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## Forecasting Ontario provincial drug expenditures - a hybrid approach to improving accuracy

ARCC – MAY 26, 2017

# Outline

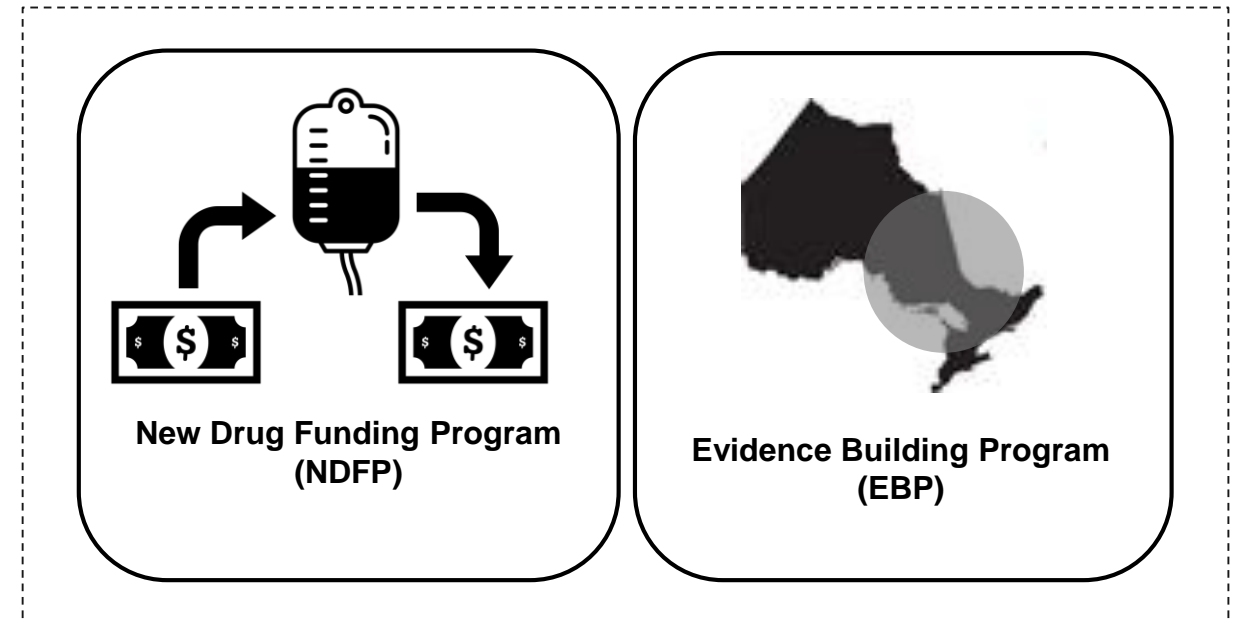
1. Oncology Drug Funding
2. Drug Budget Forecasting
3. Data Insights
4. Forecasting Strategy
5. Results
6. Forecasting Tool
7. Next Steps

# Oncology Drug Funding

## Cancer drugs are costly – how are they administered?

- The **Provincial Drug Reimbursement Program (PDRP)** at Cancer Care Ontario (CCO) administers outpatient injectable cancer drug funding to hospitals and drug centers through the **New Drug Funding Program (NDFP)** and the **Evidence Building Program (EBP)**
- In 2015/2016, the NDFP and EBP together funded **\$347.7M** in injectable cancer drug claims for **28,000 patients**
- Due to the significant cost associated with cancer drugs, it is important for the PDRP to develop **accurate budget forecasts**

## Provincial Drug Reimbursement Program (PDRP)



# Drug Budget Forecasting

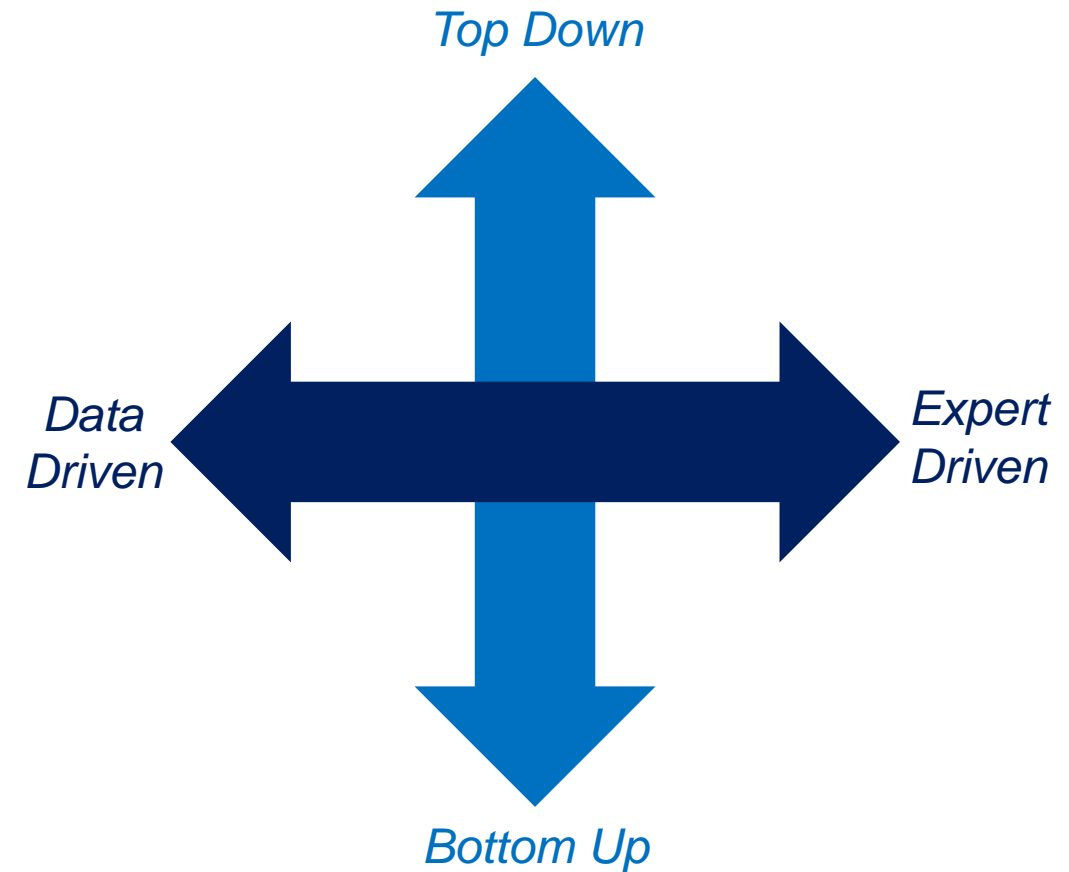
## Different approaches to expenditure forecasting – what is the most effective?

### Automation vs supervision

- **Data driven** forecasts often use historical time series data, but are only effective when the time series are long and stationary
- **Expert driven** forecasts can account for new drugs or anticipated disruptive factors, but are arbitrary without any statistical input

### Allocation vs aggregation

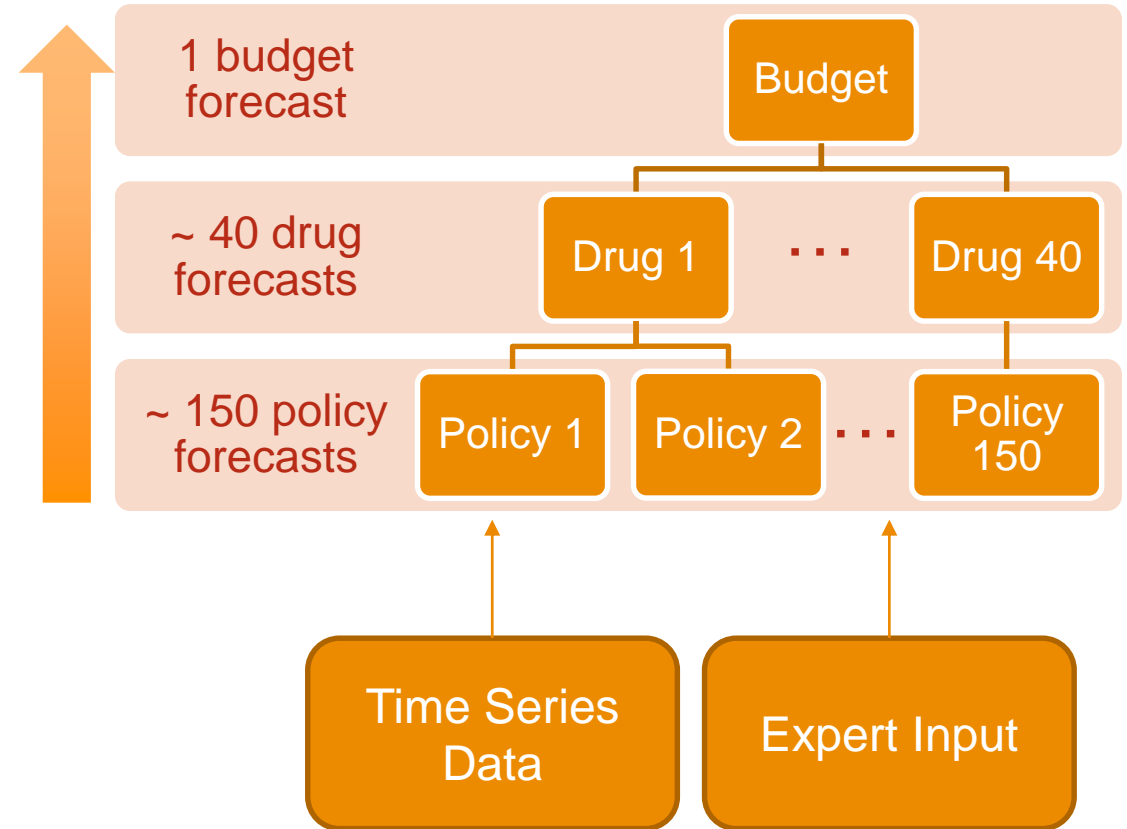
- **Top down** forecasts are effective in situations where the low level units belong to the same markets and display similar trends and behaviour
- **Bottom up** forecasts are better options when the low level units are less homogenous, and are especially effective at capturing short to medium term trends



# Drug Budget Forecasting

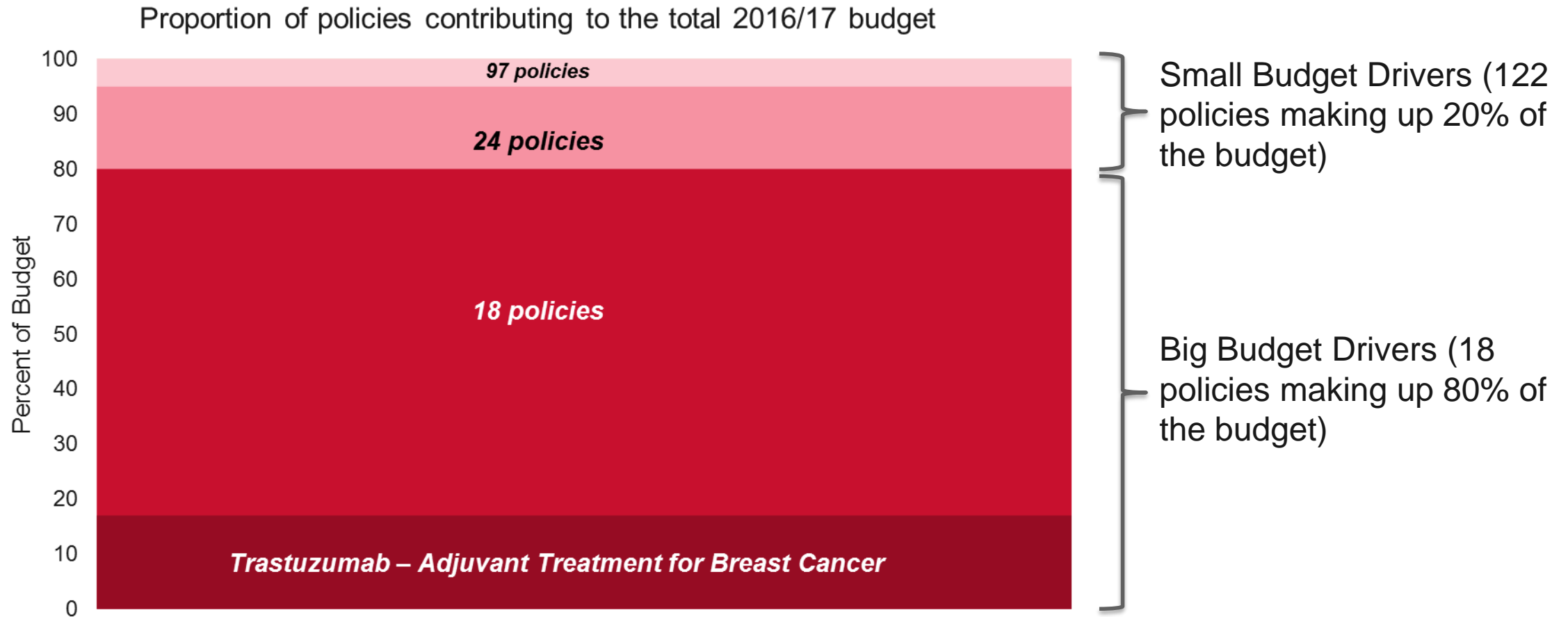
## We took a hybrid approach to drug forecasting

- There are over **40 cancer drugs** currently funded through the PDRP with approximately **140 policies**
- Each policy contains patient eligibility criteria and treatment regimen specifications describing the associated drug dosage and frequency
- Policies may be modified mid-year
- Lack of homogeneity amongst policies necessitates a **bottom-up approach**
- **An automated analytical methodology** incorporating time series data was developed to accommodate the large number of forecasts
- **Expert input is incorporated** to adjust for policy changes



# Data Insights

## A large proportion of the total budget is composed of a small number of policies

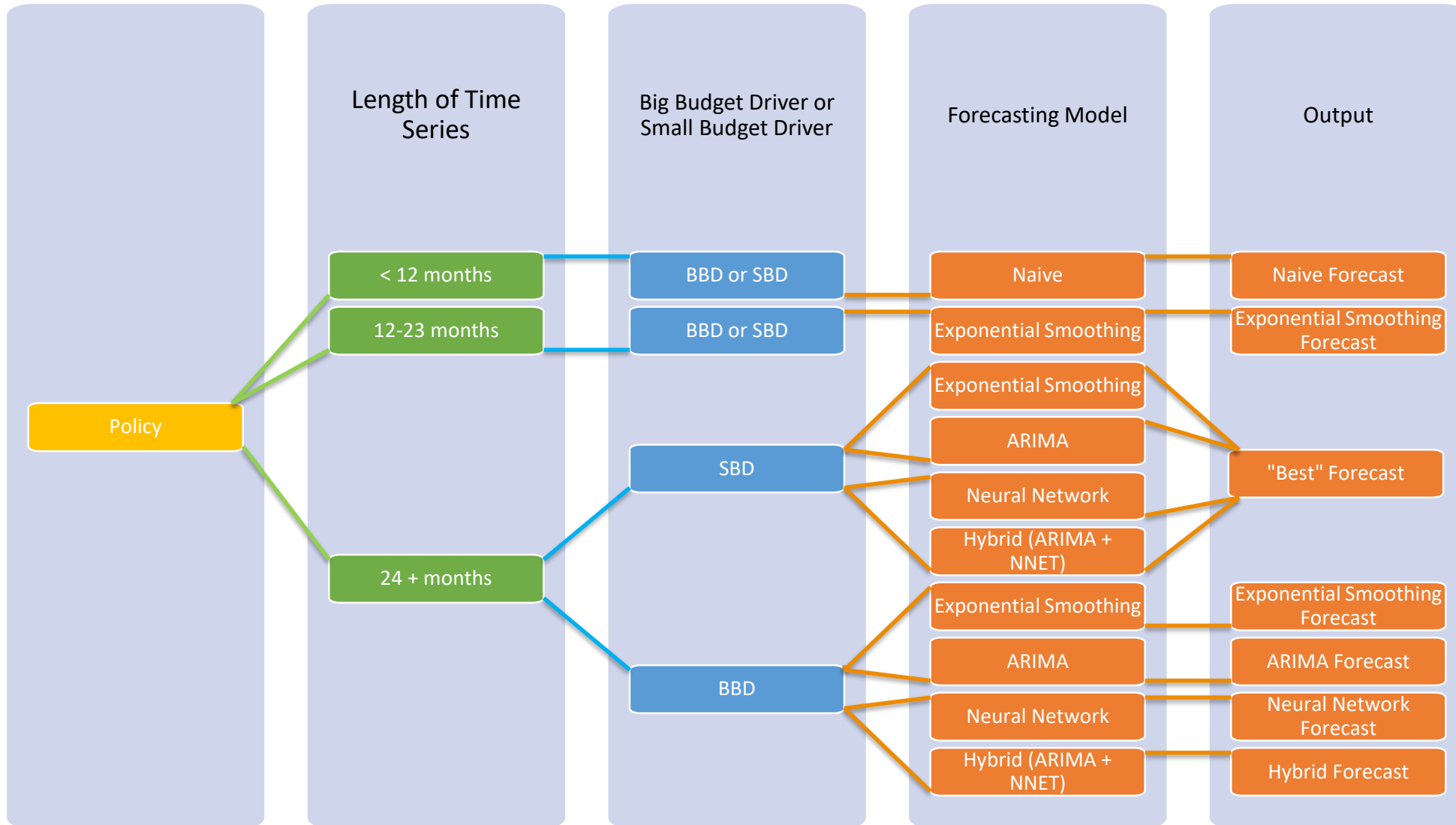


# Forecasting Strategy

## Developed a strategy that implements established analytical forecasting methods as well as user judgement

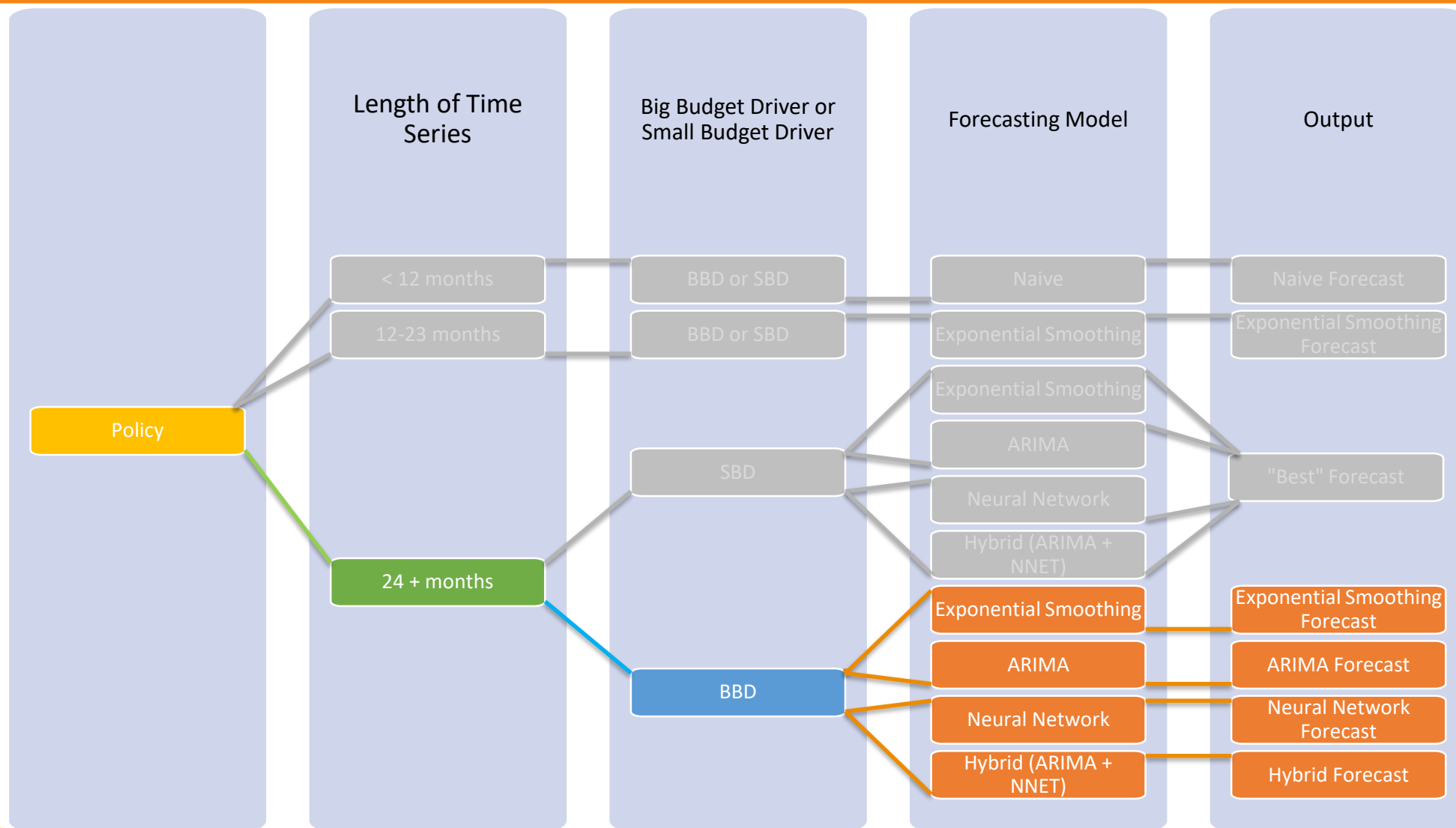
- Forecasts for Big Budget Drivers (BBD) include both automated and user-defined forecasts
  - Policies with sufficient data are forecasted using four models and the best forecast is selected by the user
  - Policies with insufficient data are forecasted using naïve methods, however the user is encouraged to input their own forecast
- Forecasts for Small Budget Drivers (SBD) are *completely* automated
  - Policies with sufficient data are forecasted using all four models and the best forecast is selected by comparing the Goodness of Fit results of the methodologies on the previous fiscal year
  - Policies with insufficient data are forecasted using naïve methods

# Visual Depiction of Forecasting Methodology





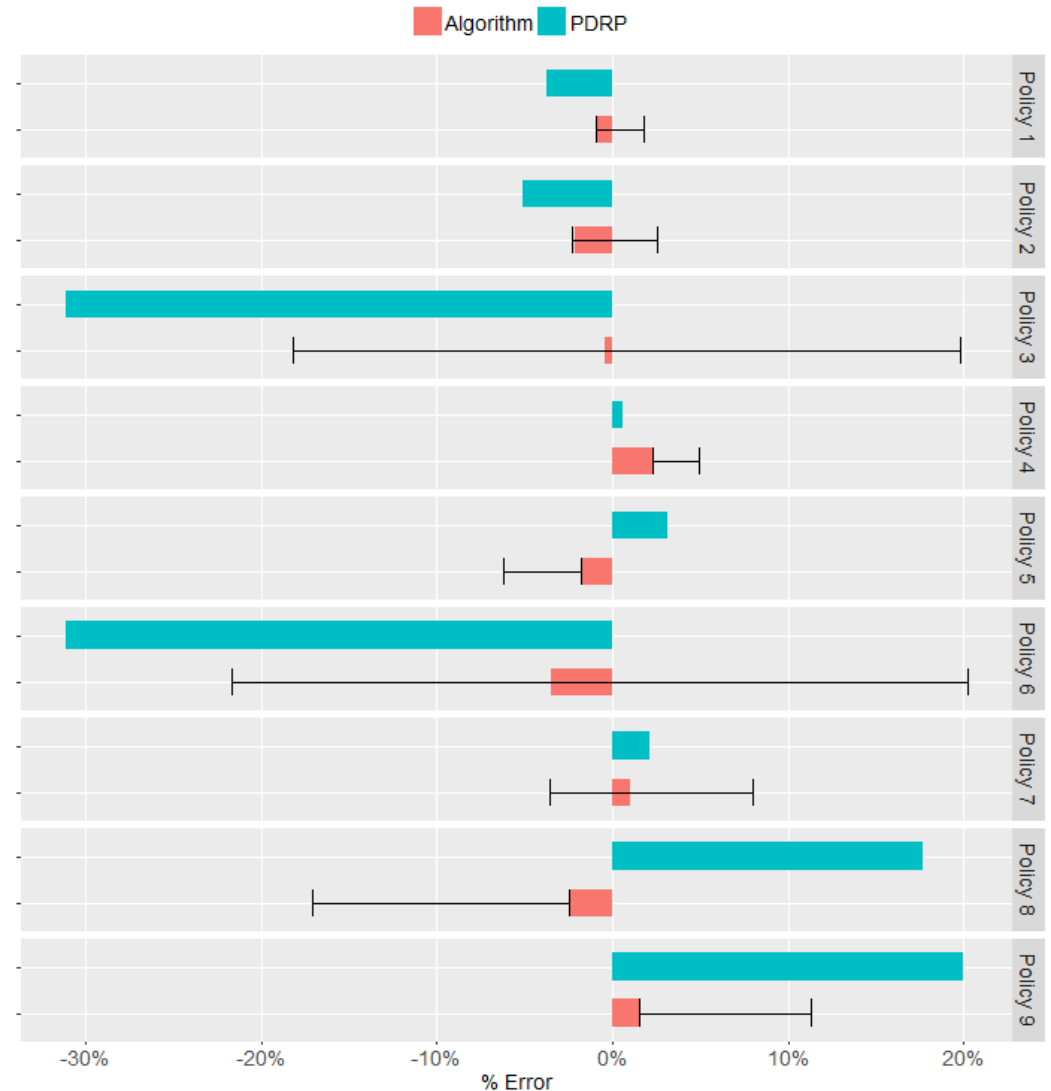
# Focusing on BBD Policies with long time series (2+ years)



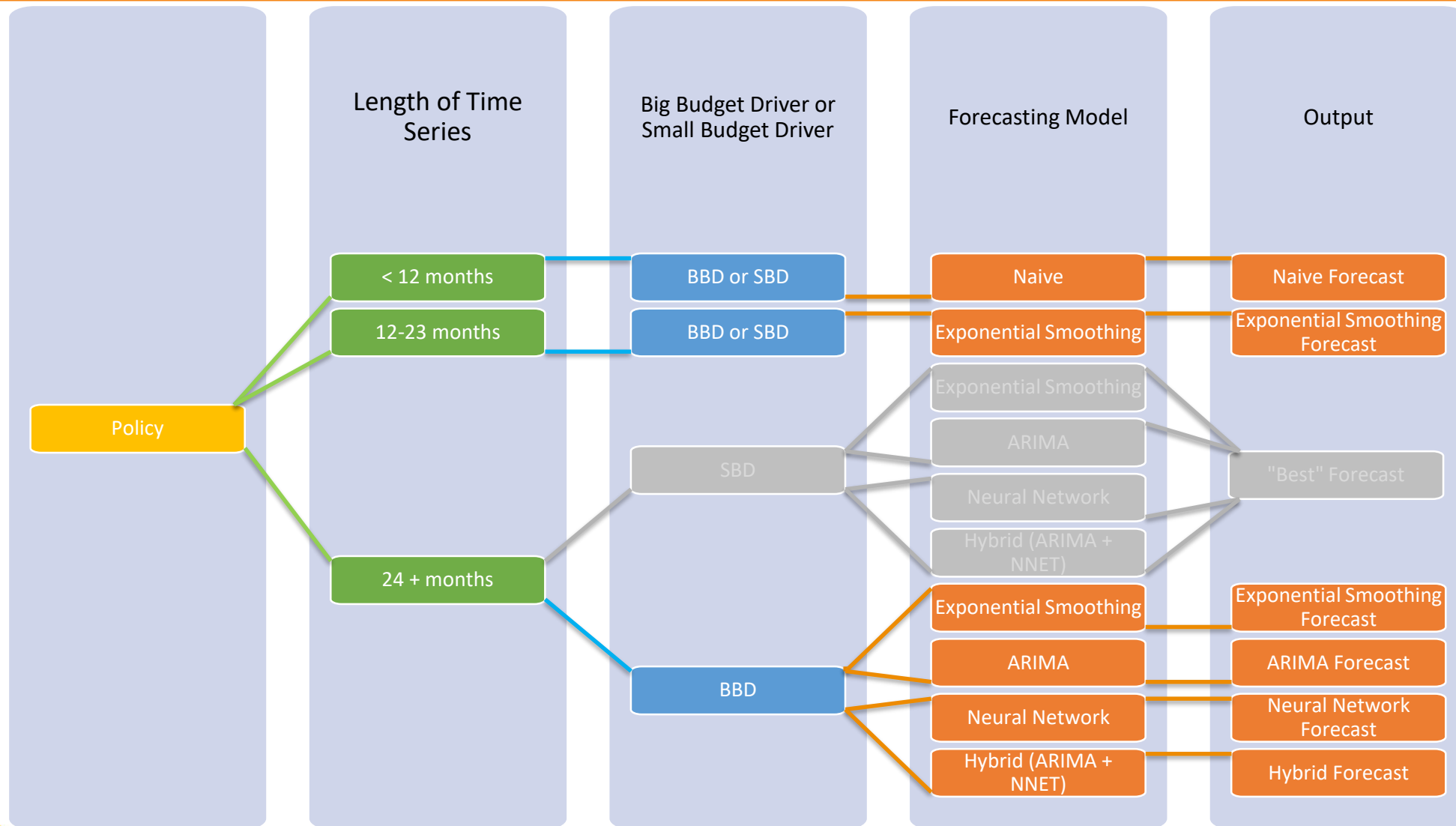
# Automated forecasts perform well with long time series

## BBD Policies with long time series (2+ years)

- The top 9 BBD policies make up over 60% of the budget
- Optimal forecasts for these policies generated by the algorithm (pink bars) are all within  $\pm 4\%$  error
- Whiskers around pink bars denote the min./max. of possible forecasting errors
- Wide ranges in forecasts correspond to policies with less predictable behaviour



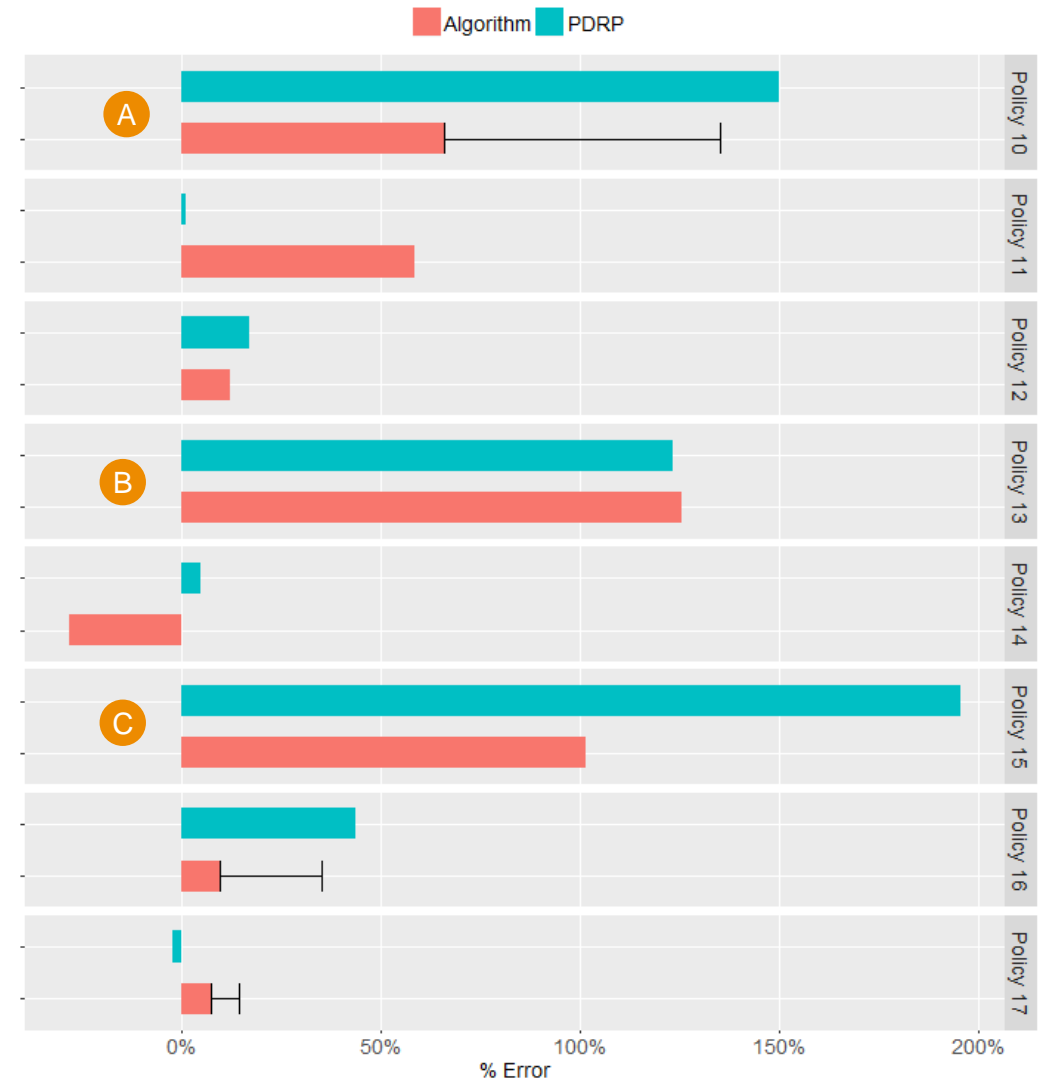
# The remaining 8 BBD policies have a mix of long and short times series



# Automated forecasts require supervision for “unstable” policies

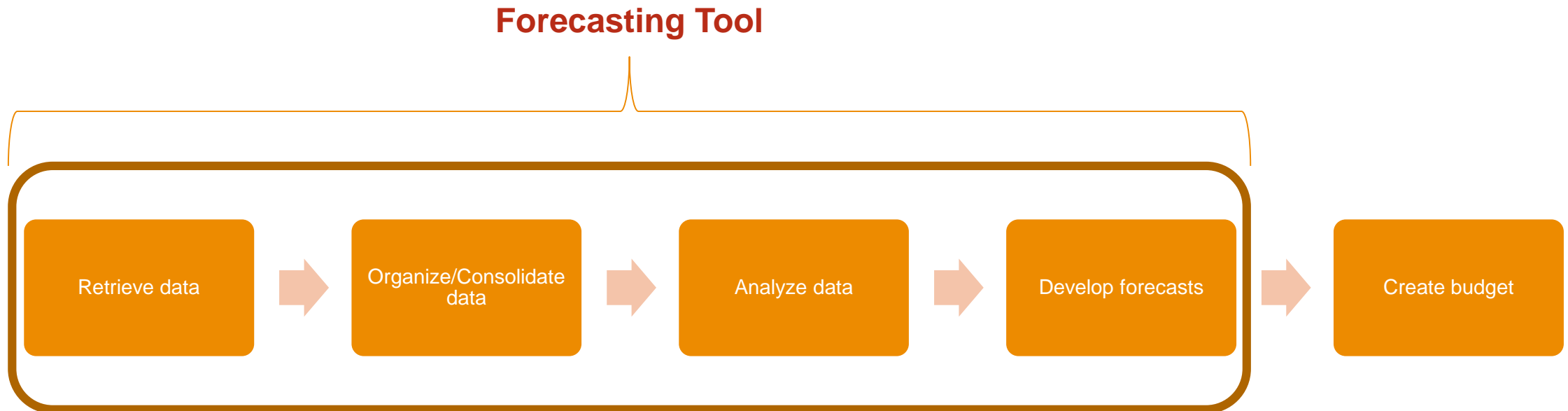
The remaining 8 BBD policies have a mix of long and short times series

- Two policies (A, B) experienced *significant price changes*
- Policy (C) experienced a drop in use as a *newer, more effective policy emerged* mid year
- Error is significantly higher on policies with shorter time series and time series that are disrupted by external events
- Foreknowledge of price and policy changes is necessary to forecast these policies at a low error



# Forecasting Tool – “before” and “after”

**Delivered a tool that automates multiple (previously) manual steps in the forecasting process, and provides a comprehensive overview of all available data to better equip the user with the information they need to create a budget.**



# Forecasting Tool – Screenshot

**Select drug and policy of interest**

**Create yearly custom forecasts**

<b>Disease Site</b>	Haematology		Budget Proportion: 1.33%	<input type="button" value="Add new policy"/>  <input type="button" value="Delete policy"/>
<b>Drug</b>	Rituximab			
<b>Policy</b>	Rituximab - Previously Untreated Chronic Lymphocytic Leukemia			
<b>Forecast Used</b>	NNET			

FY	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Actual	\$4,734,947.55	\$4,053,724.85	\$4,174,851.74	\$4,149,301.56	No Data	No Data
BIA	No Data	No Data	No Data	No Data	No Data	No Data
Forecast	No Data	No Data	No Data	\$4,082,608.12	\$4,182,330.82	\$4,182,330.82

**Exploratory graphs to aid in analysis**

**Select analytical forecasts for budget calculations**

**Create monthly custom forecasts**

2016/2017	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17
Actual	\$328,081.51	\$342,541.66	\$312,040.31	\$333,157.66	\$396,799.85	\$346,074.72	\$364,186.59	\$394,418.12	\$310,946.84	\$353,560.33	\$321,718.83	No Data
BIA	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Forecast	\$345,687.51	\$333,768.54	\$333,474.76	\$340,217.75	\$329,501.71	\$339,965.93	\$340,847.28	\$337,056.10	\$347,702.18	\$342,679.92	\$343,178.88	\$348,527.57

2017/2018	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18
BIA	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Forecast	\$348,527.57	\$348,527.57	\$348,527.57	\$348,527.57	\$348,527.57	\$348,527.57	\$348,527.57	\$348,527.57	\$348,527.57	\$348,527.57	\$348,527.57	\$348,527.57

2018/2019	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19
BIA	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Forecast	\$348,527.57	\$348,527.57	\$348,527.57	\$348,527.57	\$348,527.57	\$348,527.57	\$348,527.57	\$348,527.57	\$348,527.57	\$348,527.57	\$348,527.57	\$348,527.57

**Create monthly custom forecasts**

# Discussion and Next Steps

- The tool will be deployed in budget forecasting for the first time in FY2017/2018
- Creating accurate drug budget forecasts is challenging due to factors like price changes, policy changes, and new drugs
  - This approach combines time-series forecasting methods for automation with the ability to customize forecasts based on expert knowledge of these external factors
- Initial results have shown the tool to be effective in generating accurate automated forecasts
  - There is room for even further improvement as the tool allows the user to modify projections manually (i.e. semi-supervised)
- The tool will possibly be shared with the Ministry of Health and Long Term Care