RFR Statistics and Empirical Observations

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The Alternative Reference Rates Committee (ARRC) has proposed SOFR, SONIA and CORRA to replace LIBOR as the risk-free benchmark rates for the US Dollar, GB Pound and Canadian Dollar markets, respectively. Derivative model developers will have to capture the material dynamics of these rates in their pricing models. Herein I present a look at some of the statistical attributes of these three overnight rates and their corresponding daily-compounded rates.

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The Federal Reserve Bank of New York publishes the Secured Overnight Financing Rate (SOFR), the Bank of England the Reformed Sterling Overnight Index Average (SONIA), and the Bank of Canada the Canadian Overnight Repo Rate Average (CORRA). The time-series of these daily fixings is shown in Fig 1 . For comparison the figure includes some non-RFR rates: the Effective Federal Funds Rate (EFFR) and the USD overnight LIBOR rate. It is apparent the SOFR rate is the most volatile (see Fig 2) and that all these rates evidenced precipitous Covid-era drops in value. SOFR is moderately positively correlated with EFFR (Pearson's correlation coefficient $\rho(SOFR, EFFR) = 0.34$) and overnight LIBOR ($\rho(SOFR, LIBOR) = 0.25$). The idiosyncracies in the different repo markets create the structural differences in the SOFR, SONIA and CORRA timeseries.

Fig. 2 plots the annualized volatility of these overnight rates [1]. The volatility is estimated using an Exponentially Weighted Moving Volatility estimate with damping constant 0.053. This constant was estimated by employing an optimization procedure suggested in Ref (3) - the constant is chosen to minimize an error and smoothness objective function. On each observation date this EWMV estimate assigns more significance to rate observations close to the observation date and reduced weight to less-contemporaneous observations. It is designed to closely follow the changing volatility of the overnight RFR's. It is apparent the SOFR overnight rate is materially more volatile than the other rates in the figure.

Although derivative modelers should appreciate the features of these benchmark overnight RFR rates, the underlying RFR rate referenced in deals will most likely be the daily-compounded overnight rates[2]. The ISDA standard for calculating the compounded rate $C[S,T]$ over the reference interval (*e.g.*, a coupon accrual period) bounded by the start date S and the end date T is

$$C[S,T] = \frac{N^{(year)}}{d_c[S,T]} \left[\prod_{i=1}^{d_b[S,T]} \left(1 + \frac{r_i \times n_i}{N^{(year)}}\right) - 1 \right] \tag{1}$$

where:

[1] The input for these Exponentially Weighted Moving Volatility estimates is the de-trended one-day changes in the levels charted in Fig. 1 .

[2] See, for example, ARRC comments in Ref. (1)

$N^{(year)} =$ the market convention for quoting the number of days in the year (in the United States and Canada the convention for money markets is N = 360, in the UK it is N=365)
$d_c[S,T] =$ the number of calendar days in the reference interval
$d_b[S,T] =$ the number of business days in the reference interval
$r_i =$ the RFR rate applicable on business day i
$n_i =$ the number of calendar days for which r_i applies

The continued product is indexed by the business days in the reference period. A floating rate note or other derivative contract may define an arbitrary reference period $[S,T]$, typically one/two/three months. The structure of Eq. (1) creates a predictable oscillation in the compounded rates due to the fact that $n_i = 1$ on most days but is 3 on Fridays and $n_i > 1$ on the day preceeding a Central Bank holiday. Ref. (2) outlines this characteristic of the compounding formula Eq (1). Hence, if the end of the compounding reference interval T is a Friday, the final term in the continued product in Eq. (1) is $\left(1+\frac{r_i \times 3}{N^{(year)}}\right)$ whereas it is $\left(1+\frac{r_i \times 1}{N^{(year)}}\right)$ on normal business days that do not preceed a holiday. The oscillation is demonstrated in the left-panel of Table 1, where the one/two/three-month compounded SOFR rate timeseries is shown. The right-panel sows a smoothed version of the left-panel timeseies, a simple 20-day moving average filter. Market Risk groups that employ timeseries of risk factors in VaR models will have to decide how to address this deterministic oscillation. Leaving the oscillation 'as-is' is certainly a rational choice. Another possible VaR modeling choice would be to simply filter it out - the result is demonstrated in the right panel in Table 1.

Fig. 3 shows the timeseries of the simple moving averaged three-month daily-compounded RFR rates (SOFR, SONIA, CORRA) since 2018. The higher Covid-era CORRA overnight rates shown in Fig. 1 result in materially higher CORRA daily-compounded rates, relative to its USD and GBP counterparts.

References

(1) The Alternative Reference Rates Committee. *A User's Guide to SOFR* (April 2019).

(2) Federal Reserve Bank of New York, *Additional Information about the Treasury Repo Reference Rates*.

(3) Raudys, A. and Pabarskaite, Zidrina, *Optimising the smoothness and accuracy of moving average for stock price data* , **Technological and Economic Development of Economy**, 24(3), 984-1003 (2018).

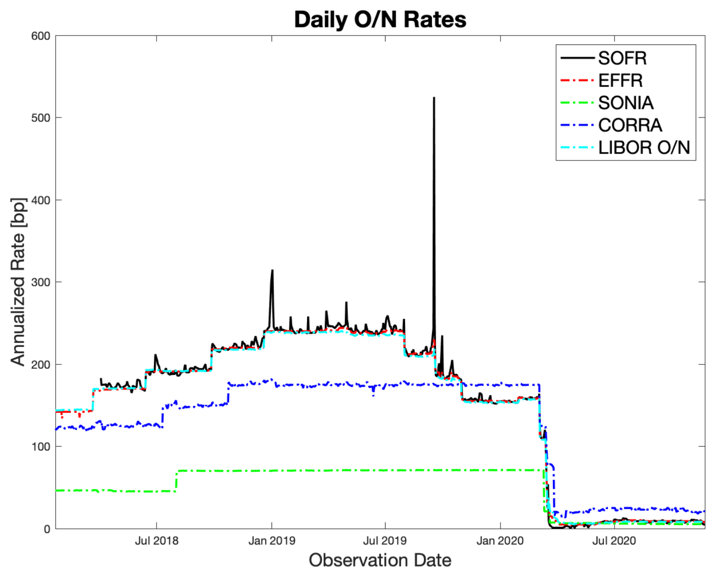

Figure 1: Daily overnight rates (annualized) since 2018. The candidate USD, GBP and CAD RFR rates, the USD Effective Federal Fund Rate and the overnight USD LIBOR rate are shown. All these rates manifest the Covid-19 drop in 2020Q1. The SOFR rate has been published since April 3, 2018, whereas all the other rates in the figure have much longer histories. Data sourced from Federal Reserve Bank of St. Louis, Bank of England and Bank of Canada.

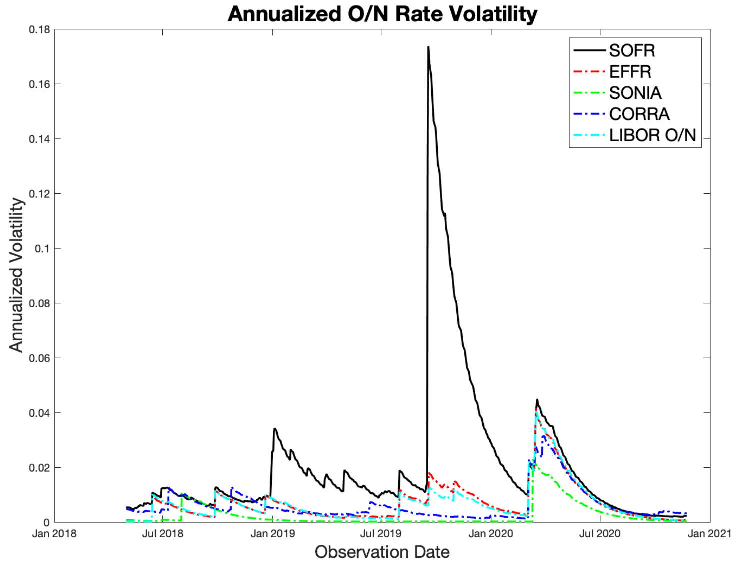

Figure 2: Annualized Exponentially Weighted Moving Volatility (EWMV) of overnight rates in Fig. 1. Moving window contains 20 observations of detrended daily level changes. The EWMV damping constant is 0.053.

<table>
<tr><th colspan="2">Table 1: Compounded SOFR Rates</th></tr>
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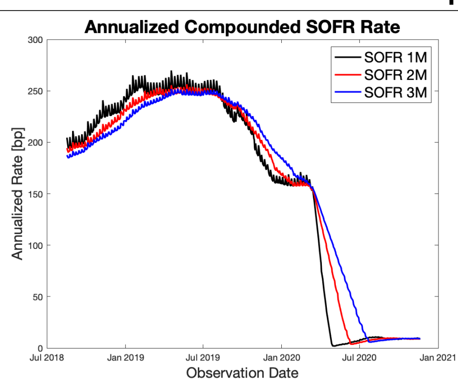
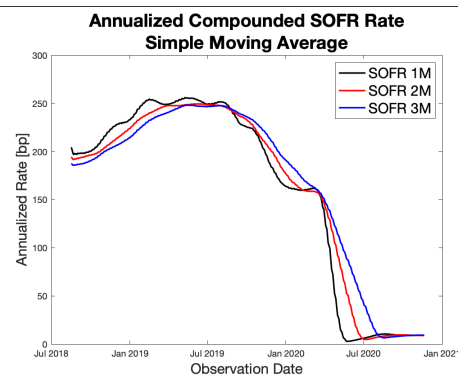
<td>

Compounded SOFR for reference period tenors 1-month, 2-month, 3-month</td>
<td>

Compounded SOFR for reference period tenors 1-month, 2-month, 3-month, moving average.</td>
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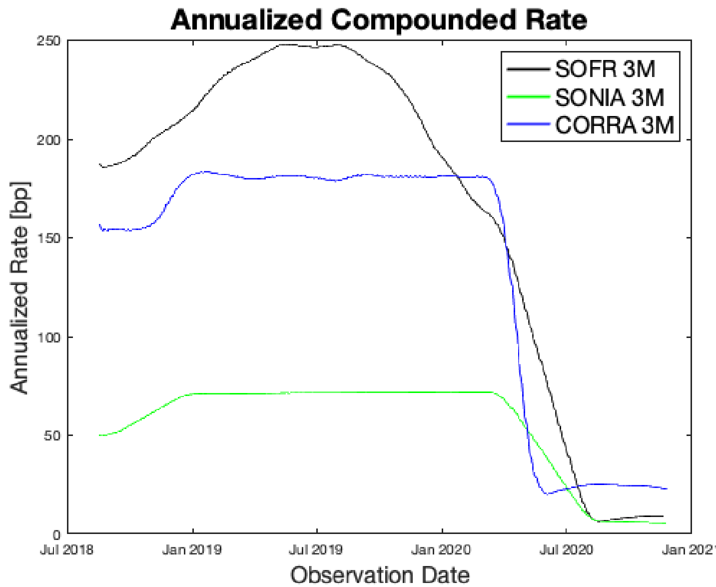

Figure 3: Annualized simple moving average compounded three-month RFR's . Moving window contains 20 observations of daily compounded rates.