**Project: Forecasting global dairy prices***Client: Oscar Dowson, Dairy Analytics,* [*oscar@dairyanalytics.co.nz*](mailto:oscar@dairyanalytics.co.nz)

**Background**

The majority (84%) of dairy farmers in New Zealand supply milk to Fonterra, a large milk processing co-operative. However, the farmers are not paid for their milk on delivery. Instead, at the end of each season (one year), they are back-paid the *farmgate milk price* for each kilogram of milk supplied during the preceding season. The farmgate milk price is calculated from a series of international auctions that occur during the year. Therefore, at the start of the season, there is some uncertainty surrounding the farmgate milk price, since the auctions have not yet occurred. At the start of each year, this uncertainty can be up to 50%!

The auctions are held twice a month on the GobalDairyTrade platform. (See [www.globaldairytrade.info/en/product-results](http://www.globaldairytrade.info/en/product-results) for the latest results). In addition to setting the price at which actual goods are exchanged, the prices set on GlobalDairyTrade are used to settle a variety of financial derivative products on the New Zealand stock exchange.

The client for this project, DairyAnalytics, runs a website (<https://dairyanalytics.co.nz>) that provides a probabilistic forecast of the farmgate milk price. This is a notable exception to other participants in the market, which only provide point-forecasts. The goal of this project is to improve the DairyAnalytics forecast model. Improvements will be incorporated into the model in production, helping participants in the dairy industry make better decisions in the face of uncertainty.

*Areas of improvement*

The farmgate milk price is settled each September and has three main inputs:

1. The revenue earnt by Fonterra selling milk on GlobalDairyTrade (in USD)
2. The exchange rate at which Fonterra converts USD into NZD. (This is complicated by the fact that Fonterra uses futures and options contracts to *hedge* their exchange rate. Thus, the exchange rate realized by Fonterra is not the same as the spot-price published in the market.)
3. Processing costs (in NZD).

This project will focus on improving the first input by improving the method for forecasting prices on GlobalDairyTrade.

**GlobalDairyTrade**

The basis of the GDT platform is a twice-monthly series of auctions (known as trading events). A GDT trading event is as an ascending price clock auction. The trading event begins with the sellers submitting an offer quantity (supply) and a price is set at which it is expected there will be more demand than the available the offer quantity. After being notified of the initial price, buyers submit demand quantities for each product. If this quantity exceeds the total available supply then, in a series of rounds, the price is slowly incremented, and buyers are given the opportunity to reduce the quantity they wish to purchase. The trading event ends when the total demand of the buyers is equal to the sellers’ offer quantity (set at the open of the trading event). All buyers pay the final price. Trading events are held on the first and third Tuesdays of each month and begin at 12:00 GMT.

You can read more about GDT events here:

<https://www.globaldairytrade.info/en/gdt-events>

<https://www.globaldairytrade.info/en/gdt-events/gdt-events-frequently-asked-questions/>

**Data**

*trading\_data.json*

Data is provided in the form of a JSON file containing information on the last 121 auctions. Each auction contains an event summary (in the EventSummary field) and a breakdown of each product group sold on the auction (in the ProductGroupResult field).

The EventSummary object contains the following fields:

* EventNumber: the number of the auction (note that we are missing data on auctions < 107)
* EventDate: the date of the auction
* EventLabel: ignore
* EventGUID: ignore
* QualifiedBidders: the number of participants who were eligible to bid in the auction
* ParticipatingBidders: the number of qualified bidders who placed a bid in the auction
* WinningBidders: the number of participating bidders who successfully purchased product
* TotalRounds: the number of rounds that were conducted before an equilibrium was found
* EventDuration: the time (hours:minutes) that the auction lasted
* QuantitySold: the quantity (in tonnes) of all products sold
* AverageWinningPrice: the quantity weighted average price (in USD/tonne) of sold products
* ChangeInPriceIndex: a change (in %) of the AverageWinningPrice since the last auction
* MaxSupply: maximum supply available in the auction
* MinSupply: minimum level of supply that must be sold
* TwelveMonthQtySold: total quantity of products sold over last 12 months

Each object in the ProductGroupResult list contains the following fields:

* ProductGroupGUID: ignore
* ProductGroupCode: short-form of the name (feel free to use this in plots, etc.)
* ProductGroupName: long-form of the product name
* SupplyOffered: whether the product was offered by a seller in the auction
* ProductSold: whether the product was purchased by a buyer during the auction
* PriceIndexPercentageChange: a change (in %) of the AverageWinningPrice since the last auction
* TwelveMonthQtySold: total quantity of this product group sold over last 12 months
* ProductGroup12MSalesSplit: proportion (in %) of all sales (across all products) over the last 12 months that were from this product group
* AveragePublishedPrice: the quantity weighted average price (in USD/tonne) of sold products.

*gdt\_historical\_trading\_data.xls*

In addition to the up-to-date JSON data, historical GlobalDairyTrade data is also provided in the form of a spreadsheet (gdt\_historical\_trading\_data.xls) containing similar data dating back to the first auction in June 2008. This spreadsheet includes a breakdown of each product by the contract period (denoted CP1, CP2, etc). The contract period is a delivery date X months in the future, e.g., CP3 is a contract for delivery in 3 months. We only care about the weighted average prices.

*anz\_commodity\_price\_index.xlsx*

We also provide a monthly commodity index dating back to 1986 in the spreadsheet anz\_commodity\_price\_index.xlsx. Series 2 (Dairy Products) is the most relevant. This series demonstrates a strong cyclic trend prior to 2008 (when GDT was introduced).

**Deliverable**

Provide a means to forecast the average published price of product groups on GlobalDairyTrade over the next 12 months.

Product groups are not equally important. Effort should be directed into forecasting individual product groups according to the importance weights given in the table below.

|  |  |
| --- | --- |
| Product Group | Importance Weight |
| Whole Milk Powder (WMP) | 55% |
| Skim Milk Powder (SMP) | 20% |
| Anhydrous Milk Fat (AMF) | 10% |
| Butter (BUT) | 10% |
| Butter Milk Powder (BMP) | 5% |
| All others | - |

**Potential pitfalls**

* There is correlation between products
* Some products are not sold in some auctions.
  + Can you impute the missing prices?
  + Do different imputation methods impact the forecasts?
* In some cases, the winning price may be withheld (for example if there are too few bidders, of the product fails to clear the starting price)
* Can we quantify the uncertainty in our predictions?
* Theoretically, prices on GlobalDairyTrade are driven by global supply and demand. Unfortunately, this data is unobservable. Can the (im)balance between supply and demand be estimated from the data?
* Does the cyclic trend in the commodity price index still exist?
  + Can it be used to improve the forecasts of GDT products?