Pricing Project Statement

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June 11, 2025

1 Context

Pricing in the financial services industry is a necessary skill to remain competitive. The aim of this workstream is to revolutionise the way we do pricing at NatWest, to create a tool which can ensure that we are always pricing our products efficiently against the market.

2 Definitions

1. Product: A product group (e.g. saving account) + a balance tier (e.g. '£1m-£10m'). A product can be internal (controlled and owned by NatWest) or external (a competitor's product that we have information on).

2. Portfolio: A set of products. 'Our Portfolio' relates to all internal products.

3. Flow / Flow of funds: Funds (money) moving from one product (the source product) to a different product (the target product). Each one of these flows is predicted by a linear regression model.

4. Period: 4 weeks / 1 month - the timeframe over which we are optimising.

5. Product Balance: The total amount of monetary assets against any individual product

6. Rate: The 'price' (to NatWest) or interest rate (to the customer) of a product, such as 4% interest applied on an account. Here, a higher rate will drive deposits towards a product, and a lower interest rate will typically drive funds away.

7. Models: Relates to the suite of linear regression models which predict the flow of funds between two products.

8. Forecasting: Using the result of our models to predict the state of the balances over the period. This is done using the 'forecaster'.

2.1 Approach

We discovered that predicting and optimising balances directly is not accurate enough for our purposes since balances can have elastic and inelastic portions simultaneously - for a fixed term account, different customer's deposits will be maturing at different times, meaning that only a portion of that product's balance is elastic at any given moment. The decision was made to predict the *flow of funds* between two different products (some being internal and some being external) within a given timeframe, primarily using a suite of *linear regression models*. We can sum all of our predicted the flow of funds to predict the overall net flow of funds across our portfolio. This step is known as *forecasting*.

One of the features in each linear regression model will correspond to the rate of either the source or target product. These features, r_i are the focus of our optimisation; by optimising over the forecaster, can we choose the best set of product rates such that we maximise some objective function. The objective function which will be the focus of this research is to maximise product balances.

The current approach is roughly as follows:

Construct a pricing

2.2 Constraints

Constraints come in four main varieties:

- Rate Change constraints - $\Delta r_i \leq c_i$, the absolute change in rate for a product from it's current rate is bounded

- Rate Bound constraints - $l_i \leq r_i \leq u_i$, a rate is bound by a lower and upper bound

- Rate interplay constraints - $r_i \leq r_j$ for some i and some j.

- Balance constraints - The final balance of a product must be within some bounds.

2.3 Nuances

Here are some nuances to bear in mind:

Each flow in the forecaster is describing how funds move from one product to another - our forecaster & optimiser is focussed on the *balances* of products. This means that the optimiser cannot just optimise each flow individually, as this will only maximise the absolute net flow of the portfolio, rather than the final portfolio balance.

The rate features for product i could be something like *forecastRate*, where it's independent of any other variable, or *spread*, where r_i represents the difference between the current rate of product i and the forecast rate of another prodcut, say product j. The rationale here is such that we want to maintain incentives for customers to use certain types of accounts over another, such as a 1 year fixed term saver vs a 3 year fixed term saver. The 3 year fixed term saver will (typically) have a lower rate. This adds some cross dependencies into our constraints,

Since our models include flows to and from external sources, we are also caluclating the net change in balance of these external sources due to NatWest. When calculating the final balance of our portfolio, we need to exclude these external sources from our calculations since we are not our products to claim the deposits for.

2.4 Questions

- Is this a convex or non convex optimisation problem?
- If the problem is non convex, can we project this into convex space?
- Are the constraints linear or non linear?
- If the constraints are non linear, are there any approaches we can apply to create linear constraints?
- What optimisation approaches suit this scenario? Can we use something like CVXPy?
- Produce a proof of concept code base which simulates an optimisation of this problem.