Estimating a Quarterly Output Gap*

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1 Motivation

Although the potential GDP has gained somewhat of a disputed position, it has still an important place in theoretical concepts such as the Taylor rule. However, what I can tell, there are no (openly) accessible output gap time series for a higher frequency then annually for many countries, including Germany.[1] This means, that for estimating a sub-annual Taylor rule without going through the process of estimating an own potential output model, one has to find alternatives. Two obvious possibilities are to find a proxy for porential output which is available with a higher frequency or to interpolate

2 Data

The analysis is carried out for Germany, for the years 1991-2024.

2.1 Time-Series

The yearly time series for the potential output is obtained from AMECO.[2] The quarterly time series for the real German GDP is obtained from DESTATIS.[3] Both of the time series are measured in 2015 Mrd. EUR, the quarterly real output data is seasonally adjusted.[4]

2.2 Interpolation

Why is not the output gap data directly interpolated? As the output gap is a non-stochastic function of potential GDP and real GDP, it is also possible to just interpolate the annual potential GDP time series. This way, the additional data from the quaterly real GDP data is not lost. As potential GDP is by construction a lot less prone to fluctuation, interpolating potential GDP should also be generally a lot less costly then interpolating the output gap or real GDP. Of course, for this to work it is crucial that the annual potential GDP estimation and the quarterly real GDP estimation follow similar guidelines. To gain an indication whether this is the case, the annual real GDP time series of AMECO (which should follow the same rules as their potential GDP time series) is compared to the sum of the quarterly real GDP data from DESTATIS, to gain an understanding, whether there could be a systematic deviation between the two time series. For this, a R^2-style measure is used, which gives the percentage of variance of the yearly AMECO time series by using the sum of the quaterly time series from DESTATIS. This measure is found to be >0.9984, indicating that the two time series have compatible measures of GDP.

Now, to interpolate the yearly output data to a quarterly time series. Simple transformation methods would include to divide the yearly data by four or use a linear trend within each year, thereby distributing the yearly growth of potential GDP equally over all four quarters.

*The GitHub, including data and code, can be found at: https://github.com/timjasch/Quaterly-Output-Gap.

[1] There is however, quaterly data for the US available: https://fred.stlouisfed.org/series/GDPPOT.

[2] https://economy-finance.ec.europa.eu/economic-research-and-databases/economic-databases/ameco-database/download-annual-data-set-macro-economic-database-ameco_en#gross-domestic-product-income-approach-labour-costs

[3] Available at: https://www-genesis.destatis.de/genesis/online?operation=result&code=81000-0002&deep=true#abreadcrumb.

[4] The seasonal adjustment is via the 'X13 JDemetra+' directly by DESTATIS.

However, in the following the Denton-Cholette-method in a univariate context is utilised. For this, the R-implementation of the R-package ‘tempdisagg’ by Christoph Sax and Peter Steiner is used.[5]

The analysis could also make use of a second, higher frequency time series as an indicator.[6] An obvious candidate for this would be to make use of the quarterly real GDP series, as real GDP and potential GDP have an obvious, large correlation for higher time horizons. However, interpolating in this fashion would lead to the quaterly potential GDP would mimic the fluctuations of the real GDP time series very closely, resulting in a time series which seems way to volatile, to be a sensible measure of potential output.

Also, my intuition leads me to think that by using the real GDP time series, the output gap estimate later on should carry a negative bias. As the quarterly potential GDP makes use of the real GDP time series by correcting it its direction, the gap between the quarterly real GDP and the interpolated quarterly potential GDP time series would be artificially small.

Therefore, an univariate interpolation of potential GDP from annual to quarterly data is carried with the constraint, that the sum of the interpolated quarterly data matches the annual of AMECO for the corresponding year. The resulting time series is depicted in Figure 1 and available on GitHub.

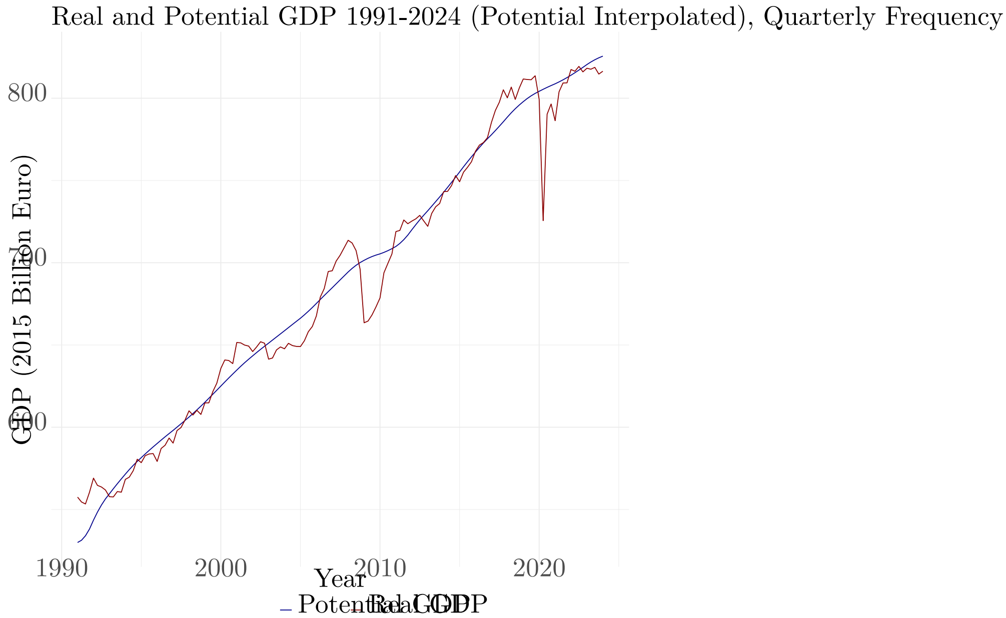


Figure 1: Caption for the SVG plot

3 Output Gap

Now that the potential and the real output data is in a quarterly frequency The data for the quarterly output gap is calculated as follows:

$$Output\ Gap = (GDP_{Real} - GDP_{Potential})/GDP_{Potential}$$

This is conducted for data from 1991Q1–2024Q1, resulting in 133 observations.

3.1 Results

The average output gap is –0.032%, which seems plausible.

[5] https://journal.r-project.org/archive/2013-2/sax-steiner.pdf

[6] There is a example for an analysis such as that in Sax & Steiner (2013).

3.2 Comparison to the AMECO output gap

A comparison of the constructed quarterly output gap to the yearly output gap is depicted in Figure 2

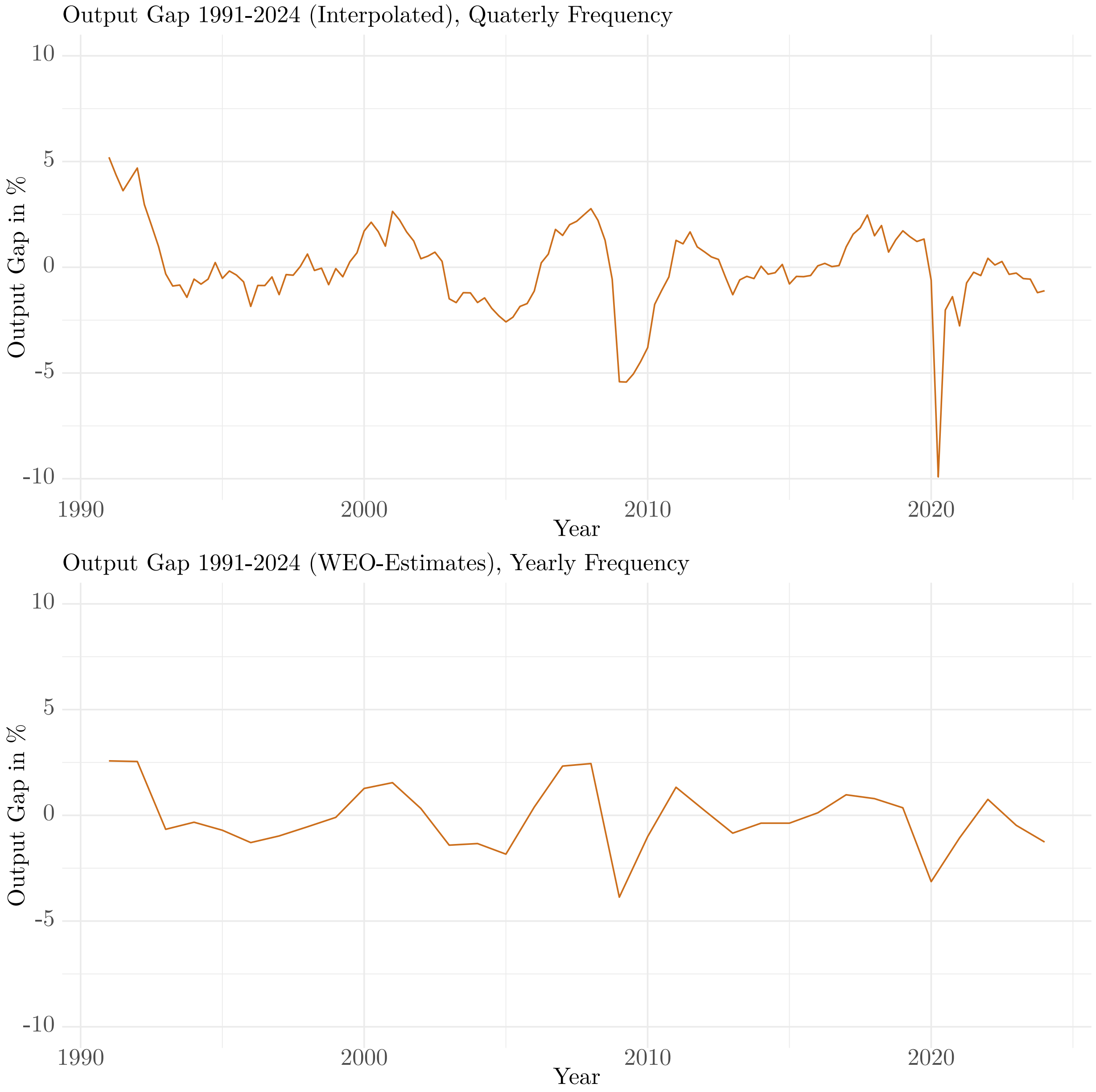
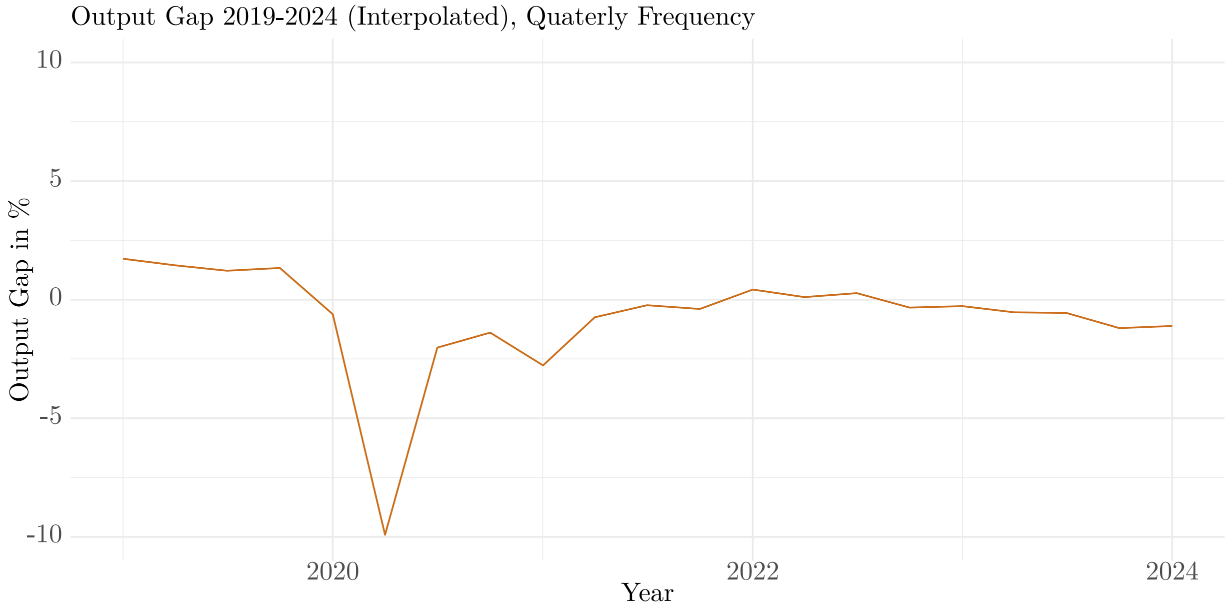
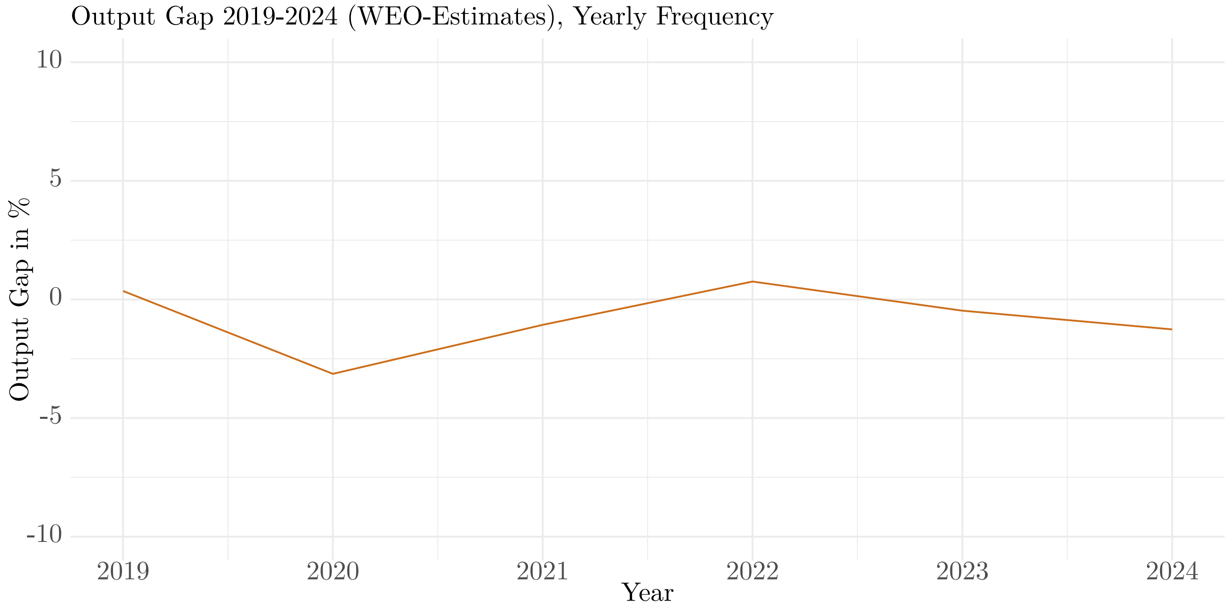


Figure 2: Caption describing the content of the combined plot.





4 Taylor Rate

The Taylor Rule is calculated by the following equation:

$$taylor\_rate = 0 + 1.5 * (pi\_yoy - 2) + 0.5 * output\_gap$$

Where for the output gap, the interpolated quarterly time series from the previous section is used. Notably, the 'natural interest rate' is set equal to 0, with standard coefficients 1.5 and 0.5 for the inflation and output gap control. As the used inflation rate is measured monthly, so the frequency of the resulting Taylor Rule is.

Additionally, as an alternative measure, a interest rule solely based on the inflation rate is measured, by simple taking the difference of the current yoy-inflation rate and the ECB target of a 2% inflation level.

$$pi\_overshoot = pi - yoy - 2$$

Figure 3 shows the Taylor Rate implied Interest Rate, from the first quarter of 2019 until the first quarter of 2024.

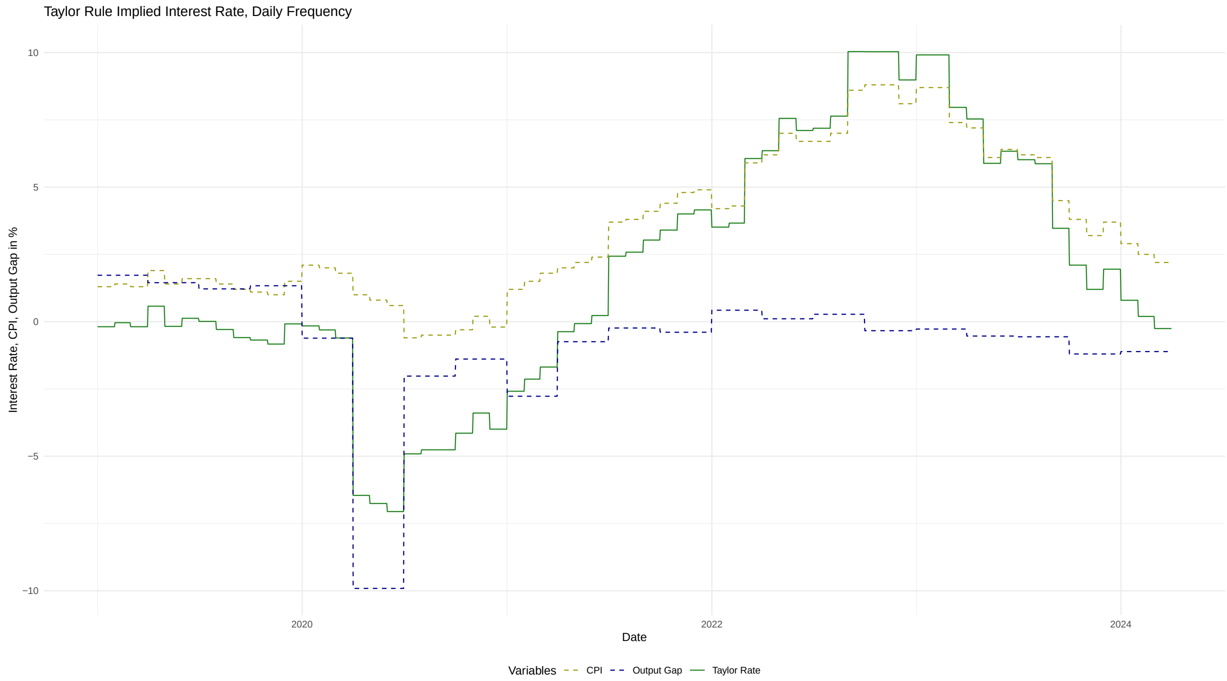


Figure 3

Further, Figure 4 shows the movement of four interest rates: The implied Taylor Rate and the Inflation Overshoot Rate, as well as the actual set Deposit and Fixed Interest Rate by the ECB.

Finally, Figure 5 reveals the difference between the ECB set deposit rate and the implied Taylor Rate.

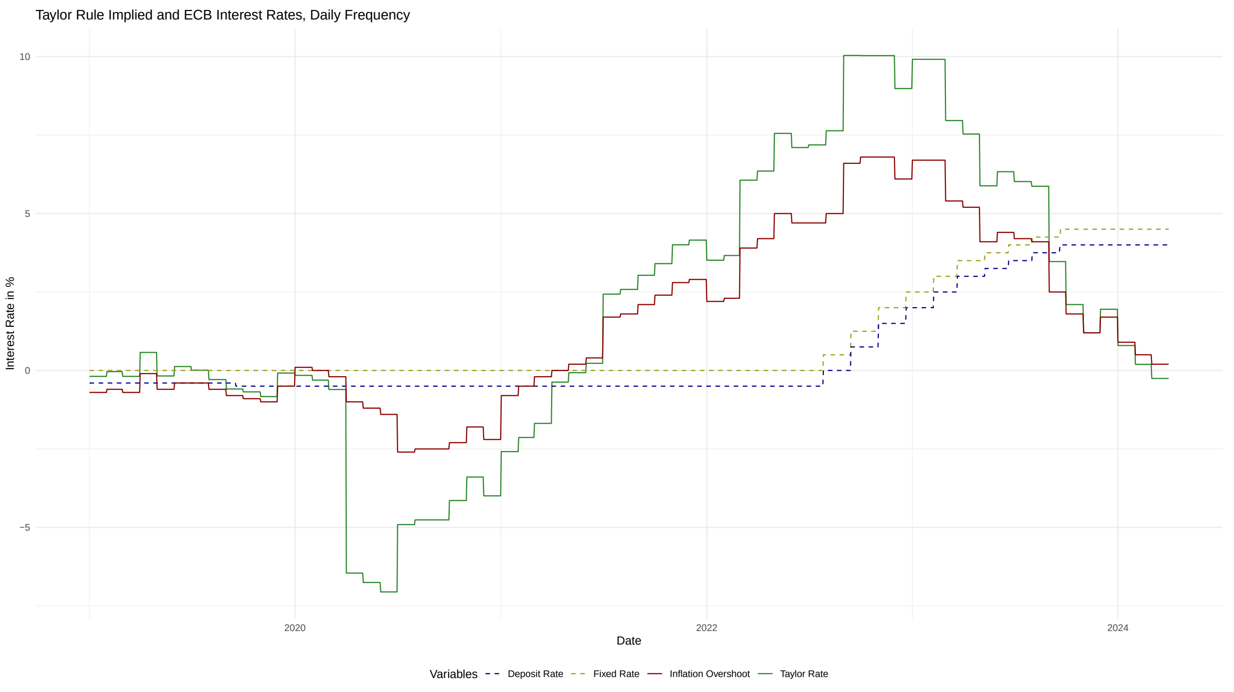


Figure 4

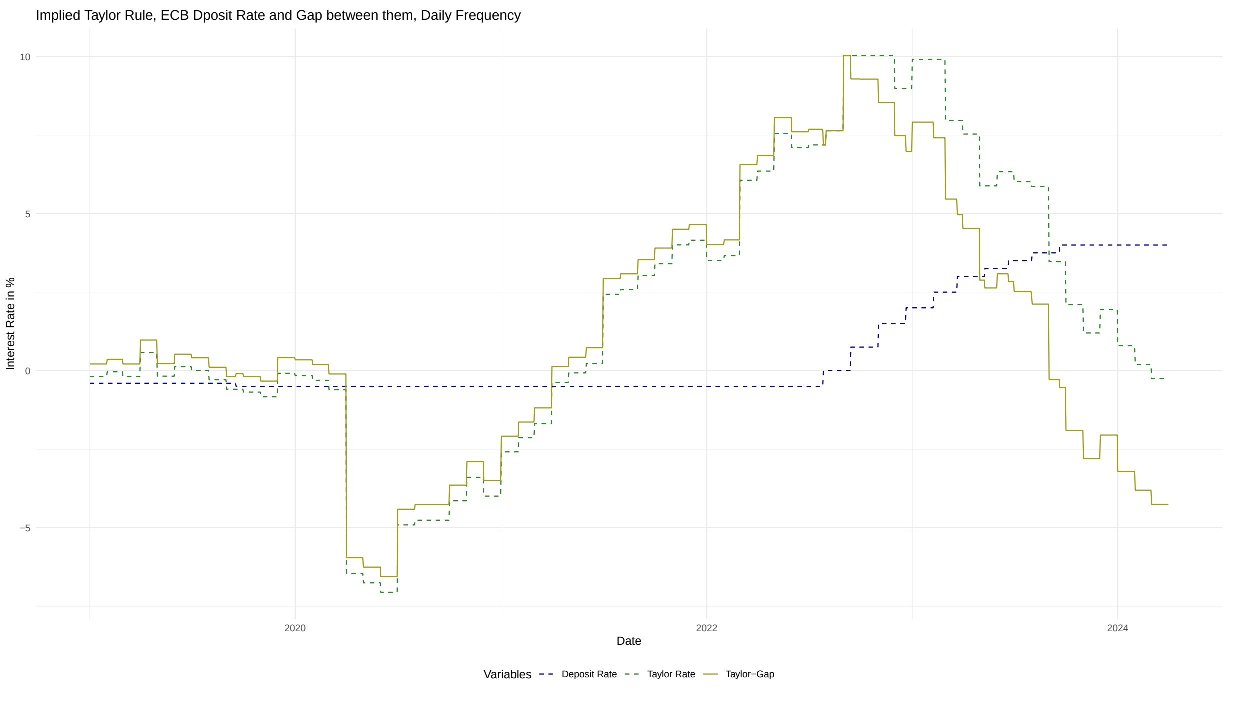


Figure 5