Methodology paper – Milk Price Index
Department of Agriculture and Water Resources
June 2018
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1 Introduction

The Department of Agriculture and Water Resources has engaged Deloitte Access Economics to produce regular updates on an Australian Commodity Milk Price Index (CMPI), and the Regional, Retrospective Farmgate Milk Price Index.

The CMPI and Regional, Retrospective Farmgate Milk Price Index are data series being produced as part of this engagement. The CMPI is based on the prices received for Australia’s dairy commodity exports. The Regional, Retrospective Farmgate Milk Price Index is based on data collected directly from Australian dairy farmers by the Department of Agriculture and Water Resources on the prices they receive for their milk.

Information on how the CMPI and the Regional, Retrospective Farmgate Milk Price Index change from month to month is published in the Dairy Bulletin, which is available on the Milk Price Index site (www.agriculture.gov.au/milkpriceindex). The Dairy Bulletin also includes a 12-month forecast of the CMPI, with the forecast updated every three months.

This methodology paper provides information on the CMPI (and how it is forecast) and the Regional, Retrospective Farmgate Milk Price Index:

- Chapter 2 has information on the CMPI, including the data it is based on and how it is calculated.
- Chapter 3 has information on how the CMPI is forecast.
- Chapter 4 provides information on the Regional, Retrospective Farmgate Milk Price Index and data sources used to provide commentary on factors impacting milk production and farmgate prices in the Dairy Bulletin.
2 The CMPI

The CMPI is an index of prices received for Australia’s dairy commodity exports. The index is calculated using monthly data on the price and volume of Australia's dairy commodity exports released by the Australian Bureau of Statistics (ABS).

The trade data used to calculate the CMPI is reported by the ABS at the 8-digit level of the Australian Harmonized Export Commodity Classification (AHECC). Data at the 8-digit level is aggregated to form the four major dairy commodity exports: Skim Milk Powder (SMP), Whole Milk Powder (WMP), butter and cheese.

The types of products (at the 8-digit AHECC level) that make up each of the four major dairy export commodity is shown in Figure 2.1, which also shows how the 8-digit level commodity groupings fit within the AHECC hierarchy. All of the dairy commodities included in the CMPI are included within the category '04 – Dairy products; birds' eggs; natural honey; edible products of animal origin, not elsewhere specified or included'. Many products within this 2-digit level category are not included in the CMPI.

The CMPI does not include every product that Australia exports which has milk as an ingredient. The four major dairy commodity categories making up the CMPI align with the classifications used by the Australian Bureau of Agricultural and Resource Economics (ABARES), and represent around three quarters of Australia’s total dairy commodity exports.

The CMPI is a chained Fisher price index, calculated using the price and volume of Australia’s exports of SMP, WMP, butter and cheese each month. The price index is similar to a simple weighted average price, but the index approach avoids problems with simple weighted average prices. The Global Dairy Trade (GDT) price index is also a chained Fisher price index, but is based on the commodities, prices and volumes in the dairy commodity auctions that GDT manages.

Chart 2.1 below shows the history of the CMPI from July 2008 to April 2018. Over this period, there were significant fluctuations, but the index is now around the level it was in July 2008.

![Chart 2.1 CMPI – July 2008 to April 2018](source: Deloitte Access Economics calculations based on ABS data.)
Figure 2.1 The commodities included in the CMPI

04 – Dairy produce; birds’ eggs; natural honey; edible products of animal origin, not elsewhere specified or included

0402 – Milk and cream, concentrated or containing added sugar or other sweetening matter

040210 – In powder, granules or other solid forms, of a fat content not exceeding 1.5%
040221 – In powder, granules or other solid forms, of a fat content exceeding 1.5%
040229 – Containing added sugar or other sweetening matter, in powder, granules or other solid forms, of a fat content exceeding 1.5%

0405 – Butter and other fats and oils preserved from milk; dairy spreads

040510 – Butter
040520 – Dairy spreads
040590 – Fats and oils derived from milk (other than dairy spreads)

0406 – Cheese and curd

040610 – Fresh cheese (including whey cheese), not fermented, and curd
040620 – Cheese of all kinds, grated or powdered
040630 – Cheese, processed (not grated or powdered)
040640 – Cheese, blue-veined and other cheese containing veins produced by Penicillium roqueforti (not grated, powdered or processed)
040690 – Cheese, (not grated, powdered or processed), not elsewhere specified in 0406

04061000 – Fresh (unripened or uncured) cheese, including whey cheese, and curd
04062000 – Grated or powdered cheese, of all kinds
04063014 – Processed, canned cheese (excluding grated or powdered cheese)
04063014 – Processed, canned cheese (excluding grated or powdered cheese)
04063021 – Cheddar cheese, processed (excluding canned and grated or powdered cheese)
04063029 – Cheese, processed (excluding canned, cheddar and grated or powdered cheese) canned
04063029 – Blue-veined cheese and other cheese containing veins produced by Penicillium roqueforti
04063090 – Cheese (excluding fresh (unripened or uncured) cheese, grated or powdered cheese, processed cheese, cheddar cheese and blue-veined cheese and other cheese containing veins produced by Penicillium roqueforti)

04069010 – Cheddar cheese (excluding grated or powdered cheese and processed cheese)
04069090 – Cheese (excluding fresh (unripened or uncured) cheese, grated or powdered cheese, processed cheese, cheddar cheese and blue-veined cheese and other cheese containing veins produced by Penicillium roqueforti)
3  Forecasting the CMPI

Every quarter, a 12-month forecast of the CMPI will be produced. For example, the June 2018 edition of the Dairy Bulletin will include a forecast of the CMPI for every month out to June 2019. The forecasts will be updated every quarter.

The forecast is made using a regression model based on the historical relationship between the CMPI and rural export prices, and how the CMPI has behaved in the past. Deloitte Access Economics forecasts of agricultural commodity export prices and the recent history of the CMPI are used to forecast what value the CMPI will take in future months. In relation to the recent history of the CMPI, the forecast model is based on year to growth rates with autoregressive moving average errors. This type of approach has a long history in time series forecasting, and is used to forecast oil and other commodity prices.

To ensure the most up-to-date information is used to forecast the CMPI, its value for the previous, current and next month are ‘now-cast’. This is done because the ABS trade data used to calculate the index is produced with a two-month lag (for example, April data is only released in June).

The previous, current and next month values of the CMPI are estimated using a regression model based on the relationship between the CMPI and the GDT price index. The GDT price index is updated by GDT after each trading event (of which there are generally two each month) so provides an up-to-date indicator of dairy commodity price movements (of course, the GDT price index is not a perfect predictor of the prices received for Australia’s dairy commodity exports). This regression model is a vector autoregression model. Beyond one month into the future, the forecast model based on the CMPI’s recent history and forecast rural export prices takes over.

Chart 3.1 shows the history of the CMPI from July 2008 to April 2018, the preliminary estimates (‘now-casts’) for May to July 2018, and the forecast out to June 2019. The forecast model suggests that export commodity prices will fluctuate but trend slightly downwards over the next 12 months.

Chart 3.1 CMPI history, preliminary estimates and 12-month forecast as at June 2018

Index July 2008 = 100

Source: Deloitte Access Economics calculations based on ABS and GDT data.

1 This is a forecast of all agricultural export prices, taken together, not a forecast of every individual agricultural commodity’s export price.
How the CMPI forecast model was chosen
Commodity prices are notoriously hard to predict. The best forecast is often a random walk (or the current spot price). If a time series is best modelled as a random walk, it can be thought of as the sum of two quantities – the previous observation plus some random error. Because the random error is unforecastable (by definition), the forecast is just the current price. Random walks characterise a large number of economic and financial time series, and can produce surprisingly good forecasts.

To evaluate different possible forecasting models’ performance, a forecast simulation exercise known as cross validation was undertaken. This had several steps:

1. Separate the data into training (80%) and testing (20%) sub-samples.
2. Estimate the model using the 80% training sample.
3. Use the model to calculate forecasts, and compare the root mean squared error (RMSE) and mean absolute percentage error (MAPE) over the remaining sub-sample.\(^2\)
4. Add one new time period to the training sample.
5. Repeat steps 2-4 until all data is exhausted.

Steps 1-5 were repeated for each forecast model that was considered.

While the forecast model that has been selected outperformed other candidate models, its performance will be reviewed in the coming months to ensure it continues to be the preferred model.

If the CMPI forecast model had been used at the start of financial year 2016-17, it would have forecast an average annual value of the index that deviated 4% from what ultimately occurred.

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\(^2\) The RMSE and MAPE are both calculated based on the difference between model forecasts and actual data.
4 The Regional, Retrospective Farmgate Milk Price Index

The Regional, Retrospective Farmgate Milk Price Index for each region and month will comprise three values (jointly referred to as the Regional, Retrospective Farmgate Milk Price Index):

- the average of the milk price received in dollars per kilogram milk solids ($/kgMS) or cents per litre (c/L);
- the average of the fat price received; and
- the average of the protein price received.

The range of prices received (the maximum and the minimum) will also be reported.

The Regional, Retrospective Farmgate Milk Price Index for each dairy region will only be reported on if enough dairy farmers provide data on the prices they receive. The Regional, Retrospective Farmgate Milk Price Index will be reported for Gippsland, Murray and Western Victoria if 20 or more responses are available. For other regions, the Regional, Retrospective Farmgate Milk Price Index will be reported if 10 or more responses are available. These thresholds are set based on the number of dairy farmers in different regions, and expected variation in farmgate prices in each region (in regions where milk is not used for manufacturing it is expected there would be less variation in prices, so fewer responses are needed to provide an indication of prices in the region).

Note that the Regional, Retrospective Farmgate Milk Price Index is not, strictly speaking, an index. It is the simple average of the data points available in each dairy region in each period.

Data source
Data used to calculate the Regional, Retrospective Farmgate Milk Price Index will be sourced directly from Australian dairy farmers by the Department of Agriculture and Water Resources. Farmers will be able to supply their data at [www.agriculture.gov.au/milkpriceindex](http://www.agriculture.gov.au/milkpriceindex). Data will be provided on a voluntary basis, and will include information on the:

- dairy region where the respondent’s farm is located;
- the month of the milk statement
- milk price received in $/kgMS or cents per litre c/L;
- fat price received (c/kg); and
- protein price received (c/kg).

The Department of Agriculture and Water Resources will also collect email addresses and Australian Business Numbers (ABNs) from all contributors to help validate authenticity of information being collected.

If farmers only provide fat and protein prices these will be used to calculate a $/kgMS or c/L price. This will be done using data on average fat and protein tests for the relevant region. This data is sourced from Dairy Australia (who receive it from processors).

Regional commentary
The Dairy Bulletin will also include high level information and commentary on factors that may influence local prices over time including:

- milk production;
- rainfall;
- water prices;
feed prices; domestic demand; and other factors.

Particular data sources are used to inform on the first four of these factors, and these are discussed below.

Data on milk production in each of the eight dairy regions is supplied by Dairy Australia. This data is sourced from processors. Everything else being equal, higher production will tend to have a negative effect on farmgate milk prices.

Data on rainfall in each of the eight dairy regions is sourced from the Bureau of Meteorology (BoM). For each region, the top five dairy production statistical area level 2s (SA2s) have been identified (based on the number of dairy cows (in milk and dry) as indicated by ABS publication 7121.0 – Agricultural Commodities, Australia, 2015-16). Subject to the length and consistency of the data series, a weather station located in the approximate centre of each SA2 was selected.3

References to rainfall in each dairy region in the Dairy Bulletin are, unless stated otherwise, references to average rainfall across the stations associated with each of the top five SA2s in the region. Everything else being equal, higher rainfall will (up to a point, and depending on timing of rainfall) contribute to a longer growing season, greater pasture availability and local milk production, which will tend to put downwards pressure on local farmgate milk prices.

Table 4.1 below shows the top five dairy production SA2s in each dairy region.

Table 4.1 Top five dairy production SA2s in each dairy region

<table>
<thead>
<tr>
<th>Dairy region</th>
<th>Top five dairy production SA2s</th>
</tr>
</thead>
<tbody>
<tr>
<td>South West Victoria</td>
<td>Corangamite - South, Moyne - East, Colac Region, Corangamite - North, Moyne - West</td>
</tr>
<tr>
<td>Gippsland</td>
<td>Foster, Maffra, Rosedale, Leongatha, Korumburra</td>
</tr>
<tr>
<td>Murray</td>
<td>Numurkah, Shepparton Region - West, Kyabram, Lockington - Gunbower, Tocumwal - Finley - Jerilderie</td>
</tr>
<tr>
<td>Subtropical</td>
<td>Malanda - Yungaburra, Gympie Region, Crows Nest - Rosalie, Beaudesert, Lismore Region</td>
</tr>
<tr>
<td>Tasmania</td>
<td>North West, Deloraine, Scottsdale - Bridport, Smithton, Waratah</td>
</tr>
<tr>
<td>South Australia</td>
<td>Grant, Yankalilla, The Coorong, Strathalbyn Region, Wattle Range</td>
</tr>
<tr>
<td>West Australia</td>
<td>Augusta, Harvey, Pemberton, Busselton Region, Capel</td>
</tr>
<tr>
<td>New South Wales</td>
<td>Bega-Eden Hinterland, Taree Region, Forbes, Culburra Beach, Port Macquarie Region</td>
</tr>
</tbody>
</table>

Water prices can impact dairy farmers’ ability to produce pasture and so can impact milk production. While farmers in a number of regions may irrigate, the importance of particular sources is not generally known in most regions (or there may not be publicly available information

3 Data on the precise location of dairy farms within SA2s is not available. If it were, weather stations closer to actual dairy production locations could be selected.
on the relevant water markets). In these regions it is not possible to use a single price (or limited range of prices) to indicate the impact of water prices on the region. As a result, only water prices in the Murray and Gippsland region are discussed in the Dairy Bulletin. References to changes in water prices in the Murray region in the Dairy Bulletin refer to changes in Murray Irrigation System or Northern Victoria average prices, as reported in the Dairy Australia Production Inputs Monitor. References to changes in water prices in the Gippsland region in the Dairy Bulletin refer to changes in the median price of water traded in Trading Zone 41 Macalister.

Feed prices referred to in the Dairy Bulletin are drawn from the Dairy Australia National Hay Report. The National Hay Report provides information on hay and grain prices in a number of regions that do not align perfectly with the dairy regions. Table 4.2 shows how the prices reported in the National Hay Report are allocated to each of the dairy regions. The average of prices in each relevant region are reported in the Dairy Bulletin for each dairy region. The allocation of the regions for which hay and grain price data are reported in the National Hay Report have been allocated to the dairy regions following consultation with Dairy Australia.

Table 4.2 Feed price data sourcing

<table>
<thead>
<tr>
<th>Dairy region</th>
<th>Regions in the National Hay Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gippsland</td>
<td>Gippsland</td>
</tr>
<tr>
<td>Murray</td>
<td>Goulburn/Murray Valley</td>
</tr>
<tr>
<td>New South Wales</td>
<td>Central West NSW, Bega Valley</td>
</tr>
<tr>
<td>South Australia</td>
<td>Central Districts SA, South East South Australia</td>
</tr>
<tr>
<td>Subtropical</td>
<td>North Coast NSW, Darling Downs, Atherton Tablelands</td>
</tr>
<tr>
<td>Tasmania</td>
<td>North West Tasmania</td>
</tr>
<tr>
<td>Western Australia</td>
<td>South West WA</td>
</tr>
<tr>
<td>Western Victoria</td>
<td>South West Victoria</td>
</tr>
</tbody>
</table>
Limitation of our work

General use restriction
This report is prepared solely for the use of the Department of Agriculture and Water Resources. This report is not intended to and should not be used or relied upon by anyone else and we accept no duty of care to any other person or entity. The report has been prepared for the purpose of set out in our contract dated 9 May 2018. You should not refer to or use our name or the advice for any other purpose.