

A methodology for forecasting cash balances

Q 6-04. What is the value of a forecast of treasury cash balances?

Forecasting the overall cash balance of the government is a basic and a critical function for monitoring and maintaining treasury liquidity. While the cash forecast is important, there are some real mathematical challenges to address in applying standard methods to the forecasting model.

The treasury cash balance at any point in time is calculated as the net impact of all individual cash flows, negative and positive, since the last accounting period close added to the last closing balance.

Q 6-04.01. What are the mathematical issues in forecasting the cash balance?

Forecasting a cash balance is the same as attempting to forecast the total of a group of separate variables, but without using information particular to each variable. Further, because a net value is composed of a collection of cash flows, each flow contributes its own error or variability to the sum.

The constituent flows may be correlated positively or negatively with each other or with subsets of flows and this will affect the variability of the total. It is not reasonable to assume simply that the errors will cancel each other out.

Mathematically, the aggregate error structure can be very unstable. It is likely to display heteroscedasticity, the condition that the variance of a random variable increases with the size of the variable. For example, the variability about the GDP figure probably increases with the value of the GDP. Complications such as this impede the ready use of simple statistical regressions for forecasting.

Q 6-04.02. How can one forecast a balance directly despite the challenges?

A naïve method of applying past values can provide a rough model of cash balances. This approach simply uses flows for the same place on previous years' calendars inflated or deflated as necessary.

A more sophisticated approach would involve modeling the cash balance from the previous values of the series itself by using autoregressive methods.¹ This is essentially a regression of current values of the cash balance fitted on past values of the cash balance, and differences between successive past value. The method can even incorporate seasonal variations as well. The key assumption, however, is that

¹ These models are usually referred to as ARIMA (i.e., autoregressive integrated moving average models) and are fitted by Box-Jenkins methods.

the underlying data series is stationary. This means that the series can be reduced to a random walk model by enough data transformations or taking differences between values. In new economies, this may not be guaranteed.

Q 6-04.03. Can other data be used to forecast balances?

It is reasonable to look for other data series that are highly correlated with cash balances and lead by some useful amount of time. The requirement of high correlation makes standard linear regression applicable; the requirement to lead by some period means that values known today can be used to forecast something else at a future date. If this were all, it might be possible to rely on exogenous estimates of GDP or other economic activity to serve as a proxy for unseen fiscal flows.

Unfortunately, the issue of frequency becomes relevant. Cash balance forecasts are likely to high frequency, even daily, data observations. There are few equally high frequency macroeconomic variables available. For example, GDP is usually estimated quarterly; daily variations make little sense. Models of the aggregate cash balance will have limited sources of data to drive the forecast.

Q 6-05. How can one forecast cash balances?

The answer to the challenge of forecasting the cash balances is not to attack the problem directly. It is a simple mathematical truth that many complex patterns can be created by a series of simple patterns. Treasury cash balances are the result of several individual flows and the overall balance can exhibit some very complex patterns. It is far more likely that individual flows will be easier to model than the overall value.

It is recommended that the cash balance forecast be derived from forecasts of major constituent sub-flows. Concentrate on disaggregating flows as much as possible to estimate individual components. Use accounting data, known cash flow movements, and limited statistical analysis *to model individual cash flows* at individual or related combined budgetary entities.

Q 6-05.01. How are the forecast data divided by usage?

Begin by partitioning the individual cash flows into three categories: those that follow known administrative schedules, those that display a distinctive pattern, and those that display no pattern or are inconsequential in amount. This means that not all cash flows will have to be fit to a model.

- For flows that follow an administrative schedule, begin by identifying the timing of known cash flows and accounting data. This will provide all the forecast needed for these variables. It will be important to maintain

communications with line ministries regarding their spending plans and revenue forecasts.

- For flows that show a distinctive pattern and which are of significant size, study each flow individually and build the simplest satisfactory model possible. For most of these, the statistical modeling requirement will be slight.
- For the remaining cash flows, trends and averages will be sufficient to build the forecast.

Use statistical methods to calculate how much of a reduction in forecast noise is achieved at each step of the modeling.

Q 6-05.02. Are there fixed rules regarding statistical models?

The reason for breaking the system down to its individual flows is that they are likely to be more consistent in certain patterns that can more easily be modeled. It is likely that even simple regressions with dummy variables or related budget data will provide a satisfactory fit.

Use a variety of methods when building statistical models instead of depending too heavily on one perfect answer. There is even scholarly evidence that an unweighted index of a cluster of forecasts or estimates can outperform any single econometric forecast method over the long-term.

Q 6-05.03. How are the flows rolled up to produce a forecast balance?

The cash balance is estimated by adding for each day (or week) the net change in cash resulting from the sum of all estimated sub-flows. The estimated cash balance is then a derived value as the accounting result of detailed forecasts of individual cash flows. The result is the cash forecast for all future periods. Each day's change in the actual closing balance and any adjustments made to the forecasts of the individual flows will generate a new forecast for the remaining days of the horizon.

If the change is only in today's closing balance, the entire trajectory of balances will shift rigidly up or down by the error in today's forecast. If changes are made in individual flows, this will change the shape of the trajectory.