito 2015). This is in

Table 1 Select studies on the pricing-to-market (PTM) analysis in agricultural sectors

Title (Author, Year)	Exporting country(ies); data; commodity	Econometric modelling	Results
Pricing-to-market behaviour of India's high-value agri-food exporters: an empirical analysis of major destination markets (Issar and Varma 2016)	India; 2006–2014 (monthly); onion, groundnut, guar-gum, dairy products (butter and other fats and oils derived from milk) and cereal preparations	Linear regression with panel corrected standard errors	Evidence of non-competitive pricing either through price discrimination across destinations or through imperfect exchange rate pass-through. Asymmetric effect of exchange rates with depreciation of Indian rupee having a greater impact than the appreciation.
Are Indian rice exporters able to price discriminate? Empirical evidence for basmati and non-basmati rice (Issar and Varma 2016)	India; 2009–2014 (monthly); rice (basmati and non-basmati)	Linear regression with panel corrected standard errors	The presence of non-competitive pricing behaviour of India's rice exporters in majority of destination markets.
Pricing-to-Market and Exchange Rate Pass-Through in the U.S. Broiler Meat Export Markets (No *et al*. 2015)	US; 1990–2011 (annual); broiler meat	Between and within panel regressions	The implementation of a long-run pricing-to-market strategy in the U.S. broiler meat exports mitigates the rising imbalance between the domestic production and consumption via incomplete exchange rate pass-through.
Are Russian Wheat Exporters Able to Price Discriminate? Empirical Evidence from the Last Decade (Pall, Perekhozhuk *et al*. 2013)	Russia; 2002–2010 (quarterly); wheat	Fixed-effect regression with cluster robust standard errors	Russian wheat exporters exercised PTM in only a few importing countries; and PTM behaviour was more pronounced in the aftermath of the export tax period than before.
The exchange rate pass-through into import prices: the case of Japanese meat imports (Miljkovic and Zhuang 2011)	Japan; 1996–2006 (monthly); beef, pork and chicken	The ITSUR method to take into account any cross-equation correlations	More competitive markets among poultry importing firms, somewhat competitive markets among beef importing firms, while competitiveness of pork importing firms could not be assessed due to existing import policies.
Competitive Structure of U.S. Grain Exporters in the World Market: A Dynamic Panel Approach (Hyun and Dragon 2008)	US; 1989–2004 (quarterly); wheat, corn and soybeans	Dynamic two-way fixed effects panel estimator Fixed-effect model	The presence of pricing-to-markets behaviour by U.S. grain exporters overall, and towards some importing countries in particular.

Table 1 (*Continued*)

Title (Author, Year)	Exporting country(ies); data; commodity	Econometric modelling	Results
Pricing-to-Market Behaviour by Canadian and U.S. Agri-food Exporters: Evidence from Wheat, Pulse and Apples (Carew and Florkowski 2005)	Canada and US; 1980–1998 (annual); wheat, pulse, apples		U.S. exporters are sensitive to exchange rate changes, while Canadian exporters in most cases raised price mark-ups in response to a depreciated currency in overseas markets highlighting the differences in pricing policy employed by the two countries.
Price Discrimination in the Context of Vertical Differentiation: An Application to Canadian Wheat Exports (Lavoie 2005)	Canada and US; 1982–1994 (monthly); wheat	Ordinary least square regression for each of possible market pairs	The Canadian Wheat Board has market power emerging from product differentiation, and price discriminates across export markets.
Pricing-to-Market Behaviour: Evidence from Selected Canadian and U.S. Agri-Food Exports (Carew 2000)	Canada and US; 1980–1994 (annual); wheat, pulse and tobacco	Pooled cross-section-time series regression model	Evidence of a greater degree of imperfect competition in international markets for U.S. wheat. Price discrimination and market segmentation apparent for Canadian exports in selected markets with the export adjustment pattern in most cases tended to exacerbate.
Further Evidence on Competition in the US Grain Export Trade (Patterson and Abbott 1994)	US; 1979–1989 (annual); grain	Pooled cross-sectional, time series data	Discriminatory export pricing behaviour significantly related to export seller concentration, US market share, total export volume and import market size. Yet, the estimated coefficients linking these market structure variables to the export price mark-up were relatively small in magnitude, suggesting little quantitative impact from market power.
Pricing-to-Market with Transactions Denominated in a Common Currency (Pick and Carter 1994)	Canada and US; 1978–1988 (quarterly); wheat	Ordinary least squares regression	Foreign-exporter to home-exporter exchange rate can influence the home exporter's pricing decision.
Non-competitive Pricing and Exchange Rate Pass-Through in Selected U.S. and	US and Thailand; 1980–1987 (quarterly); rice	Generalised least squares estimates of coefficients	Evidence of non-competitive pricing either through price discrimination across

Table 1 (*Continued*)

Title (Author, Year)	Exporting country(ies); data; commodity	Econometric modelling	Results
Thai Rice Markets (Yumkella, Unnevehr *et al.* 1994)		generated by using a cross-sectional heteroskedastic and time wise autoregressive model	destinations or through imperfect exchange rate pass-through
The competitive structure of US agricultural sectors (Pick and Park 1991)	US; 1978–1988 (quarterly); wheat, cotton, corn, soybeans, soybean oil, cake and meal	Pooled cross-section-time series regression model	Market power revealed in the adjustment patterns of export prices in response to exchange rate movements.

Source: Author's compilation.

line with results from a study on Indian imports suggesting that foreign exporters have reacted to its tariff liberalisation through increasing their mark-ups, thus partially or even totally offsetting the tariff reduction and leaving minimum or even no benefits to local consumers (Mallick and Marques 2008).

Narrowing down to the PTM analyses of the Australian agriculture sectors, a literature search finds a limited number of studies. Griffith and Mullen (2001) look at the New South Wales rice export markets using monthly data from July 1982 to April 1995. The study finds that the Ricegrowers' Cooperative Limited has been able to price discriminate between destinations through varying mark-ups and in its response to the exchange rate change (Griffith and Mullen 2002). Meanwhile, Swift (2004) uses multivariate cointegration techniques to examine the effects of exchange rates changes on the prices of Australia exports of milk products, cheese, beef, sheepmeat and hides and skins using monthly data from July 1985 to June 1996. The study finds different results between the dairy products group and other commodities. On dairy products, the study observes a complete pass-through in Australian dairy exports. However, it highlights that the reduction in import barriers over the study period was minimal, and an assessment of the effects of subsequent trade reforms may shed some light on possible changes in exchange rate pass-through for the sector (Swift 2004). The period covered by the present study which includes the commencement of FTAs between Australia and its trading partners shows a contribution of this study to address those trade-related aspects.

As a baseline, most empirical studies that examine pricing behaviour across destination markets adopt Knetter's model (Miljkovic, Brester *et al.* 2003; Carew and Florkowski 2005; Pall *et al.* 2013):

$$\ln(p_{it}) = \theta_t + \lambda_i + \beta_i(\ln e_{it}) + u_{it} \quad (1)$$

where $\ln(p_{it})$ is the natural log of the export price charged to an importing country i at period t. θ_t refers to time-specific effects at period t. λ_i is country i-specific time-invariant effects indicating mark-ups included in the exporting country's price charged to importing country i. β_i is the exchange rate pass-through coefficient, while $\ln(e_{it})$ is the natural log of importing country i's currency per Australian dollar. u_{it} is the error term.

Time-specific effects (θ_t) capture factors that have common impacts in each time period across all destination markets. Within the context of PTM, these refer to the time varying marginal costs of Australia as an exporter influenced by a range of factors such as milk supply, input costs. Meanwhile, country-specific factors (λ_i) include aspects that influence export demand of importing country i such as changing income levels, their respective domestic policies, and preference towards commodities and quality. Miljkovic *et al.* (2003) point out that significant country effects imply the exporting country's ability

to practice price discrimination. The error term (u_{it}) captures other unobservable factors.

The estimated β_i and λ_i parameters from Equation 1 allow the tests for three hypotheses.

- Null hypothesis: $H_0 : \beta_i = 0, \lambda_i = 0$
- Alternative hypothesis 1: $H_A : \beta_i \neq 0$, and/or
- Alternative hypothesis 2: $H_A : \lambda_i \neq 0$

The null hypothesis implies that there is not enough evidence to reject the perfect competition and price non-discrimination, and the export price is equal to the exporting country's time varying marginal cost θ_t. In such a market structure, the exchange rate changes have negligible impacts on the export prices.

The two alternative hypotheses indicate imperfect competition with price discrimination. A statistically significant β_i implies the presence of PTM. The exchange rate is said to be 'incomplete' if $\beta_i < 0$ where the exporting country adopt 'local currency price stabilisation'. In contrast, a positive β_i means that the exporters amplify the effects of exchange rates changes. Meanwhile, one could interpret that $\lambda_i \neq 0$ implies mark-up differences across destination markets. Earlier studies, however, highlight that the significance of λ_i does not necessarily imply imperfect competition as these destination-specific effects also capture quality differences (Knetter 1989; Pall, Perekhozhuk *et al.* 2013; Issar and Varma 2016). If both β_i and λ_i are statistically significant, this means that Australian dairy exporters are able to price discriminate with varying price elasticity of demand.

Next, the impacts of trade-related effects are considered. Without their inclusion in the model, these aspects would be included in the error term u_{it}, hence possible omitted variable bias. As noted earlier, there are three aspects considered in this study: (i) tariff rate that can be influenced by the entry into force on an FTA; (ii) other FTA effects; and (iii) different responses to exchange rates change as a result of FTA with a trading partner.

First, the inclusion of the tariff variable in the model allows us to identify TRPT. As shown in Appendix S2, in addition to trade in goods, the areas covered by Australia's bilateral and regional FTAs are extensive and vary between partner countries with many including 'WTO^X' aspects, which are new areas not covered in the WTO agreement such as cooperation, competition, SME, environment and labour (Horn *et al.* 2010). This implies that in addition to benefits from tariff reduction and elimination, countries may receive other benefits from FTAs. To address this possibility, similar to earlier studies such as Miljkovic *et al.* (2003), this study uses a dummy variable on FTA to see its impacts on the export prices. This dummy variable captures other FTA effects particularly those not directly related to tariff reduction.

One may concern about the endogeneity of this FTA dummy variable. A study finds that while the cross-section techniques using instrumental variables and control functions are not able to provide stable estimates of

the average treatment effects of the FTA, the use of panel data presents convincing empirical evidence (Baier and Bergstrand 2007). Specifically, to capture unobserved time-invariant variables that are likely correlated with FTAs, the estimates are best controlled using 'fixed effects' compared to the random effects which assume zero correlation between those unobserved variables and FTA.[3]

Third, we consider whether an FTA between Australia and its trading partner results in different responsiveness to exchange rate volatility. The rationale behind the use of this interaction term is that FTA may incentivise exporters to build and maintain the confidence of its FTA partner through absorbing the mark-ups amidst exchange rate fluctuations, hence price certainty. The study uses an interaction term between a dummy variable on FTA and the exchange rate variable to capture this aspect. A similar use of interaction terms has been adopted by a number of studies. Issar and Varma (2016) test the differential impact of appreciation and depreciation through introduction interaction terms between exchange rate variables and a dummy which equals to one when the exchange rate depreciates. Similarly, interaction terms are also used by a study on the different exchange rate pass-through coefficients between firms with different trade regimes (i.e. processing or assembly firms with typically high shares of import content, and regular firms) (Bouvet *et al*. 2017) and a study on heterogeneity in the exchange rate pass-through between industries with different market structure (Bugamelli and Tedeschi 2008).

Equation 1 is therefore re-defined as follows:

$$\ln(p_{it}) = \theta_t + \lambda_i + \beta_{1_i}(\ln e_{it}) + \beta_{2_i}(\ln e_{it} \times FTA_{it}) + \alpha_i FTA_{it} + \delta_i \ln(1 + T_{it}) + w_{it} \quad (2)$$

T_{it} is the tariff rate imposed by importing country i at time t. δ_i is the TRPT coefficient with a complete tariff pass-through defined when $\delta_i = 1$. FTA_{it} equals to one at period t when an FTA between Australia as an exporting country and its trading partner is in effect. A significant and negative coefficient of β_2 implies that the effect of the exchange rates change is smaller when Australia has entered an FTA with the trading partner implying 'price stabilisation' effects of the FTA.

4. Data and descriptive statistics

This study uses commodity-level dairy trade data for the period from 1996 to 2016. It focuses on the trade between Australia and its FTA partners in Asia, hence exclusion of the US and Chile. To observe the impact of FTA, the

[3] In Baier and Bergstrand (2007), these 'fixed effects' refer to the bilateral fixed effects. Given the inclusion of only one exporting country in the present study, this is equivalent to country fixed effects.

sample inclusion is confined to countries that entered into an FTA with Australia over the study period[4], *and* a change in the tariff rates for the commodities included in the analysis during the focus period.[5] This implies that, first, the study excludes countries like India with which Australia has no FTA relation.[6] Second, despite their FTA relations with Australia, countries imposing unchanged tariff rates between 1996 and 2016 such as New Zealand, Singapore and Brunei Darussalam, all of which have imposed zero MFN tariff over the whole period of 1996–2016, are not included in the sample.[7] Furthermore due to limited data availability, three least developed countries in ASEAN, namely Cambodia, Lao PDR and Myanmar, are also excluded from the analysis[8]. In total, there are eight countries included in the analysis, namely China, Indonesia, Japan, Korea, Malaysia, Philippines, Thailand and Viet Nam.

Unlike the rest of the sample which have bilateral FTAs with Australia, preferential schemes for Indonesia, Philippines and Viet Nam refer to their participation in the AANZFTA given their ASEAN Member State status. It is important to note that the levels and commencing years of preferential tariffs on Australian products vary between different ASEAN Member States.[9]

This study conducts the PTM analysis of three dairy commodities, namely whole fresh milk, skimmed dried milk and (whole milk) cheese. Data on export volume (in tonnes) and total export value ('000 US$) are taken from the FAO (FAO 2019), based on which the export unit values are derived (in US$/tonne) before being converted to A$/tonne (p_{it}). Annual average exchange rates are calculated from historical daily exchange rates data from

[4] If non-FTA partners were included, their FTA dummy variable would be the same as the country-specific effects.

[5] This is to avoid multicollinearity with country-specific effects.

[6] While excluded from the main analysis, an additional analysis as shown in Appendix 5 is presented to estimate India's exchange rate pass-through. This analysis provides insights into the dynamics of Australian dairy exports to India, which will be useful considering India's possibility to be one of the RCEP's signatory countries.

[7] New Zealand has become Australia's FTA partner since the entry into force of the Australia - New Zealand Closer Economic Relations Trade Agreement (ANZCERTA) in 1983. Under the ANZCERTA, most preferential rates of duty, including dairy products, have been set at zero. As for Singapore, being Australia's first FTA with an ASEAN Member State, the Singapore-Australia Free Trade Agreement (SAFTA) became operational since July 2003. This led to removal of tariffs on Australian products exported to Singapore. For dairy products, this tariff concession, however, is not only enjoyed by Singapore's FTA partner given its zero MFN tariffs offered to all WTO members. With regard to Brunei Darussalam, noting that Brunei Darussalam is not Australia's bilateral FTA partner though both are the parties to the AANZFTA, Brunei Darussalam has applied zero MFN tariff on the studied dairy products for decades indicating the insignificant change in the applied tariff rates on Australian products at the start of the FTA involving the two countries.

[8] Limited or even no tariff concession has been reported. Cambodia, for example, only reported preferential tariff rates on Australian buttermilk (040390) in 2014, while both TRAINS and the WTO IDB record no preferential tariffs on Australian dairy products reported by Myanmar.

[9] See a footnote in Appendix 2 on the AANZFTA's differing entry into force dates.

the Reserve Bank of Australia (RBA 2019). Pre-1999 and missing exchange rate data are filled in using those from Euromonitor's Passport database (Euromonitor International 2019). Exchange rates (e_{it}) are expressed in importing country's currency per Australian Dollar ($A). Hence, Australian dollar depreciation is marked by a decrease in the exchange rate variable.

Tariff rates (T_{it}) are taken from the UNCTAD Trade Analysis Information System (TRAINS) (UNCTAD n.d). The study also uses tariff information published by Dairy Australia.[10] The tariff variable in Equation 2 refers to the lowest tariff between most-favoured nation (MFN), which is applicable to all WTO members, and preferential tariff rates as part of a regional or bilateral trade agreement in effect between Australia and a trading partner is included in the analysis. To match between trade data from the FAO and tariff data (in HS code), the correspondence map by the FAO is used. See Appendix S3 on the correspondence of the three dairy commodities included in this study.

Table 2 presents descriptive statistics. The share of exports to eight countries included in the analysis (as a percentage of total Australian exports of respective dairy commodity) generally increased between 2000 and 2016, from 26% to 55% for whole fresh milk and from 51% to 78% for cheese. Except for Indonesia, whole fresh milk exports increased significantly with exports to China representing one-third of Australia total exports of whole fresh milk. In contrast, Australia's skimmed dried milk total exports decreased by 64% from 203,914 tonnes in 2000 to 73,649 tonnes in 2016. China emerged as a main export destination for skimmed dried milk accounting for nearly one-fifth of Australia total exports. These trends of increasing whole milk exports and decreasing demand for skimmed dried milk are consistent with literature on the shift in consumer's preference in Asia, and other parts of the world, who demand for more fresh food items such as fresh milk. This also indicates increased health awareness and change in lifestyle. Meanwhile, demand for Australian cheese exports continuously came from Japan representing nearly half of Australian total cheese exports in 2016. Similar to other dairy products, China emerged as a new cheese export destination accounting for about 12% of Australian total cheese exports in 2016.

Looking at the MFN tariff across different sample countries, Table 2 shows different levels of openness between countries. Following the entry into force of respective bilateral and regional FTAs, relative to each country's MFN tariffs, Australian dairy exports can access concessions offered by partner countries such as Malaysia, Philippines and Thailand and to a lesser extent, Indonesia[11] and Vietnam. Tariff rates also vary between dairy

[10] Dairy Market Regulations 2009, 2010, 2011 and 2013; Export Market Dairy Tariffs 2014-2015 and 2016-2017.

[11] It is important to note that tariffs imposed by Indonesia have been low since early 2000s. Following the signing of the International Monetary Fund's Memorandum of Economic and Financial Policies on 20 January 2020, tariffs on all food items including dairy were cut to a maximum of 5%. Furthermore, dairy local content regulations were also abolished.

Table 2 Descriptive statistics, 2000 and 2016

Export destination (FTA entry into force)	Export quantity in 2000 (tonnes)	Export share in 2006 (% Australian total export)	Export quantity in 2016 (tonnes)	Export share in 2016 (% Australian total export)	MFN Tariff - Average 2000–2002 (%)	MFN Tariff in 2016 (%)	Preferential tariff in 2016 (%)
(i) Whole fresh milk							
China (ChAFTA, 20 December 2015)	4,272	6.3	63,713	34.4	22.7	15.0	12.0
Indonesia (AANZFTA, 10 January 2012)	652	1.0	320	0.2	5.0	5.0	4.0
Japan (JAEPA, 15 January 2015)	3	0.0	71	0.0	234.1	n.a.	n.a.
Korea (KAFTA, 12 December 2014)	17	0.0	1,969	1.1	39.7	36.0	30.6
Malaysia (MAFTA, 1 January 2013)	3,458	5.1	15,235	8.2	0.0	27.5	0.02†
Philippines (AANZFTA, 1 January 2010)	6,949	10.3	13,194	7.1	3.0	3.0	2.0
Thailand (TAFTA, 1 January 2005)	22	0.0	293	0.2	40.0	40.0	8.0†
Viet Nam (AANZFTA, 1 January 2010)	2,414	3.6	7,573	4.1	20.0	15.0	5.0
(ii) Skimmed dried milk							
China	4,023	2.0	14,499	19.7	22.5	10.0	8.3
Indonesia	4,147	2.0	919	1.2	5.0	5.0	4.0
Japan	5,390	2.6	2	0.0	117.7	84.4	n.a.
Korea	464	0.2	517	0.7	189.2	176.0	176.0
Malaysia	15,937	7.8	2,548	3.5	0.0	0.0	0.0
Philippines	36,521	17.9	492	0.7	3.7	1.0	0.0
Thailand	13,244	6.5	2,079	2.8	5.0	18.0	0.0
Viet Nam	8,587	4.2	7,676	10.4	22.5	3.0	0.0
(iii) Cheese							
China	49	0.0	20,778	11.9	40.15	12.0	9.5
Indonesia	3,934	1.7	3,658	2.1	5.0	5.0	0.8
Japan	90,358	38.8	85,961	49.1	24.1	21.8	14.4
Korea	15,996	6.9	8,657	4.9	37.5	36.0	0.0†
Malaysia	2,036	0.9	8,893	5.1	6.8	0.0	0.0
Philippines	5,306	2.3	4,710	2.7	5.6	4.5	1.0
Thailand	705	0.3	3,407	1.9	49.5	30.0	4.8
Viet Nam	25	0.0	535	0.3	30.0	10.0	4.5

Note: Author's calculation using export data from FAOSTAT and tariff data from WITS and Dairy Australia publications. See Footnote 12.
†In-quota preferential tariff used.

commodities. For instance, trade access to Japan and Korea for fresh milk and skimmed dried milk is subject to higher tariffs than that to other countries in this analysis. The JAEPA is therefore expected to improve trade access to Japan, which accounted nearly half of Australia's total cheese exports in 2016.

The data in Table 3 compare the average and standard deviation in export unit values over two decades. Increased prices of the three commodities can be observed. To some extent, cross-country variations in export unit values indicate product differentiation distributed to these different markets. Japan, for instance, has long been a 'mature, high-value' market for Australian dairy exports which may explain its high export prices of whole fresh milk and skimmed dried milk in recent years compared to most other markets. This difference, however, is not evident in the cheese exports possibly due to the type of Australian cheese being exported to Japan, which is predominantly natural-style cheese used by food service customers such as bakeries and ice-cream manufacturers (Dairy Australia 2019) that do not necessarily use high-end products. Tariff differences seem to also explain variations in export prices. The high average export price of whole fresh milk to Korea in the 1996–2006 period seems to be driven by a high price combined with over 200% tariff rate imposed in 1998 amidst the Asian financial crisis, which severely affected the Korean economy. Moreover, the use of aggregated data based on the FAO Commodity List implies that these different export prices can be due to different 'export baskets' across destination markets particularly in the 'whole fresh milk' category which includes both milk and cream with the average price of the latter obviously higher than the earlier.

Table 3 also shows rather high within-country variations in export unit values especially in the 2006–2016 period. One possible explanation is increased volatility due to a mixture of the dynamics in the domestic production levels, global dairy markets and the global financial crisis. Despite drought conditions in inland regions, given the 'favourable' international conditions due to strong demand and tight supplies, Australian dairy commodity prices reached to record levels in 2007–2008 before declining in the subsequent years following the global financial crisis (Dairy Australia 2008).

5. Estimation results

5.1 Panel unit root test

Fisher-type panel data unit root tests were performed. As pointed out by Carew and Florkowski (2005), results from the standard Dickey-Fuller and augmented Dickey-Fuller (ADF) tests almost never reject the null hypothesis of a unit root and the power of these tests is especially low when there are only few observations included in the analysis. There has been some work to address a unit root in panel data (Quah 1994; Levin *et al.* 2002; Im *et al.*

Table 3 Summary statistics of export unit values ($A/tonne)

Country	(i) Whole fresh milk				(ii) Skimmed dried milk				(iii) Cheese			
	1996–2005		2006–2016		1996–2005		2006–2016		1996–2005		2006–2016	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
China	893	162	1,085	218	2,667	566	5,410	1,505	4,492	1,022	4,469	542
Indonesia	797	108	2,050	1,279	3,035	434	3,834	677	3,393	407	5,483	894
Japan	1,514	1,145	4,687	1,161	3,208	606	7,104	7,217	3,566	305	4,323	579
Korea	3,019	1,937	2,293	774	3,062	549	5,379	1,426	3,498	389	4,592	602
Malaysia	640	133	932	137	3,329	476	4,428	715	4,608	744	5,017	703
Philippines	755	119	780	211	3,283	530	3,884	516	3,261	373	4,896	719
Thailand	1,511	486	4,375	2,302	3,473	598	4,008	567	3,940	381	5,206	690
Viet Nam	743	82	1,108	217	2,789	499	4,013	1,061	5,059	1,643	5,301	621

Note: Author's calculation using export data from FAOSTAT by dividing the export value (in '000 US$) by export quantity (in tonnes), and converted the unit value in US$/tonne to A$/tonne by using exchange rate data from the RBA and Passport.

2003). This study uses the four methods proposed by Choi (2001). The method is under more general assumptions that previous tests including the assumptions that the number of groups in the panel data can be either finite or infinite; each group has different types of non-stochastic and stochastic components; different time spans for the groups; and the alternative where some groups have a unit root and others do not (Choi 2001). These assumptions suit the nature of the panel data in this study given the rather short time series $T = 20$ (unbalanced panel) and few countries $N = 8$.

The Choi's test combines the p-values of a unit root test on each countries' series. Cross-sectional means are removed from the test, and nonzero drift is taken into account. The null hypothesis is that all panels contain a unit root, while the alternative hypothesis is that at least one panel is stationary. Results from the Choi test in Appendix S4 suggest that all four of the tests strongly reject the null hypothesis of nonstationary in levels. The Kao test was also performed to ensure that cointegration is not of an issue for the preceding analysis. The test suggests that there is not enough evidence to reject the null hypothesis of no-cointegration at 5% level of significance.

5.2 Pooled sample

To assess export price behaviour and price discrimination, this study employs panel data series. It considers empirical models used by existing studies. The summary of select studies in Table 1 illustrates various panel data regression models to estimate the PTM model. These include the fixed effects (Carew and Florkowski 2005; Hyun and Dragon 2008; Pall, Perekhozhuk *et al*. 2013) and GLS (Yumkella *et al*. 1994; Miljkovic, Brester *et al*. 2003), among others. Concerns over the presence of autocorrelation within panels and heteroscedasticity across panels have been expressed by some studies.

This study therefore conducts the analyses as follows. First, it starts with a base regression assuming common country slopes by using the pooled samples and inserting both country-specific and product-specific fixed effects in the analysis. Second, it exploits different country slopes and addresses the possible presence of heteroscedasticity and autocorrelation correlation by applying the feasible generalised least squares (FGLS).[12]

The following specification is estimated:

$$\ln(p_{ijt}) = \theta_t + \gamma_{ij} + \beta_1(\ln e_{it}) + \beta_2(\ln e_{it} \times FTA_{it}) + \alpha FTA_{it} + \delta \ln(1 + T_{ijt}) + v_{ijt} \tag{3}$$

where γ_{ij} is country-commodity fixed effects. Note that the ERPT and TRPT coefficients β_1 and δ, respectively, are assumed to be the same for all different export markets. To allow for first-order autoregressive disturbances, the error

[12] See for example page 296 of Greene, W. H. (2003). *Econometric Analysis*. Pearson Education, Singapore on FGLS.

term is defined as follows:

$$v_{ijt} = \rho_i u_{ij(t-1)} + \varepsilon_{ijt} i = 1, \cdots, Nt = 1, \cdots, T \quad (4)$$

where the autoregressive parameter can vary across cross-sections. Further to this, the remainder error ε_{ijt} is assumed to follow normal distribution with mean zero and is allowed to be heteroscedastic and correlated across panels. Table 4 shows the regression results for common country coefficients. Column (i) shows that when a single coefficient is imposed to exchange rate variations of all panels, as expected, the estimated ERPT is positive and significant at 10%. Given that the exchange rate variable is expressed in importing country's currency per \$A, the positive coefficient means that the depreciation of a partner country's currency relative to \$A tends to be responded by an upward adjustment in the export unit value. This implies relatively inelastic demand for Australian dairy products and can be seen as an indicator of Australia's market power in the global market. Miljkovic *et al*. (2003) argue that a positive exchange rate coefficient can also mean that the exporting country requires higher prices to compensate exchange rate uncertainty.

As expected, the coefficient of the tariff variable is positive and significant at 5% level. A 10% decrease in tariff (as a result of preferential tariff reduction following an FTA's entry into force, or a reduction in the MFN tariff) is associated with 0.7% export unit value cut. Results in this study could mean that the inelastic demand for dairy exports is less likely influenced by tariff rates than other commodities especially non-agricultural commodities. This TRPT is significantly lower than those suggested by Hayakawa and Ito (2015) who find that the average TRPT is 0.727 for RTAs and 0.282 for MFN rates. However, the magnitude of the coefficient is quite comparable to the one suggested by Mallick and Marques (2008) on TRPT of India's dairy import prices at 0.06%, which is significantly lower than TRPT coefficients for other industries such as nickel, non-ferrous metals and metalworking machinery.

Column (ii) of Table 4 includes the FTA dummy variable and its interaction with the exchange rate variable. Coefficients of the exchange rate and tariff variables are both positive, significant and relatively similar to those in Column (i). The insignificant coefficients of both the interaction term and the FTA dummy mean that there is no significant difference in the exchange rate effects driven by the entry into force of an FTA between Australia and its trading partner. This implies that apart from benefits from tariff reduction, there is no sufficient evidence of the significance of an FTA to incentivise Australian exporters to expand market share for example through a price reduction, which would be the case if the coefficient of the FTA dummy was a negative. In short, Table 4 suggests that Australian dairy exports are responsive to both exchange rate fluctuations and tariff reduction, due to either a reduction in MFN or preferential tariff. The export price change,

Table 4 Panel regression results for Australian dairy export prices (common country-commodity slopes), 1996–2016

Dependant variable: Ln(p_{ijt})	Pooled sample		By dairy commodity		
	(i)	(ii)	(iii) Whole fresh milk	(iv) Skimmed dried milk	(v) Cheese
Ln(e_{it})	**0.166***	**0.156***	**0.443***	−0.093	0.11
	(2.421)	(1.991)	(2.485)	(−0.602)	(1.467)
Ln($1 + T_{ijt}$)	**0.069****	**0.070****	0.031	0.051	**0.058***
	(2.959)	(2.981)	(0.405)	(1.171)	(2.340)
Ln(e_{it}) × FTA_{it}		0.001	0.025	−0.013	−0.011
		(0.151)	(1.289)	(−0.705)	(−1.178)
FTA_{it}		0.011	−0.032	0.007	0.071
		(0.174)	(−0.227)	(0.058)	(1.102)
Cons.	6.735***	6.772***	4.826***	8.112***	7.475***
	(20.930)	(18.884)	(5.665)	(11.497)	(21.513)
Year fixed effects (θ)	Yes	Yes	Yes	Yes	Yes
Country-commodity dummies (γ)	Yes	Yes	Yes	Yes	Yes
N obs.	448	448	130	158	160
N country-commodity	24	24	8	8	8
R^2	0.422	0.422	0.502	0.495	0.584

Note: Fixed-effect regressions; ***, **, * indicate a coefficient significantly different from zero at, respectively, the 1%, 5%, 10% level. t-statistics are in parentheses. Countries in the sample are China, Indonesia, Japan, Korea, Malaysia, Philippines, Thailand and Viet Nam.

however, is less than proportional to the change in exchange rate or to the tariff reduction, that is incomplete pass-through.

Next, regressions by dairy commodity are performed. Columns (iii) to (v) of Table 4 show that different dairy commodities respond to the exchange rate dynamics and tariff change differently. The positive ERPT at 10% level of significance for the whole fresh milk exports in Column (iii) indicates that Australian exporters have the market position to amplify exchange rate changes, but the association between tariff cut and export price is insignificant. One may argue that increasing and large demand from China, which represents one-third of Australia's total whole fresh milk exports, may have shaped a rather inelastic demand for Australian fresh milk, hence drives a positive ERPT. However, when the analysis is re-estimated by excluding China from the sample countries (results are not presented here), the ERPT coefficient is even higher at 0.781 and significant at 5% level of significance. This implies that Australian dairy exports do have the market power to increase mark-ups over the currency change across various destination markets.

On the contrary, at 10% level of significance, cheese export unit values are positively associated with the tariff changes as shown by Column (v) of Table 4. One may argue that this association is likely to be driven by a decrease in tariff for cheese imposed by Japan, to which Australia exported nearly half of its total cheese exports in 2016. The reduction is observed in

both the MFN tariff prior to 2015, and the preferential tariff following the entry into force of JAPFA in January 2015. However, when China is excluded from the sample (results are not presented here), the TRPT coefficient becomes insignificant. As previously mentioned, China has applied a significant reduction in the MFN tariff and become the second largest export market for Australian cheese accounting for nearly 12% of Australia's total cheese export. There is no sufficient evidence of the significant ERPT and TRPT for skimmed dried milk. Likewise, the impacts of FTA and its interaction with exchange rates are insignificant for all of the three commodities. In short, the results show that the change in export price is largely driven by the change in time varying marginal costs of Australian producers and country-specific effects.

5.3 Whole fresh milk

Next, individual country TRPT (δ_i) and ERPT (β_i) coefficients are allowed by estimating Equation (2). Table 5 focuses on the whole fresh milk export price. The analysis takes into account heteroscedasticity across panels. With regard to the ERPT, the results show that relative exchange rate movements do not influence Australian whole fresh milk export prices to the eight trading partners.

With regard to the pass-through of the tariff into Australian exports, out of the eight sample countries included in the analysis, only Korea shows a significant coefficient for TRPT with varying elasticity of demand, that is $\delta \neq 0, \lambda \neq 0$. Moreover, looking at the country effects λ, there is no sufficient evidence that Australian dairy exporters discriminate the prices of whole fresh milk across different export markets as indicated by the two parameters $\beta_1 = 0, \lambda = 0$ for all countries, except Korea. For Korea, the possible explanation for the positive and significant TRPT coefficient is that following the outcomes of the Uruguay Round negotiations, Korea and Japan established tariff rate quotas (TRQs) for agricultural imports, which had contributed to increased imports (Choi and Sumner 2000). Australia's whole fresh milk exports to Korea had doubled between 2000 and 2005. In recent years, however, despite the putting in place of KAFTA, Australian dairy exports to Korea are competing with the US, EU and New Zealand the three largest dairy exporters, all of which have also concluded FTAs with Korea with faster tariff reduction schedules (Dairy Australia 2019).

Overall, the results suggest the presence of competitive pricing behaviour among Australian whole fresh milk exporters. Changes in export prices are mostly explained by changes in Australia's marginal costs as captured by time effects. With exports to Korea as an exception, there is not enough evidence for the FTA effects on the export price for most countries, in terms of tariff effects nor through different responses to the exchange rate changes.

Table 5 Results of the PTM model for whole fresh milk, 1996–2016

Country	Exchange rate (β_{1i})	Interaction (β_{2i})	Tariff (δ_i)	Country effect (λ_i)
China	−0.557	0.046	−0.051	
	(−1.586)	(0.036)	(−0.172)	
Indonesia	0.446	0.11	−0.001	−4.943
	(1.947)	(0.504)	(−0.006)	(−1.758)
Japan	−0.743	0.03	−0.131	4.258
	(−1.294)	(0.068)	(−0.388)	(1.011)
Republic of Korea	0.717	0.224	6.802***	−29.888***
	(1.591)	(0.736)	(3.349)	(−3.426)
Malaysia	0.719	0.343	−0.008	−2.062
	(1.513)	(0.187)	(−0.132)	(−1.462)
Philippines	−0.003	0.066	−0.199	−1.064
	(−0.007)	(0.119)	(−0.311)	(−0.522)
Thailand	1.016	0.138	0.106	−3.746
	(1.077)	(0.219)	(0.912)	(−1.160)
Viet Nam	0.112	0.042	−0.02	−2.167
	(0.408)	(0.199)	(−0.182)	(−0.704)
FTA	−0.377			
	(−0.184)			
Cons.	8.043***			
	(6.391)			
Year fixed effects	Yes			
N obs.	130			
Wald chi-sq.	6867.67 (0.000)			

Note: Degrees of freedom = 77. The estimates are produced using FGLS with heteroskedastic panels; ***, **, * indicate a coefficient significantly different from zero at, respectively, the 1%, 5%, 10% level. t-statistics are in parentheses. Countries in the sample are China, Indonesia, Japan, Korea, Malaysia, Philippines, Thailand and Viet Nam. China is the intercept.

5.4 Skimmed dried milk

Table 6 looks at the exchange rate and tariff effects on the export prices of skimmed dried milk. Similar to the whole fresh milk exports, for majority of the sample countries, there is not enough evidence to reject the null hypothesis of a competitive pricing behaviour of Australian dairy exporters. The exchange rate and tariff parameters as well as the country effects for all countries, except for Philippines and China, are insignificant.

For Philippines, the significant and positive ERPT parameter reflects Australia's market power to amplify exchange rate changes by increasing the export price to Philippines. This result may also mean that an increasingly inelastic demand for Australian skimmed dried milk as prices go up, and changing preferences over the product mix of the Australian skimmed dried milk towards higher-value varieties, hence increased prices. This could happen, if a devaluation of the Philippine Peso causes a decline in dairy consumption of low-income consumers, while higher income consumers might not be as price-sensitive. Comparing data in 2000 and 2016, it can be seen that there was a massive decline in Australian exports of skimmed dried milk to Philippines, from 36,521 tonnes to only 492 tonnes. With regard to the TRPT, despite the positive and significant tariff parameter, given the zero

Table 6 Results of the PTM model for skimmed dried milk, 1996–2016

Country	Exchange rate (β_{1i})	Interaction (β_{2i})	Tariff (δ_i)	Country effect (λ_i)
China	−0.313	−0.262	−0.264*	
	(−1.228)	(−0.192)	(−2.225)	
Indonesia	−0.141	−0.109	−0.032	−0.008
	(−0.972)	(−0.462)	(−0.311)	(−0.005)
Japan	−0.643	0.17	0.03	1.341
	(−1.835)	(0.350)	(0.370)	(0.724)
Republic of Korea	0.247	−0.193	−0.034	−2.606
	(0.956)	(−0.603)	(−0.288)	(−1.231)
Philippines	1.062**	−0.191	0.489***	−5.501**
	(2.762)	(−0.324)	(3.293)	(−3.194)
Thailand	0.724	−0.362	0.045	−3.493
	(1.306)	(−0.544)	(1.312)	(−1.752)
Viet Nam	−0.177	−0.06	0.195	−0.264
	(−0.698)	(−0.262)	(1.850)	(−0.103)
FTA	0.87			
	(0.395)			
Cons.	9.137***			
	(12.866)			
Year fixed effects	Yes			
N obs.	137			
Wald chi-sq.	817.68 (0.000)			

Note: Degrees of freedom = 88. The estimates are produced using FGLS with heteroskedastic panels; ***, **, * indicate a coefficient significantly different from zero at, respectively, the 1%, 5%, 10% level. t-statistics are in parentheses. Countries in the sample are China, Indonesia, Japan, Korea, Malaysia, Philippines, Thailand and Viet Nam. China is the intercept. Z-statistics are in parentheses.

tariff already imposed by Philippines for this commodity there is no further tariff reduction that can be possibly made. Furthermore, after reaching its peak in 2002, Australia's skimmed dried milk exports to Philippines have been declining significantly.

With regard to China, it is interesting to find a negative TRPT coefficient at 10% level of significance. A 10% tariff reduction is associated with 3% increase in the export price. Given that the ChAFTA that has only come into force in end-December 2015, the tariff rates used in this analysis are MFN tariff that apply to all WTO members. Tariff reduction may afford Chinese consumers to shift and/or expand to higher-value commodity baskets, including infant formula powder. To get a complete understanding of the preferential tariff effects under ChAFTA, however, future assessment is required as it may take time to realise its full market benefits.

In brief, the overall results suggest competitive pricing behaviour among Australian skimmed dried milk exporters. The tariff effects are only significant for China and Philippines with further analysis required to get a full understanding of the benefits from newer preferential trade agreements such as the ChAFTA. Further, the estimate suggests that Australian export price is sensitive to change in Philippine Peso. For most markets, similar to the whole fresh milk markets, the skimmed dried milk prices are determined by Australia's own marginal cost.

5.5 Cheese

Table 7 shows the estimates for cheese export prices. The ERPT coefficients for Japan, which is Australia's largest cheese importers, are found to be negative and significant at 1% level of significance. Likewise, negative and significant parameters are obtained for Korea and Viet Nam, each of which represents nearly 5% and 0.3% of Australia's total cheese exports. The parameters indicate that Australian export prices decline by 3–4% for a 10% depreciation of Japanese Yen, Korean Won and Vietnamese Dong relative to Australian dollar.

In contrast, positive ERPT coefficients are observed for Indonesia and Thailand implying Australian exporters' market power to amplify the effect of exchange rate fluctuations by adjusting cheese prices upward in these two export markets when their currencies depreciate against Australian dollar. Miljkovic *et al*. (2003) indicate that a positive exchange rate parameter for a small destination market may imply that the exporting country is not willing to divert exports from its major markets unless there is an increase in export prices.

With regard to TRPT, as expected, Table 7 shows positive coefficients for China and Viet Nam with a 10% decrease in tariff associated about 2% export unit value decrease. On the other hand, negative coefficients are observed for Korea and Philippines at 5% and 10% levels of significance, respectively. Despite a significant decrease in tariff, cheese export unit value to these two markets have generally been increasing in the past two decades.

In terms of the interaction term between FTA and the exchange rate variable, Table 7 shows a significant and negative coefficient for Korea at 5% level. This implies that the effect of exchange rate change on the cheese export price to Korea is smaller following the entry into force of KAFTA in 2015.

In short, the estimates highlight that Australian exports exercise different pricing behaviours of Australian cheese exporters, compared to those of whole fresh milk and skimmed dried milk exporters. Australian cheese export prices to several markets such as Japan, Korea and Viet Nam increase by 0.3–0.4% in response to 1% depreciation of Australian dollar. Meanwhile, tariff effects vary across different markets.

Lastly, a robustness check is conducted to capture the possible autocorrelation within panels. Despite unbalanced panels in this article, an assumption that the time variable is equally spaced must be imposed to allow the estimates. There is no significant difference between results presented in Tables 5 to 7 and the re-estimates.

6. Concluding remarks

Understanding the magnitude of both tariff and exchange rates pass-through remains a topic that is of both economic and policy importance. This is particularly relevant amidst continued global economic adjustment and the

Table 7 Results of the PTM model for cheese, 1996–2016

Country	Exchange rate (β_{1i})	Interaction (β_{2i})	Tariff (δ_i)	Country effect (λ_i)
China	−0.447	−0.494	0.197***	
	(−1.892)	(−0.940)	(3.840)	
Indonesia	0.153*	−0.062	0.013	−1.582*
	(2.428)	(−0.684)	(0.224)	(−1.989)
Japan	−0.440***	−0.151	0.17	1.091
	(−4.459)	(−0.817)	(1.496)	(1.589)
Republic of Korea	−0.303***	−0.944**	−1.563**	7.442***
	(−3.906)	(−3.085)	(−3.105)	(3.575)
Malaysia	−0.357	−0.586	0.063	0.169
	(−1.331)	(−0.768)	(1.250)	(0.294)
Philippines	0.059	−0.185	−0.101*	−0.307
	(0.627)	(−0.810)	(−2.237)	(−0.502)
Thailand	0.584*	−0.224	0.034	−2.111*
	(2.564)	(−0.883)	(1.471)	(−2.387)
Viet Nam	−0.367*	−0.064	0.199*	2.983
	(−2.048)	(−0.737)	(2.413)	(1.625)
FTA	0.636			
	(0.750)			
Cons.	8.363***			
	(16.888)			
Year fixed effects	Yes			
N obs.	160			
Wald chi-sq.	2210.90 (0.000)			

Note: Degrees of freedom = 107. The estimates are produced using FGLS with heteroskedastic panels; ***, **, * indicate a coefficient significantly different from zero at, respectively, the 1%, 5%, 10% level. t-statistics are in parentheses. Countries in the sample are China, Indonesia, Japan, Korea, Malaysia, Philippines, Thailand and Viet Nam. China is the intercept. Z-statistics are in parentheses.

further opening of the Australian economy through the signing of bilateral and regional trade agreements. To this end, this article contributes to the scholarly discussion by addressing the under-researched Australian dairy sector. The high reliance of the agricultural sector on export revenues warrants a closer look at the Australian exporters' competitive behaviour. Furthermore, this study takes into takes into account three trade-related aspects including the effects of FTA, tariff and the possible difference in responses to exchange rate change following the enforcement of an FTA.

Three key findings are derived by this study. First, it finds that variations in competitive pricing behaviour exist within industries and between commodities. At the industry level using pooled samples of the three commodities' exports data, the empirical work suggests significant ERPT and TRPT, albeit incomplete. The study finds that the dairy export prices decrease by 1.7% if the Australian dollar depreciates by 10%, while a 10% tariff reduction is associated with a 0.7% export price cut.

At the commodity level, the study finds minimal evidence of non-competitive pricing in the majority of the export markets of whole fresh milk and skimmed dried milk. But the results show different export pricing behaviours across export cheese markets. More specifically, the study finds that export prices to main markets such as Japan, Korea and Viet Nam

increase by 3–4% in response to a 10% depreciation of Australian dollar. Estimates on the cheese export prices also show positive and significant yet incomplete tariff pass-through in markets such as China and Viet Nam.

Overall, results from this study are similar with findings of some earlier studies. The small ERPT found in this study is similar to what is suggested by Saha and Zhang (2016) who note that compared to two major economies namely China and India, Australia has smaller ERPT. The small pass-through seems to also be driven by the agriculture commodity – that is dairy – used in this study. Studies for example Saha and Zhang (2016) and Mallick and Marques (2008) show that ERPT and TRPT to the trade price in the agricultural sector such as dairy is less than those of mining and manufacturing industries. The study, however, finds a different result from Swift (2004) who finds a complete pass-through for dairy.

With regard to the interaction term between the exchange rate and FTA variables, out of multiple regressions conducted as part of this study, the estimate on cheese exports to Korea is the only one that shows a significant coefficient. Therefore, it can be concluded that over the study period there is minimal evidence of export prices' responsiveness to exchange rate change that is dependent on the FTA.

For policy makers and the Australian dairy industry, results from this study highlight two points. First, given the insufficient evidence of price discrimination between destination markets and insignificant effects of exchange rate, this study notes that the Australia dairy export price is mainly influenced by its own marginal costs. This 'internal' determinant means that the country's ability to manage its production supply and improve cost efficiency continue to serve as a main success factor, as well as challenges to continue to be a globally competitive exporter. Nevertheless, given challenges from seasonal conditions, the important role of imports in the agricultural input sector such as agricultural machinery, processed stockfeed and fertilisers, among others, means that such ability to manage the domestic production would most likely still be affected by global dynamics.

Second, to some degree, the results raise a question about the extent to which Australian exporters have perceived and utilised FTA beyond benefits from tariff reduction. New forms of FTAs are seen as a form of partnerships that cover aspects such as investment, movement of natural persons, e-commerce activities and economic and technical cooperation, among others. All these are common elements in Australia's recent FTAs. While analysis of the effects of these aspects on export prices is beyond the scope of this study, as each FTA implementation gets more intensified, there is a need to re-assess whether this FTA changes the exporters' pricing behaviour in the future. The lack of evidence to support the argument that tariff reduction and FTA participation decreases export prices does not necessarily mean that Australian exporters increase marginal costs following the entry into force of an FTA. It could be the case that although FTAs have potential to provide greater market opportunity for Australia, the nature of bilateral and regional

trade agreements requires exporters to comply with the Rules of Origin (ROO), and hence, to bear the associated compliance costs to benefit from preferential tariff concessions. This increased cost may offset the export price reduction effects of tariff cut or elimination. Testing this hypothesis, however, is beyond the scope of the present study.

One caveat from this study is that it uses data up to 2016 where Australia's FTAs with partner countries like China, Japan and Korea had only been in place for less than two years. This warrants future studies to revisit this topic especially after a sufficient implementation period of those FTAs as well as several new FTAs that entered into force between 2018 and 2020. The additional observations from longer datasets would also improve the statistical estimates of the PTM analysis.

Future studies should also look at the recently concluded RCEP negotiations. The RCEP is particularly important given that it involves some of the biggest economies in the world including China and Japan as well as the ten Member States of ASEAN. Together with Australia, RCEP participating countries represent almost half of the global population and about one-third of global output. A possibility of India, which was involved in the RCEP negotiations, to be a signatory country should also be considered. The Indian dairy market has been seen as a 'challenging export market and remains largely self-sufficient in dairy' given its high MFN tariffs and non-tariff barriers with only few exporters having successfully entered the market (Dairy Australia 2018). As of 2018, Dairy Australia had no specific programs to promote Australian dairy exports to India. Combined with a possibility of a future FTA signing, India's sizeable population and positive economic growth, however, suggest future market expansion might be worth considering. Noting the positive tariff coefficient, the additional analysis in Appendix S5 suggests that India's tariff reduction is associated with Australian dairy export price cut. The analysis also shows variations across dairy products in terms of ERPT coefficients and country effects. Results from this study can therefore serve as a benchmark to see how the competitive export pricing behaviours have changed over time following both changes in the Australian own industry structure which may have implications for its marginal costs, as well as other factors such as increased rates of FTA utilisation among exporters.

Data availability statement

The data that support the findings of this study are available from Euromonitor International's Passport database, UNCTAD TRAINS and Dairy Australia. Restrictions apply to the availability of these data, which were used under license for this study. Other supporting data are openly available in FAOSTAT http://www.fao.org/faostat/en/#data and the RBA https://www.rba.gov.au/statistics/historical-data.html

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1 Milk Production in Selected Producing Economies, 2010 and 2016.

Appendix S2 Areas under Australia's FTAs.

Appendix S3 FAO Commodity List and HS2007.

Appendix S4 Panel unit root tests.

Appendix S5 Panel regression results for Australian dairy export prices with market destinations including India, 1996-2016.