Using a factor model to summarise developments in global commodity prices

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NON-TECHNICAL SUMMARY

A key area of focus for the central bank of a small commodity exporting country is to understand the movements in commodity prices. These movements of commodity prices flow through to real economic activity and so influence the Reserve Bank's inflation outlook and monetary policy stance. Hence it is useful to understand when movements are part of a broader global trend, and when they are due to idiosyncratic events in individual markets.

This analytical note uses principal component analysis to pull out an estimate of the underlying global trend in commodity prices and then determine whether past movements in New Zealand export commodities are part of a global trend or due to idiosyncratic events in each market. The note finds that 59 percent of volatility of New Zealand's dairy export prices can be attributed to the global trend, and 35 percent of volatility of New Zealand's meat export prices can be attributed to the global trend. In addition, it finds that New Zealand's export prices for dairy and meat products revert to the level implied by the global trend in commodity prices over the short to medium term. This means if dairy or meat product prices are above (or below) the level implied by the global trend, then they will tend to fall (rise) until they reach level implied by the global trend.

1 Introduction

This analytical note uses principal component analysis to extract an estimate of the underlying global trend in commodity prices. This estimate is also referred to as the global factor as per West and Wong (2014). Comparing historical movements of key New Zealand export commodities, dairy and meat, to this trend enables an assessment of whether price movements are due to idiosyncratic developments in each market, or due to a common global trend.

It is important for the Reserve Bank to distinguish these movements apart as they have different implications for tradables inflation and the Reserve Bank's monetary policy stance. If movements in New Zealand export prices are following a global trend, this may have broader implications for imported inflation. This is because global co-movements in commodity prices could be indicative of global demand and supply factors, as found by Gilbert (2010), Pindyck and Rotember (1990) and Svensson (2008). Meanwhile, movements in New Zealand export prices due to idiosyncratic factors in specific commodity markets may have fewer implications for imported inflation but may have implications for New Zealand's terms of trade and overall economic incomes.

This note does not attempt to explain the potential drivers of common trend in commodity prices. Instead it follows West and Wong (2014) who found evidence of an error-correcting relationship between individual commodities and the global trend in commodity prices. West and Wong (2014) use this relationship to forecast commodity prices and find these forecasts performed well at the 12-month horizon compared to forecasts generated from a random walk,[1] an industrial production model and an exchange rate model. Using root mean squared prediction error (RMSPE) as a measure of performance, they found that the global factor model forecasts of energy performed well, forecasts of metals did not perform well, and the agricultural forecasts performance fell somewhere in between. West and Wong (2014) concluded that overall commodity prices reverted to a global factor over the medium term.

[1] A random walk forecast is essentially a flat line (no change) forecast. It is often the best performing forecast for series that are very difficult to predict such as commodity prices.

This paper takes West and Wong's (2014) findings and uses them to describe the relationship between New Zealand's goods exports and our estimate of the global trend in commodity prices. The cointegrating relationship between the global trend and commodity prices allows us to understand whether price movements in individual commodity markets are predominantly due to either a particular demand or supply event occurring in that market, or the influence of the global trend.

The rest of this note is as follows. Section 2 introduces the principal component analysis which is used to create a global factor of commodity prices. Section 3 uses this finding to analyse historical movements in dairy and meat prices in relation to the global factor and section 4 comments on the outlook for dairy and meat prices based on this analysis. Section 5 concludes. Appendix B applies the West and Wong's (2014) forecasting approach to dairy and meat, skin and wool prices.

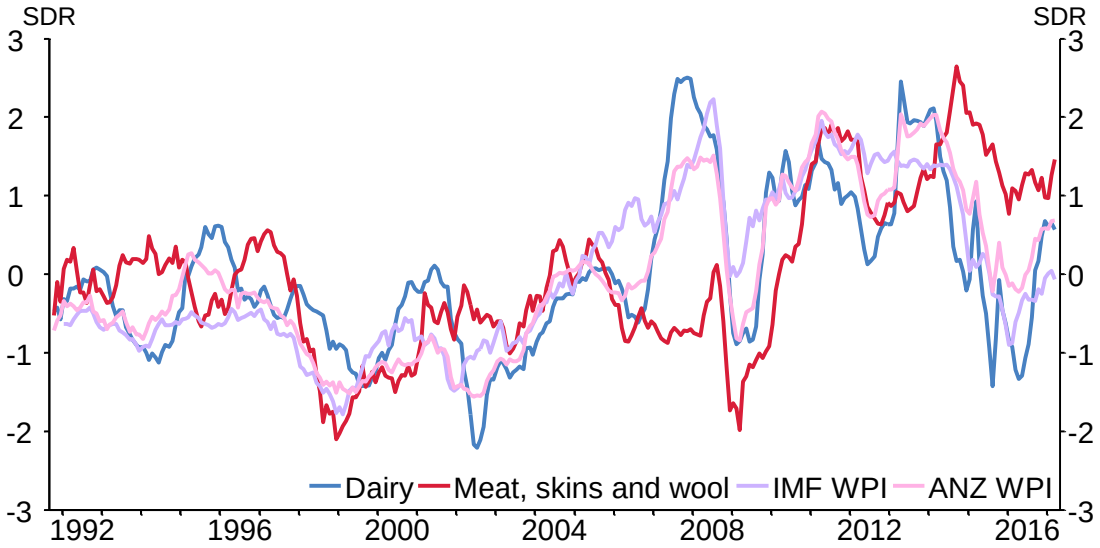
2 Using principal component analysis to understand commodity prices

Principal component analysis is applied to a panel of global commodity prices including 53 energy, metal and agricultural prices from the World Bank and ANZ commodity price datasets.[2] Within the panel of commodity prices, only one price for each commodity has been used. ANZ prices are chosen for New Zealand exports (dairy, meat skin and wool, horticulture, forestry, and seafood) as these are the prices used in our forecasting process. The data set prices are then converted into real special drawing rights (SDR) terms.[3] The SDR is defined as a basket of currencies and is used to separate out the effects of movements in a particularly currency (World Bank commodity prices are given in USD). The prices are then deflated using an estimate of the world consumer price index[4] and logged and standardised for comparability. The data set is constructed from January 1992 to March 2017.

While unique, dairy and meat price movements are not completely out of line with global commodity price movements. Figure 1 compares the ANZ world price index (weighted to New Zealand's export commodities) and the IMF world price index to dairy and meat prices.

[2] Sourced from World Bank through Haver Analytics and https://www.anz.co.nz/about-us/economic-markets-research/commodity-price-index/
[3] Sourced from IMF through Haver Analytics
[4] RBNZ estimate

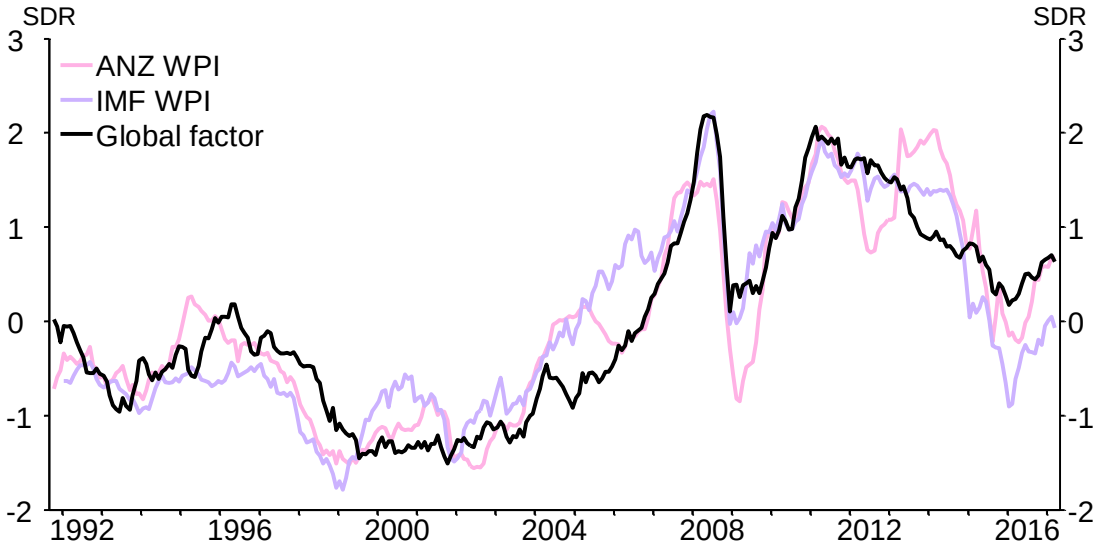
Figure 1: Commodity prices and world price indices



Source: Haver Analytics, ANZ

Figure 2 shows the first principal component estimated from the panel of global commodity prices (see Appendix for individual loadings to the factor). This component explains 43 percent of the variation in the panel and appears to have a close relationship with the world price indices. Meanwhile, the second principal component explains only 15 percent of the variation in the data. Hence, to simplify interpretation, the first principal component is used for the global factor.

Figure 2: World commodity prices and the principal component



Source: Haver Analytics, RBNZ estimates

3 Understanding dairy and meat price movements

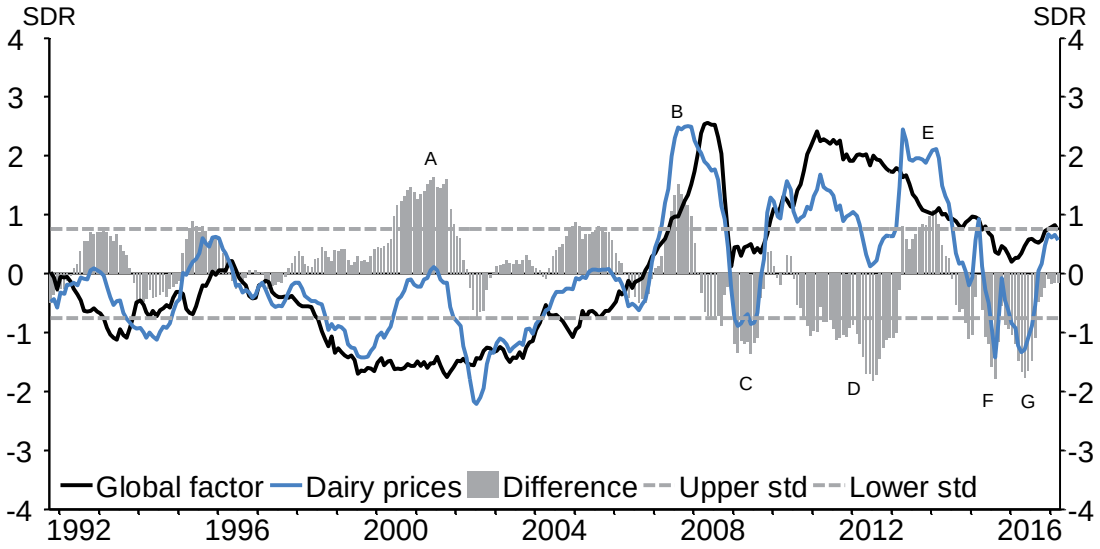
If we assume the global factor above is a good characterisation of the underlying common dynamic in world commodity prices, we can use it to determine whether movements in dairy and meat prices are due to common global developments or idiosyncratic events in each market. We focus on dairy and meat prices as they contribute 37 percent (23 and 14 percent

respectively) to total New Zealand goods exports. Regressing the fitted global factor[5] onto dairy and meat prices individually suggests that the common global developments can explain 59 percent and 35 percent of the volatility in dairy and meat prices since the start of our data set.

Dairy prices

Figure 3 charts dairy prices compared to the global factor. It appears that the general trend in dairy prices follows movements in the global factor but there are also periods where the influence of idiosyncratic events in the global dairy market outweighs the global factor. On figure 3 these are shown as the periods when dairy prices differ significantly from the global factor (by more than one standard deviation).

Figure 3: Comparing the global factor (fitted) to dairy prices



Source: RBNZ estimates

Below, we relate the episodes of divergence and convergence between dairy prices and the global factor through history to idiosyncratic developments in the dairy sector.

A. Early 2000s: higher dairy prices.
    - The portion of the market trading at truly free global market forces was small due to supportive farm policies for EU and US milk producers and low production and exports from emerging economies. This means dairy prices were more easily influenced by developments in producer countries.
B. 2003: no significant difference.
    - US relaxed dairy farm support.
    - Reduced production from Australia and the EU.[6]
C. 2007: higher dairy prices.
    - Adverse weather conditions in Australia, Argentina and Uruguay.

[5] The fitted global factor $F1_{i,t}$ is constructed following $F1_{i,t} = \partial_{1,i} * PC1_t$ where $\partial_{1,i}$ represents the loading of commodity *i* on the first principal component $PC1_t$.

[6] See Ford and Williams (2016)

- Increased dairy demand from emerging economies was met by stronger increase in domestic dairy production in China and India. China became a net exporter of dairy during 2007.[7]

D. 2008 – 2009: lower dairy prices
   - Relaxation of farm support and (restrictive) dairy production quotas in EU. These relaxations changed production incentives and resulted in an increasing number of more efficient farms.
   - Global financial crisis (reduced demand for consumption goods).
   - Increased China production.[8] [9]

E. 2011 – 2012: lower dairy prices
   - Increased production in New Zealand, US, EU and Australia and South American countries (responding to previously higher dairy prices).

F. 2013: higher dairy prices
   - Increase in demand from China due to increased wealth and changing consumption preferences.
   - Drought in New Zealand, adverse weather in Asia and an outbreak of foot and mouth disease in China.[10]

G. 2014 – 2015: lower dairy prices
   - Further removal of industry support in the EU.
   - Weak import demand from China and Russia.[11]

Meat prices

The historical composition of the meat price index is difficult to reconcile with divergences between the global factor and prices. This is partly because the ANZ index is made up of varying cuts and quality lamb and beef meats as well as skins and wool prices. However, similar to dairy prices, meat prices generally follow broader commodity trends as shown in figure 4.

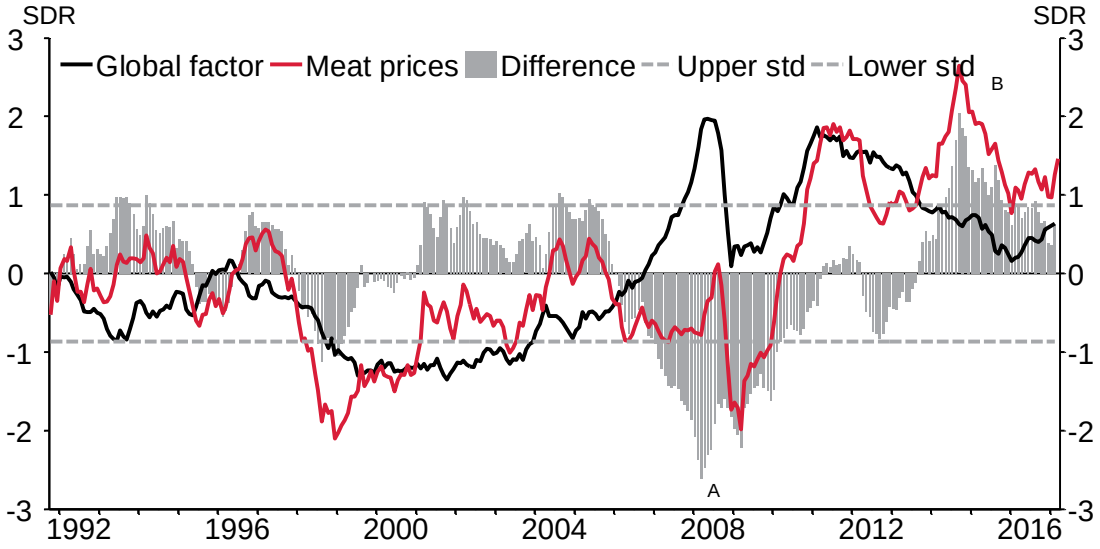
There is a particularly large deviation between the global factor and meat prices during the period of the global financial crisis (labelled A). Briggs et al. (2011) noted there were several factors influencing the differing types of meat supply and demand during this period. In particular, due to the crisis the demand for lower grade beef increased as higher grade beef became a luxury product, meanwhile higher grade beef stock declined due to rising feed costs. By late 2008, the overall reduction in beef demand resulted in lower beef prices. There was also a fall in manufacturing causing the price of skins to drop through this period.

A second noteworthy deviation on the chart (labelled B) is the run up in meat prices in 2013 above the global factor, and again in early 2017. These events look to be driven by idiosyncratic events in this sector, particularly the impact of droughts in supply countries for example US droughts in 2012 and 2014 and the Australian drought from 2012 to 2014.

[7] See Briggs et al. (2011)
[8] See Ford and Williams (2016)
[9] See Briggs et al. (2011)
[10] Wheeler (2014). Ford and Williams (2016).
[11] Wood (2015), Ford and Williams (2016).

While market analysts suggest the current strength in meat prices may be due to increased demand for lamb and beef from China.[12]

Figure 4: Comparing the global factor (fitted) to meat prices



Source: RBNZ estimates

4 Recent developments in the context of the global factor

The factor model suggests there was a broad upward trend in global commodity prices through 2016 and this recovery was not isolated in one market. In addition, by comparison the March 2017 fall in prices (as shown in figure 1) is small and relatively insignificant.

From a purely statistical point of view, this model would suggest dairy prices to remain at current levels in the short to medium term unless significant events in the dairy industry occur for example developments in farm support policies in the EU and US. The current strength in meat prices is greater than the level given by the global factor. The model suggests that meat, skin and wool prices will fall back to the level given by the global factor.

5 Conclusion

This paper introduced West and Wong's (2014) principal component analysis as a method of creating a global factor to describe the global trend within a panel of global commodity prices. The error-correcting relationship between commodity prices and the global factor found by West and Wong (2014) is shown to be relevant for New Zealand's largest goods export markets dairy and meat, skin and wool. Using this model we can infer when past commodity price movements were driven by the global trend or by idiosyncratic events. This decomposition can help the Reserve Bank form a view on imported inflation and New Zealand's terms of trade, making it a useful tool in forming the Reserve Bank's inflation outlook and monetary policy. Further, the error-correcting relationship between commodity prices and the global factor given by the West and Wong (2014) result can contribute to our view on future commodity price movements.

[12] Bloomberg (2017), Philippine bananas, Indian cotton and NZ lamb have something in common. *BloombergMarkets.* 3 April 2017

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APPENDIX

A Loadings on first and second components

Loadings are given for the first and second principal component estimated from January 1992 to March 2017. These loadings are applied to the global factor in order to create the fitted global factor for each commodity.

Table 1: Principal component loadings

Rank	Commodity	Loading (PC1)	Loading (PC2)
1	Tin	1.4224	-0.3401
2	Gold	1.3784	-0.3242
3	Silver	1.3772	-0.5445
4	DAP	1.3742	-0.266
5	Lead	1.373	-0.689
6	Copper	1.3641	-0.3737
7	Coal	1.3618	-0.0469
8	Iron Ore	1.3325	-0.6689
9	TSP	1.3242	-0.3362
10	A1 Special Rice	1.3205	0.5412
11	Rubber	1.3028	0.1594
12	Urea	1.2984	-0.3006
13	Soybean oil	1.257	0.8065
14	Phosphate Rock	1.2427	-0.3788
15	Fishmeal	1.2134	-1.0032
16	Maize	1.2008	1.0123
17	Potassium Chloride	1.1831	-0.5515
18	Sorghum	1.1697	0.8539
19	Dairy	1.1679	-0.0975
20	Oil	1.1575	-1.3192
21	Soybean meal	1.1458	0.3489
22	Platinum	1.1443	-1.4433
23	Barley	1.0994	-0.0434
24	5 Percent Broken White Rice	1.0693	1.0237
25	Soft Red Winter Wheat	1.0615	1.0601
26	Palm oil	1.0479	1.1774
27	Copra	1.0466	0.7954
28	Groundnut oil	1.0321	0.3972
29	Coconut oil	1.0197	0.807
30	Hard Red Winter Wheat	0.9999	0.9373
31	Horticultural	0.9701	0.2013
32	Cocoa	0.9135	-0.1781
33	Meat/Skins/Wool	0.9009	0.1375
34	Nickel	0.86	-0.9022
35	Sugar	0.8554	1.1272
36	Bananas	0.821	-0.3505
37	Zinc	0.774	-0.1597
38	Groundnuts	0.6766	1.2906
39	Coffee	0.5887	1.8504

40	Oranges	0.5177	-1.1281
41	Tea	0.47	0.7557
42	Seafood	0.353	-1.1279
43	Woodpulp:	0.218	0.9374
44	A Index Cotton	0.2022	2.1076
45	Logs	0.1631	2.0503
46	Chicken	0.1196	-0.7525
47	Aluminum	0.048	0.3916
48	Unmanufactured Tobacco	0.037	1.0744
49	Sawnwood	0.0353	2.0471
50	Forestry	-0.1452	1.9256
51	Gas	-0.1731	-1.4059
52	Plywood	-0.4377	1.7485
53	Shrimp	-0.9992	1.5076

B Applying West and Wong's forecast approach to dairy, meat and forestry prices

This section tests whether West and Wong's (2014) error-correcting relationship between the global trend in commodity prices and individual commodity prices applies to New Zealand exports of dairy, meat and forestry products. It does this by fitting our estimated first principal component (section 1) to dairy, meat, skin and wool, and forestry prices and compares the resulting RMSEs to those from a random walk forecast. The forecast is conducted using data from 1992 for the meat and forestry and from 2003 for the dairy forecasts. The data for the dairy forecast is restricted to 2003 as this was when global dairy markets began to emerge (section 3*).* The results suggest that the fitted global factor model forecasts dairy, meat and forestry prices no worse than a random walk in the short to medium term. Thus, the West and Wong (2014) approach can be generalised to New Zealand's export commodities.

Model

The fitted global factor model is constructed by first fitting the first principal component to each commodity price following equation 1.

Equation 1: $$F1_{i,t} = \partial_{1,i} * PC1_t$$

Where ∂_1 represents the loading of the first principal component ($PC1_t$) and *i* represents the individual commodity.

The fitted global factor $F1_{i,t}$ is then used to estimate an expanding window forecast of the change in the commodity price (p_i) from *t* to *t+h* following equation 2.

Equation 2: $$p_{i,t+h} - p_{i,t} = \alpha + \beta(F1i_{,t} - p_{i,t})$$

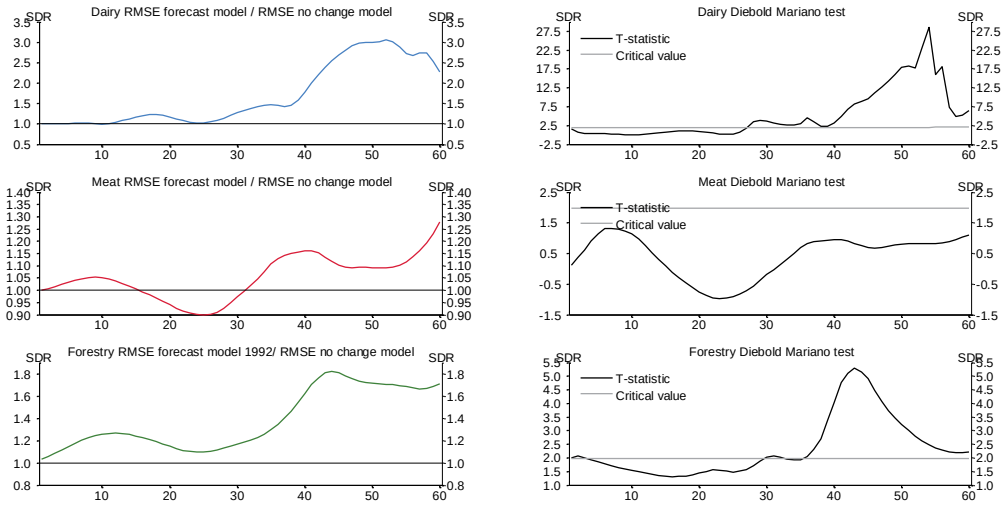
The expanding-window forecast is first estimated with the forecast horizon (*h)* set at one month and continues until *h* = 60 (five years). For each horizon the RMSE of the forecast model is compared to the RMSE of a random walk forecast model. The ratios of the RSME's for each commodity are plotted in the first column of figure 5. If the ratio is less than one then the forecast model outperforms the random walk model (but not necessarily statistically significant).

Results

At first glance, it appears that the global factor does not perform as well as the random walk forecast; the ratio does not fall below one, except for the medium term meat forecasts. To test the null hypothesis of equal RMSE against the alternative that the two RMSE are significantly different the Diebold Mariano test is used. The second column of figure 5 plots the Diebold-Mariano test statistic relative to the critical value and shows that for each commodity the difference between the ratios is not statistically significant until after two years.

As per West and Wong (2014), this paper finds that the global factor model performs adequately for agricultural prices. The dairy forecast has the lowest RMSE ratio in the short term at just over 1, while the meat RMSE ratio is the lowest in the medium term dropping below 1 from 18 -31 months. Neither is statistically significantly different from the no-change forecast of a random walk model.

Figure 5: Forecast performance of the global factor (fitted) compared to the 'no change' model



Note: the x-axis refers to months ahead.

Figures 6 and 7 show these findings are robust. Re-estimating the forecasts using both the first and second principal components in the global factor, expanding the time horizon for dairy, and using USD for dairy prices do not significantly change the results.

Figure 6: Forecast performance of the two-component global factor (fitted) compared to the 'no change' model

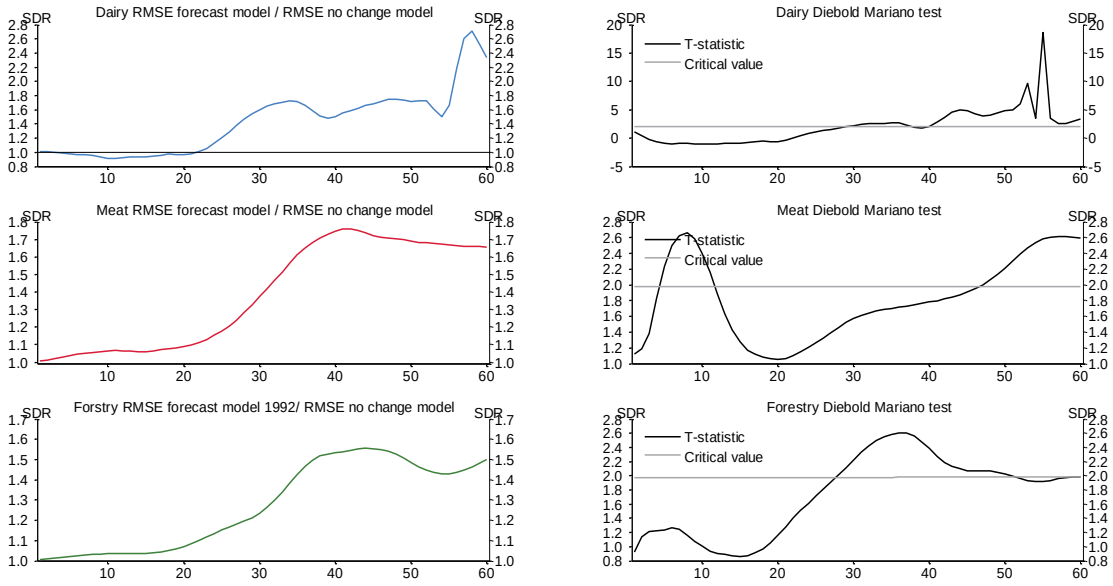


Figure 7: Dairy forecasts using 1992 data and data in USD