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Causal Factors of Australian Beef Exports

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Causal Factors of Australian Beef Exports

AN EMPIRICAL ENQUIRY QUARTERLY FROM 1995-2019

PATRICK WALTER HARRIS

Causal factors of Australian beef exports
Patrick Walter Harris

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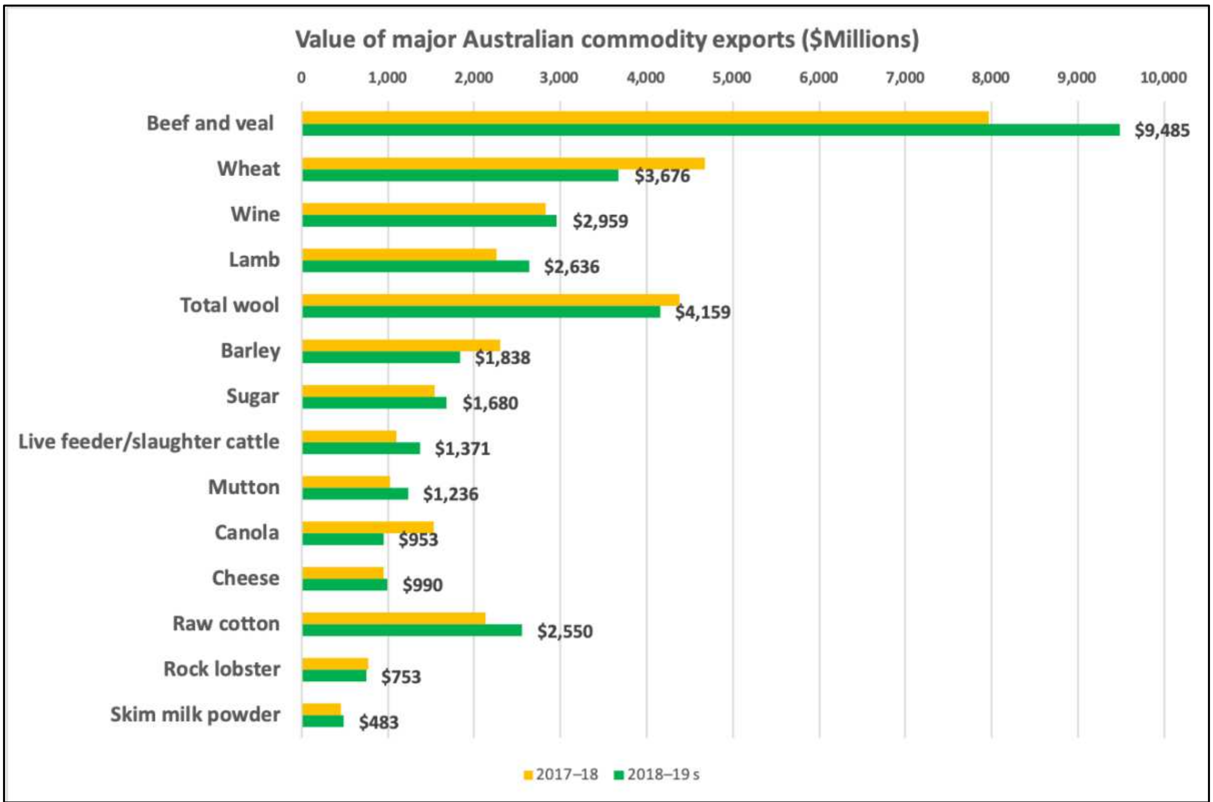
Word count: 3988

Research Question: To what extent is beef exports in Australia influenced by leading macro and microeconomic indicators (credit availability, beef production, exchange rates, employment, interest rate and drought) from 1995-2019 and is their influence on beef exports immediate or delayed.

Introduction and Literature Review:

The Australian beef industry is the most common agricultural activity in Australia with approximately 57% of farms carrying beef cattle (Department of Agriculture, 2018). Additionally, beef and veal are the country's largest commodity export accounting for circa 27% of major agricultural exports in 2018-19 with an export value of A$9.5B, illustrated in figure 1 (Department of Agriculture, 2018). Australia is the 3rd largest exporter of beef globally, exporting 1.6 million tonnes of beef and veal to 78 countries in 2017-18 (Meat and Livestock Australia, 2018). This equated to approximately 72% of total beef production in Australia being exported, illustrated in figure 2 (Meat and Livestock Australia, 2018). Recently, the macroeconomic environment has provided opportunities for Australian beef and cattle farmers. The Department of Agriculture (2018, pp1) states "The China-US trade dispute and fall in pork production due to African swine fever have increased Chinese import demand for some Australian products… demand for Australian meat is at unprecedented levels". Although these events have caused aberrations in demand short term, it does not provide a holistic interpretation of the underlying drivers of the beef export market in Australia.

Figure 1 Value of major Australian commodity exports (A$Millions) (Authors own illustration: Data sourced from: ABARES: Zammit, K., et al, 2018 Online)



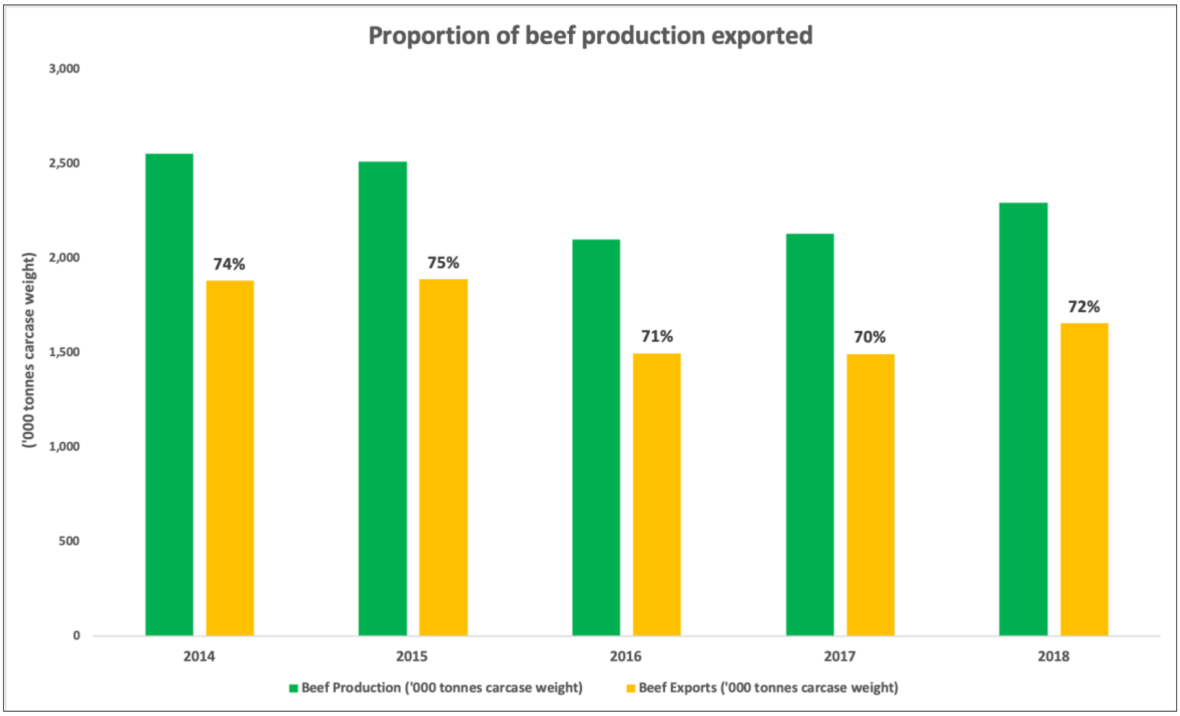
Factors influencing the agricultural export market in Australia are dependent on production and the proportion of which that production is shared between the domestic market and abroad, illustrated in figure 2 (Roberts, et al., 2009; Meat and Livestock Australia, 2018). Hence, the underlying factors of beef production become more relevant when determining export performance of beef in Australia. Yu, et al. (2011) explores the impacts of land, labour and capital have on beef production according to their farm size using panel data. They found the elasticities of land, labour and capital to be positive and statistically significant at the 10 and 1% levels (0.034, 0.155, 0.268) respectively. These results provide context to the underlying drivers of beef production that directly relates to the performance of beef exports in Australia. Additionally, previous literature identifies other key factors of export market performance in agriculture for developed and developing countries suggesting that export performance was not only positively influenced by production level but the inclusion of other variables such as exchange rates, labour productivity, and credit availability (Carlin, et al, 2001; Majeed, et al, 2006; Das, et al, 2009; Batten & Belongia, 1984). Das, et al (2009) demonstrates that district level bank loans contribute positively on agricultural production (0.53), which is statistically significant at the 1% level. However, Bravo-Ortega, et al (2004) found that credit to agriculture had a negative impact on agricultural production (-0.0011) across 84 countries using panel data.

Humphries & Knowles (1998) use the Solow-Swan model as an empirical framework to determine if agriculture has a positive affect on economic growth. The Solow-Swan model developed by Robert Solow and Trevor Swan in 1956 identify increases in human capital as one of the key contributors to long-term economic output growth as well as capturing technological progress known as productivity which is assumed to be exogenous (Humphries & Knowles, 1998). Humphries & Knowles (1998) findings of agricultural output to be positivelly influenced by increased labour and capital input which is consistent with the Solow-Swan model.

Carlin, et al. (2001) exhibits the Cournot competition model in agricultural exports. This is suitable as the cournot competition model details an industry where companies compete on quantity of output produced, where the industry sells a homogenous product at the same price (Carlin, et al., 2001). Agribusiness decisions on what to produce and how much to produce are influenced from global market prices for commodities. Hence, agribussinesses may choose to compete on quantity given the knowledge of their competitors decisions. This is an important assumption as it is assumed farmers are price takers. Although, this assumption is limiting as larger agribusinesses may be able to command higher prices for their product through branding. The impact of exchange rates on export volume showed consistent and statistically significant results of increased export volume as a result of a 1% decrease in exchange rate (Majeed & Ahmad, 2006; Batten & Belongia, 1984;Lv, et al., 2010). This is expected as domestic prices fall due to exchange rate depreciation, domestic products become more attractive to foreign buyers. Previous literature has not identified as to whether there is a delayed effect the independent variables have on the dependent.

This study aims to understand how the macroeconomic and microeconomic indicators (exchange rates, beef production, interest rate, bank loans and employment) influence the export market of beef in Australia as well as the inclusion of a bivariate (0,1) dummy variable, accounting for extreme climate aberrations such as the 'Millennium Drought' and the 2017-current drought (Australian Bureau of Meteorology, 2019). Additionally, this study will assess whether there is a delayed effect of the independent variables on Australian beef exports and draw upon neoclassical economic growth theory to assess if this economic paradigm holds in the real world.

Figure 2 Proportion of beef production exported (authors own illustration: Data sourced from Meat and Livestock Australia Data library)



Data collection:

The form of data collected for the empirical study is secondary and publicly available. This is advantageous for the purpose of this study as a large scope of data can be collected from a variety of professional and government bodies who have vast amounts of experience in their field. The sources of data used in this study is comprised of Meat and Livestock Australia (MLA), Reserve Bank of Australia (RBA), Australian Bureau of Statistics (ABS), and Federal Reserve Economic Data (FRED) with data in quarterly form from 1995 - 2nd quarter 2019. Data collected from MLA includes beef export value ('000) and beef production. Export value of beef is the dependent variable of this study and was originally in nominal value terms but has been adjusted to 2012 prices using the CPI index obtained from ABS. Observations for beef production is in carcase weight (cwt) which is an explanatory variable used to see if varying levels of production significantly explain any variation in export value. Data collected from Reserve bank of Australia includes bank loans to agriculture and interest rate. Bank loans to agriculture is collected from RBA which is an explanatory variable used to determine whether increased credit results increased beef exports, ceteris paribus.

It is assumed that bank loans to agriculture is to be used to purchase capital inputs such as land, water, machinery, livestock and feed. Bank loans will also be adjusted to 2012 prices using the CPI index. The construction of the dummy variable for drought took the dates of the millennium drought and the recent drought from the Australian Bureau of Meteorology (ABM). Data collected from ABS includes employment in agriculture and CPI index. Employment is a factor of production but is used in this study to determine whether increased employment results in greater export output or if advances in technology or farming practices have changed resulting in production efficiencies, indicating that increased employment may be subject to diminishing marginal rate of productivity. The CPI index is used purely to deflate any data in nominal value to adjust for inflation. Data collected from OECD includes unit cost of labour in Australia. Finally, data on exchange rates (AUD/USD) was collected from FRED. Changes in AUD/USD will be used to determine how demand fluctuates for Australian beef in the international market space. The data acquired is for Australia as a whole, thus, limiting the ability to assess the regional contribution to the beef export market. Additionally, this study has not tested specifically the impact of political events on beef exports such as the live cattle trade ban to Indonesia in 2011 (Willingham & Allard, 2011).

Table 1 Variables used in empirical study

Variable	**Definition**	**Type**	**Source**
Exp_Beef	Value of Export beef adjusted for 2012 prices	Time-series	MLA
Beef_prod	Beef production (cwt)	Time-series	MLA
Loans	Commercial bank lending to agriculture in Australia	Time-series	RBA
Employment	Employment in Australian Agriculture	Time-series	ABS
Er	Exchange Rate: AUD/USD	Rate	FRED
Int_rate	Reserve Bank of Australia interest rate	Rate	RBA
Drought Dummy	Indicator for periods of drought from (1996-2009), (2017-2019)	Bivariate (0,1)	ABM

Summary Statistics:

Number of Observations: 98

Table 2 descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
Exp_Beef	1361.263	368.0035	698.0848	2343.096
Beef_Prod	531293.6	55038.06	402449	690208
Loans	47083.74	14541.47	21216.3	66673.34
Emp	359.5149	42.28158	279.9734	439.6466
Er	0.7659337	0.1406566	0.489	1.0739
Int_rate	4.462959	1.785455	1.5	7.5
Drought dummy	0.5918367	0.4940206	0	1

Methodology:

Export performance in Australian agriculture is determined by the level of production, specifically the proportion of that production that is exported. Other factors, identified in the literature are exchange rates, interest rate, employment, and direct credit that contribute to export market performance of agricultural goods. Additionally, environmental factors such as drought, negatively affect production levels that will also hinder beef exports. Hence, this study aims to quantify the relationship between these internal and external factors, as well as determine whether there is a delayed effect on beef exports in Australia.

The Autoregressive Distributed Lag (ARDL) model will be used to determine if the independent variables will have an immediate effect on beef exports or if the effect is delayed. The ARDL model is suitable as the data used in this study as the data is in quarterly form.

Specification of regression model:

The method of analysis in this study is influenced by Enu & Attah-Obeng, (2013). Enu & Attah-Obeng, (2013) utilise the Cobb-Douglas production function through the application of the Ordinary Least Squares (OLS) method to determine the macroeconomic determinents of agricultural output. The Cobb-Douglas Production function mathematically estimates output (Q) as a function of aggregate input factors, Labour (L) and Capital (K) (Meeusen & Van Den Broeck, 1977). The equation for the production function can be simplified as:

$$Q_t = f\left(L_t^{\alpha} K_t^{\beta}\right)$$

Where 't' represents the use of time-series data and α and β represent the elasticities of output for labour and capital (Meeusen & Van Den Broeck, 1977). The function is homogenous where $\alpha + \beta = 1$ identifying constant returns to scale (Felipe & Adams, 2005). Alternatively, if the elasticities added together are greater than 1 this identifies increasing returns to scale and less than 1 identifies decreasing returns to scale (Felipe & Adams, 2005). For the purpose of this study, the Cobb-Douglas production function will be used as an empirical framework to determine the causal factors of Australian beef exports. The afore mentioned function can be formulated using the ARDL model, which is an OLS based estimator, used to determine if there is a delayed effect on beef exports. By applying the natural log to both sides of the equation and first differencing, helps secure stationarity, normality and homoscedasticity. The natural log is not applied to exchange rate, interest rate or the drought dummy variable as these variables are either rates or can take the value of 0. The first difference will not be applied to the dummy variable as it is bivariate. Applying the same transformation to this study provides the specification of the regression model:

$$lnd(Exp\_Beef_{t-q}) = \beta_0 + \beta_1 lnd(Beef\_Prod_{t-q}) + \beta_2 lnd(loans_{t-q}) + \beta_3 lnd(emp_{t-q}) + \beta_4 d(Er_{t-q}) + \beta_5 d(int\_rate_{t-q}) + \beta_6 (Dummy\ Variable_{t-q}) + \varepsilon_t$$

Where 'lnd' identifies that the variable has been logged as well as first differenced and 't-q' is to identify the number of lags used in the study.

Significance testing:

Following the estimation of the model parameters, a Ramsey Regression Equation Specification Error Test, commonly known as the RESET test will be applied to determine whether the functional form of the regression model is linear or otherwise misspecified (Carter Hill, et al., 2011). If it is found that the model is misspecified, the estimated coefficients may be biased, which will result in incorrect inference. Overcoming the model misspecification is to assess whether one or more of your variables are likely to take the shape of a quadratic or other polynomial shape and to adjust appropriately (Carter Hill, et al., 2011).

The Breusch-Pagan/Cook-Weisberg test for heteroscedasticity will be applied to determine whether heteroscedasticity is present within our regression results. Heteroscedasticity is the presence of non-constant variance of the standard errors over time. This is important, as the OLS method assumes that the residual errors are constant (Carter Hill, et al., 2011). Hence, if this assumption is infringed then the statistical results may not be trustworthy. If heteroscedasticity is present, a robust regression will be applied, this essentially is a trade-off between efficiency and robustness of the model. In practice this will adjust the standard error of the beta coefficients which will adjust the statistical significance of the coefficients.

Autocorrelation is where a time-series and a lagged version of itself show similarity between observations over time (Wooldridge, 2014). The problem of autocorrelation is that it violates one of the Gauss-Markov assumptions which is detrimental to the confidence of the results as the standard errors of the estimated coefficients are not reliable. To test whether autocorrelation is present within the study's data set, the Durbin-Watson (DW) test will be applied.

The DW test scores the degree of autocorrelation between 0 and 4 with 2 indicating no autocorrelation (Carter Hill, et al., 2011). A value between 1.5 and 2.5 indicates the acceptance region that autocorrelation is not a problem. A DW score less than 2 indicates positive autocorrelation and greater than 2 indicates negative correlation (Carter Hill, et al., 2011). This study is using time-series data the natural logarithm and first difference (or second difference if needed) will be applied to try remove any time trend that may cause autocorrelation.

Multicollinearity will be tested to determine if two or more of the independent variables are highly correlated, which may cause bias in the results. Multicollinearity refers to the presence of perfect correlation between two or more predictor variables in which case would violate the assumption of no multicollinearity in the OLS regression (Wooldridge, 2014). This will be displayed in a correlation matrix table. To determine if multicollinearity is present a correlation value of 1 for two or more regressors, otherwise it can be argued that there may be some correlation but if it is not perfectly correlated then the model results are still valid (Carter Hill, et al., 2011).

Stationarity is a factor to consider as this study is using time-series data as well as the nature of an ARDL regression it is likely that the data will be non-stationary. In order to test for stationarity, the Augmented Dicky-Fuller test will be applied (Wooldridge, 2014). The Augmented Dicky Fuller test rejects the null hypothesis that a unit-root is present within the time-series if the test statistic is greater than the critical values at 1, 5 and 10% (Wooldridge, 2014).

A t-test will be applied to the parameters of interest to determine their statistical significance within the model. To be confident of the coefficient of interest' statistical significance we apply the following hypothesis using the t-test formula and comparing its value to the critical value of t, read from the t distribution table at the 5% level.

The null hypothesis H_0: $\beta_k = 0$ against the alternative H_A: $\beta_k \neq 0$.

$$t = \frac{b_k - 0}{se(b_k)}$$

Interpreting the statistical significance of the results of the regression coefficients will be indicated by t-values that are less than -2 or greater than positive 2. If the t-value falls between the aforementioned range, this is an indication of low reliability of the coefficient as a predictor. Hence the use of a t-test will be applied to those coefficient estimates whose t value does not satisfy statistical significance criteria (Wooldridge, 2014). The t-test will determine whether or not the coefficient significantly differs from 0 as stated in the hypothesis above which will confirm that the independent coefficient is significantly explaining some variation in the dependent variable.

Next is to apply inference on the regression model to test the total explanatory influence. This also known as the 'Analysis of Variation' (ANOVA). The F-test statistic captures the total explanatory influence on the model as is calculated by:

$$F = \frac{(SSR_r - SSR_u/q)}{SSR_u/(n-k-1)}$$

The F-statistic essentially explains the variance of the restricted model (SSR_r) divided by the variance of the unrestricted model (SSR_u) where q is the difference in the degrees of freedom of the restricted and unrestricted model and (n-k-1) is the degrees of freedom of the unrestricted model (Wooldridge, 2014). The SSR_r will be all the β_{1-k} coefficients are equal to 0. Similarly, to the t-test, if the F-statistic generated is greater than that from the F-distribution table we may imply that the regression model is statistically significant (Wooldridge, 2014).

Expectations:

Table 3 Regression expectations

Variable	Expectation
lBeef_Prod	Positive (+)
lloans	Positive (+)
lemp	Negative (-)
Er	Negative (-)
Int_Rate	Negative (-)
Drought Dummy	Negative (-)

Results:

Estimation of the parameters:

*Table 4 ARDL OLS regression results ('***'= p-value <0.01)*

lExp_Beef	Coefficient	Standard error	t-value
Constant	0.0145	0.0112	1.28
dBeef_Prod	1.5364	0.1351	11.37
dloans	0.9219	0.3237	2.85
demp	0.3531	0.1727	2.04
dEr	-0.4973	0.1515	-3.28
dInt_rate	0.0758	0.0292	2.60
Drought Dummy	-0.0094	0.0178	-0.53

Significance testing:

Table 5 Model fitness

Model test	Significance	Decision (Reject or Accept)
RESET	Prob > F = 0.3022	**Accept** Null (functional form is not misspecified)
Heteroscedasticity	Prob > Chi2 = 0.6989 (Chi2 = 0.15)	**Accept** Null (Heteroscedasticity is not present)
Autocorrelation (Durbin-Watson Statistic)	2.042604	**Accept** Null (Autocorrelation is not present)

Table 6 Testing for Multicollinearity

Correlation matrix	Export Beef	Beef Production	loans	employment	Exchange rates	Interest Rate	Drought Dummy
Export Beef	1						
Beef Production	0.7988	1					
loans	0.6029	0.7086	1				
employment	-0.4855	-0.5869	-0.8396	1			
Exchange rate	-0.0985	0.2226	0.5634	-0.6711	1		
Interest Rate	-0.6346	-0.6104	-0.6352	0.5771	-0.1393	1	
Drought Dummy	0.0587	-0.0975	-0.2553	0.4433	-0.5986	0.2011	1

Table 7 Stationarity test: "D"= first difference "D2" second difference

Augmented Dickey-Fuller test for unit root (test for stationarity)

		Interpolated Dickey-Fuller		
Variable	**Test statistic**	**1% Critical**	**5% Critical**	**10% Critical**
D(export beef)	-5.185	-4.058	-3.458	-3.155
D(beef production)	-4.271	-4.058	-3.458	-3.155
D(loans)	-2.824	-4.058	-3.458	-3.155
D(employment)	-6.630	-4.058	-3.458	-3.155
D(exchange rate)	-4.025	-4.058	-3.458	-3.155
D(interest rate)	-4.804	-4.058	-3.458	-3.155
Drought Dummy	-2.330	-4.055	-3.457	-3.154
D2(loan)	-7.577	-4.060	-3.459	-3.155

*Table 8 Adjusted for stationarity ARDL OLS results ('***' =p-value <0.01, 'i' = immediate effect 'L' = lagged effect)*

lExp_Beef	**Coefficient**	**Standard error**	**t-value**
Constant	0.0197	0.0107	1.83
dBeef_Prod	1.5036*** (i)	0.1285	11.69
D2loans	1.2106*** (L2)	0.3729	3.25
demp	0.3698 (i)	0.1632	2.27
dEr	-0.4986*** (i)	0.1438	-3.47
dInt_rate	0.0800*** (L1)	0.0277	2.88
Drought Dummy	-0.0134	0.0133	-1.01

R^2: 0.9038, **Adjusted R^2:** 0.8801, **F (18, 73)** = 38.09

Discussion of the results:

The results obtained from the regression model are not spurious which is confirmed by the significance testing in table 5 and table 6. The RESET test confirms that the functional form can be accepted and is not misspecified nor is heteroscedasticity or multicollinearity present. After conducting the augmented Dicky-Fuller stationarity test it was found that loans were non-stationary, therefore the results were tested again but with loans differenced twice. This confirmed that there is no time trend after repeating the test by having a test statistic greater than the 1, 5 and 10% critical value, see table 7. The significance testing assures that there is no violation of the Gauss-Markov OLS assumptions and the results are BLUE. This improves the confidence that these results are not bias. Therefore, the model for Australian beef exports can be accepted and substantive significance can be drawn from the results.

The adjusted R^2 indicates the percentage of variation in the dependent variable that is explained by the independent variables that are substantively significant, that is to measure those variables that actually affect the dependent variable. The adjusted R^2 in this model is (0.8801), explaining circa 88% of the variation in beef exports. The remaining 12% is the unexplained variation in beef exports which is captured by the error term (ε_t). This indicates that the regressors in the model are explaining a large proportion of the variation in Australian beef exports. A t-test is applied to the drought dummy that was insignificant at the 5% level when compared to the critical value (1.9944). The models F-test (F (6, 73) = 32.77) verified each of the independent variables as a collection within the model effect beef exports. This was compared with the critical value F-distribution of 2.2312 which confirms that the model is statistically and substantively explaining the drivers of Australian beef exports at the 5% level.

The Australian beef industry exports circa 70% of its production, see figure 2 (Meat and Livestock Australia, 2018). Hence, as expected there is a positive and statistically significant relationship between beef exports and production noted in table 8. As beef production increases by 1% beef exports on average expect to increase by 1.437379%, ceteris paribus.

The Department of Agriculture (2018) aims to eliminate beef tariffs with China, which are Australia's largest beef importer, under the China-Australia Free Trade agreement by 1st of January 2024. Additionally, the Department of Agriculture spent circa AUD$50 million in research and development (R&D) to advance the cattle, goat, lamb and sheep sectors. This will foster a stronger beef industry with improved production. However, the increased sociatal pressures on the beef industry as a leading cause of climate change may distort the the governments intended influence of a stronger beef industry.

Das, et al. (2009) hypothesise that an increase in agricultural credit will increase input expenditures that are presumably associated with an increased production output. The impact of bank loans to agriculture in Australia was found to be positive and statistically significant at the 1% level (1.2106%). The results identified the effect bank loans to agriculture had on beef exports was delayed by 2 quarters. That is to say that a 1% increase in the previous 2 quarter change of loans will lead to an percentage increase in beef exports by 1.2106%. Although, due to the lack of government support to farmers in Australia (circa 2.4% of gross farm receipts) compared with that of the OECD average (circa 26% of gross farm receipts) and the perils associated with the industry such as drought increase the riskiness of the industry (OECD Statistics, 2019; Kingwell, 2006). Therefore, lending institutions demand a higher interest rate to compensate for the perils involved, affecting the farmers ability to access affordable debt (Gorton, 2016).

Surprisingly, the results for employment is found to be postive and statistically significant with an immediate impact. Indicating that as emloyment increases by 1% beef exports will increase by 0.3698%. This is opposite to the expectation that an increase in labour force would result in diminishing marginal rate of productivity. However, the results are consistent with neoclassical economic growth theory which is also consistent with the findings of Humphries & Knowles (1998) when applied to the beef sector in agriculture. Figure 3 illustrates a steady decline in people employed in agriculture in Australia from 1995-2019. Suggesting that employment in agriculture in Australia is becoming more productive with advances in technology and farming practises.

The affect exchange rates have on beef exports align consistent with previous literature showing negative and instant effect on beef exports. Indicating that a 1 unit increase in AUD/USD will negatively impact beef exports by -0.4986%. This impact is consistent with the findings of Batten & Belongia, 1984; Bravo-Ortega & Lederman, 2004; Lv, et al., 2010; Majeed & Ahmad, 2006. Indicating that an increase in domestic currency will reduce attractiveness for foreign buyers as more foreign currency is needed to buy Australian products. Figure 4 illustrates the inverse relationship between beef exports and exchange rates.

Figure 3 Percentage of people employed in Agriculture (Authors own illustration: source ABS)

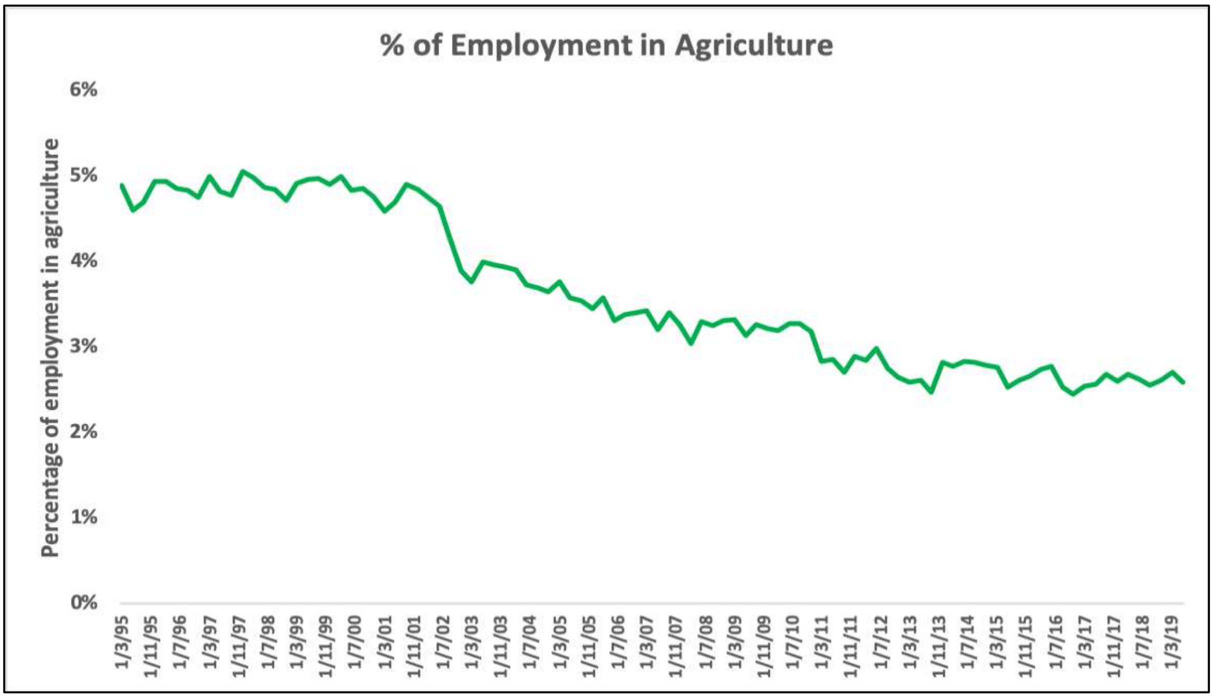
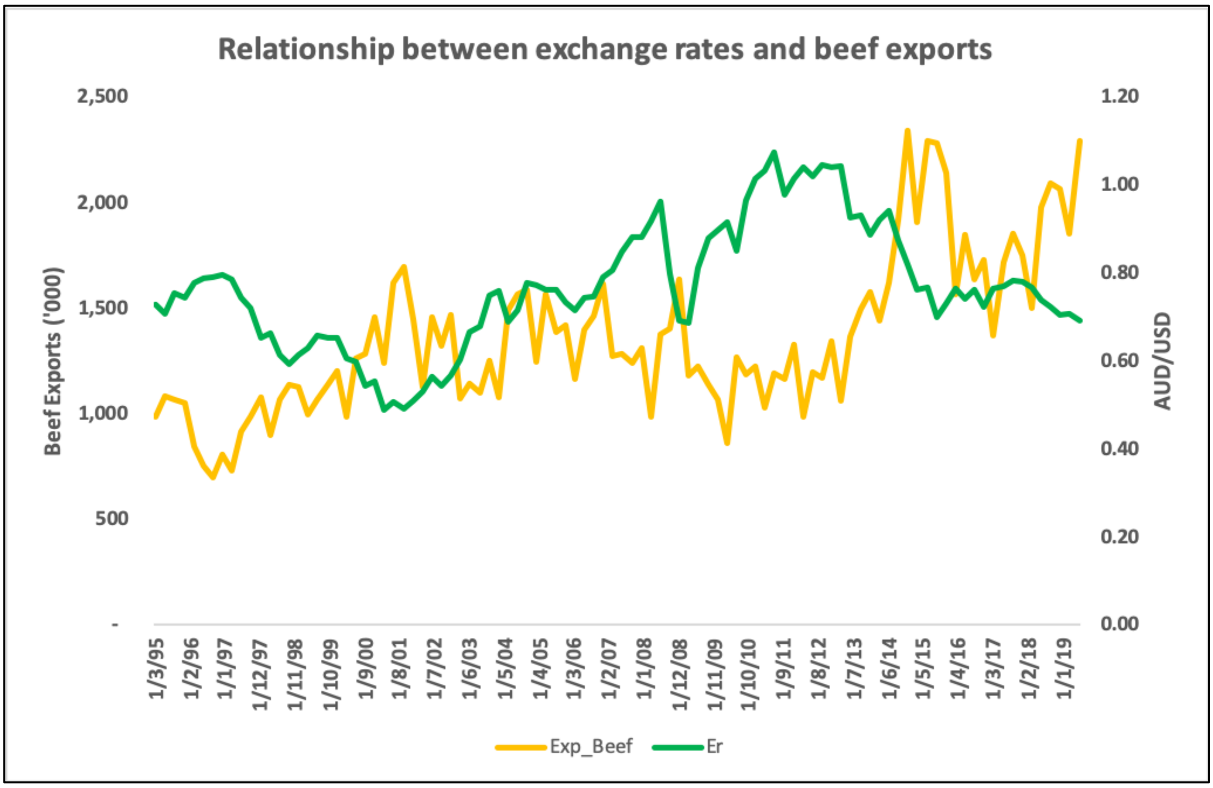


Figure 4 Relationship between beef exports and AUD/USD (Authors own illustration: source FRED and MLA)



The RBA Interest rate was found to be positive and statistically significant with its effect delayed by one quarter (0.0800%). It was expected that an increase in the interest rate would negatively impact farmers ability to service/take on debt. Conversely, an interest rate hike is generally associated increased foreign investment. This is because foreign investors may see the opportunity for higher rates of return (Gorton, 2016). This is consistent with the findings of Lv, et al. (2010) where growth in agricultural exports indicated positive impact on Chinese FDI inflow to agriculture.

Finally, the drought dummy in this study was found to be statistically insignificant. However, the coefficient was found to be negative (-0.0134) which is consistent with the expectations of the study, that drought might negatively affects beef exports. Perhaps the growth in drought/confinement feeding has helped mitigate the effects of drought and promote animal welfare in times of climate distress (Meat and Livestock Australia, 2018). The average annual growth rate in drought/confinement feeding is 3.4% from 2000 to 2019 (MLA, 2019). Although this exposes farmers to the risks of grain availability to feed, which may also become scarce during climate distress.

Conclusion

This study identified and evaluated the casual factors of Australian beef exports and whether there is a delayed effect from any of the independent variables on beef exports. The results have various implications depending on the perspective of the stakeholder, whether that be the farmer or the government. From the perspective of the farmer (exporter), having greater access to affordable funds will assist in the production process of cattle whether that be purchasing pastureland or various grain and veterinary inputs, which may lead to an increased per cow performance, leading to a greater contribution to beef exports, ceteris paribus. Additionally, farmers should monitor changes in exchange rates and the RBA interest rate, which may adjust the decision-making process of what proportion of their produce is to be exported. From the perspective of the government, it is recommended to implement schemes fostering beef production such as increased R&D expenditure into cattle development and loosening supply constraints and tariffs with international markets e.g. Japan, who are Australia's second largest beef importer (Meat and Livestock Australia, 2018). Additionally, increasing access to affordable loan schemes especially for small-medium sized farmers that may not have the same ability to adjust farming practices to those larger in size, in response to changes in the market conditions (Yu, et al., 2011). This may support a stronger performing beef industry. Governments should encourage the transfer employment in agriculture from urban to rural via the reduction in personal taxes. This will contribute to increased output as found by this study's results as well as being consistent with neoclassical economic growth theory. For future studies the evaluation of the international beef demand from other major beef exporters identified by Meat and Livestock Australia (2019) to be Argentina, USA, Brazil, Uruguay and New Zealand will provide a more holistic analysis of the global beef market and how Australia can continue to stay competitive in the long-term.

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