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by Christopher Bülte and Rebekka Buse

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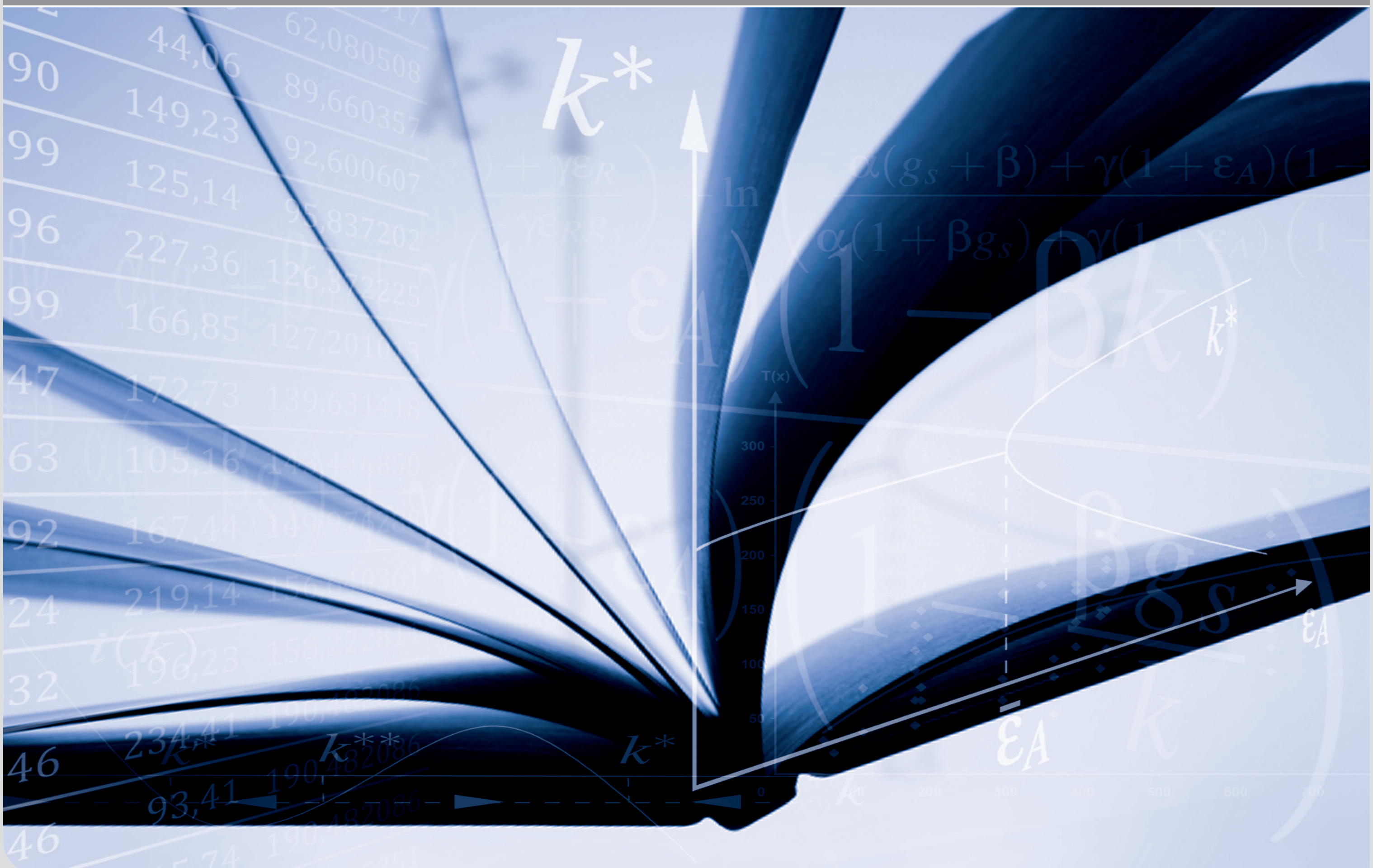

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Disentangling the economic effects of Brexit and COVID-19 in the UK

Christopher Bülte[a], Rebekka Buse[b,c]

[a] *Mathematisches Institut Ludwig- Maximilians- Universitt Mnchen*
[b] *Institute of Statistics, Karlsruhe Institute of Technology (KIT), Blücherstr. 17, Karlsruhe, 76185, Germany*
[c] *Corresponding author, rebekka.buse@kit.edu*
[d] *The authors gratefully acknowledge support by the Helhomltz Association grant COCAP (KA1-Co-10).*

Abstract

We quantify the economic costs in the UK since the Brexit referendum and discern them from the effects of the COVID-19 pandemic. The simultaneous effects of COVID-19 and Brexit are disentangled by evaluating pandemic-related indices relative to economic losses. These losses are measured with a synthetic control method, allowing for a causal interpretation of Brexit. We demonstrate that the UK has suffered exceptionally during the pandemic and that these additional losses are attributed to the long-term economic effects of Brexit.

Keywords: Brexit, COVID-19, Economic effects, Synthetic controls
JEL: H0-General, I1-Health

1. Introduction

While the United Kingdom (UK) has suffered economically in the past years, it remains unclear to which extent these losses can be attributed to the decision to leave the European Union (EU) or rather the worldwide COVID-19 pandemic. So far, there has been separate research on the economic effect of COVID-19 (Keogh-Brown et al., 2020) or Brexit (Born et al., 2019), respectively. In our empirical study, we quantify and disentangle the effects of COVID-19 and Brexit on the UK economy. This task is not trivial, because the time period of Brexit overlaps with that of the COVID-19 pandemic. The sequence of events concerning Brexit began with the referendum in June 2016 and ended with the new EU-UK Trade and Cooperation Agreement taking effect in May 2021. The overlap of Brexit and the pandemic begins in January 2020, when the UK officially left the EU and simultaneously COVID-19 was declared a public health emergency by the WHO.

We measure the economic loss since the Brexit referendum and throughout the pandemic using the synthetic control method (SCM) (Abadie, 2021). This method constructs a so-called Doppelganger of the UK gross domestic product (GDP), which allows comparing the actual GDP in the UK to that of a no-Brexit scenario and thus quantifying the causal economic effect. Then, we discern the impact of COVID-19 on the economy by evaluating two additional pandemic-related indices developed by Hale et al. (2021) and Bell and Nuzzo (2021) respectively. By putting these indices into relation with the economic development, we find that the additional economic loss in the UK during the pandemic compared to its Doppelganger is attributed to Brexit and not to the effects of COVID-19.

Limited literature is available on the economic impacts of the pandemic. Our study is related to Keogh-Brown et al. (2020) who use a macroeconomic model to estimate the effect of COVID-19 on the UK GDP but do not consider Brexit. Worldwide economic forecasts during the pandemic were given by United Nations (2020). Unlike our research question, most papers on COVID-19 study the effect of containment policies on the number of infections or mortality (see, e.g. Kosfeld et al., 2021; Ferguson et al., 2020). We fill a gap by linking pandemic-related policy measures to economic outcome and find that the comparatively low economic performance in the UK cannot be attributed to stronger pandemic-related restrictions.

Our research contributes to a study by Born et al. (2019), who use the SCM to study the short-term effect of Brexit on UK GDP. There is further literature on the Brexit effect, both with or without using the SCM, without taking into account COVID-19. In contrast to all existing studies on the impact of Brexit, we are the first to analyze the economic development over a mid- and long-term horizon and dissecting them from the COVID-19 pandemic.

2. Empirical setting and strategy

In order to quantify the economic losses in the UK, we use the synthetic control approach (Abadie et al., 2010). This method creates a Doppelganger that is a weighted combination of real GDP from 29 countries (OECD, 2022)[1] that behaves as similarly as possible to UK GDP in the case of no Brexit. As predictors for estimating the Doppelganger we use all lags of quarterly GDP from 1998Q1 until the Brexit referendum in 2016Q2, as well as seven additional covariates as standard in the literature (Abadie et al., 2010; Born et al., 2019), which are included as ten-year means: labor force, employment, consumption per GDP, investment per GDP, net exports per GDP, labor productivity growth and population growth.

Formally, we define $\mathbf{x}_1$ the (81×1) vector of predictors for the UK and $\mathbf{X_0}$ the corresponding (81×29) matrix for all other countries. Then, the optimal unit weights $\mathbf{w}^*$ are obtained by:

$$\mathbf{w}^* := \arg\min_{\mathbf{w}} (\mathbf{x}_1 - \mathbf{X}_0\mathbf{w})^\top \mathbf{V} (\mathbf{x_1} - \mathbf{X_0}\mathbf{w}),$$

subject to $w_j \geq 0 \; j = 2, \ldots 30$ and $\sum_{j=2}^{30} w_j = 1$. Here, $\mathbf{V} \in \mathbb{R}^{81 \times 81}$ is a diagonal positive semi-definite matrix.

The resulting estimator for our setting is robust with respect to the intervention date and to two alternative Doppelganger estimates. We also validate the SCM results with two further macroeconomic variables. All robustness checks can be found in the Online Appendix.

Figure 1 shows the estimated Doppelganger of the UK GDP as compared to the actual GDP development, with relevant dates highlighted. Evidently, there is a sharp decline at the second date marking the outbreak of the COVID-19 pandemic which is simultaneous to the UK's official exit of the EU. However, this drop is more pronounced in the actual UK GDP than predicted by its Doppelganger scenario. Even though the GDP recovers about half a year later, the UK economy stagnates and the gap grows to -10.8% in 2022Q1, suggesting a lasting effect of Brexit. The two trajectories already start to diverge after the Brexit decision in 2016, with a difference of -3.1% by the end of 2019. Therefore, in the following, we evaluate in how far the economic losses since 2020 should be attributed to Brexit or COVID-19.

3. Disentangling Brexit and COVID

For disentangling the negative effects of Brexit and COVID-19, two additional indices are used. First, we compare the Global Health Security (GHS)

[1] Due to data availability, not all 38 OECD members can be used.

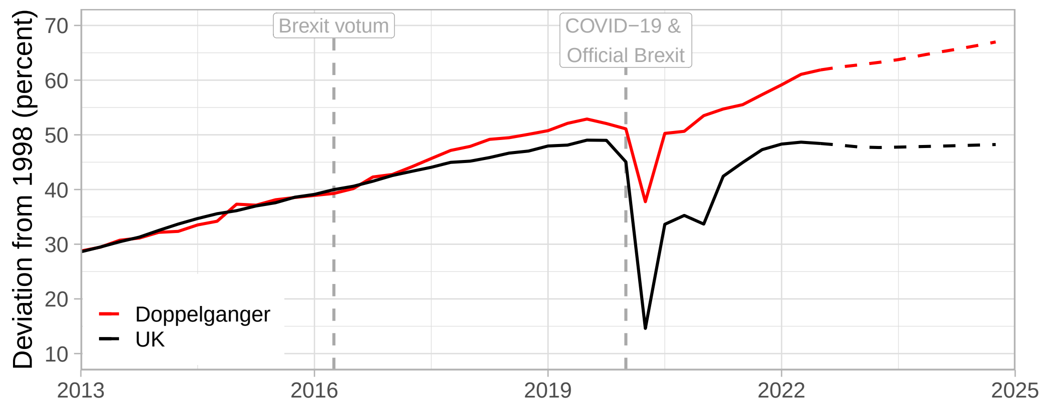

Figure 1: The figure shows the development of the British GDP in percentage deviation from 1998, including OECD forecasts (dashed lines). The vertical line marked Brexit votum is set at 2016Q2 and the line marked COVID-19 & official Brexit at 2020Q1. For improved graphical representation, only data from 2013 onwards is shown.

index (Bell and Nuzzo, 2021), which consists of different measures of policy, security and socioeconomic factors used to assess health security. The descriptive analysis of the GHS index shows that the UK has received remarkably good scores and ranks highly in relation to other countries (6th (3rd) out of all (European) countries in 2019). These favorable conditions suggest that the UK was prepared extraordinarily well and should not have been struck worse by the pandemic than its counterfactual, which is contradictory to the observation in Figure 1. Thus, the economic losses since 2020 cannot be explained by COVID-19 alone, indicating an effect of Brexit.

Second, we use the government response index (GRI) from Hale et al. (2021), which is a point-based index that contains information on governmental measures taken in response to the pandemic, e.g. containment-, economic- or vaccine-related policies. We are interested in how the pandemic-related policies, measured by the GRI, might be associated with the economic loss of the UK. The economic loss is measured by taking the difference between the SCM estimate and the observed GDP, which we define as the SCM error.

Figure 2 shows the SCM error in relation to the GRI for all countries and for all twelve timesteps after the beginning of the pandemic in 2020Q1, with the UK observations marked in red. While the majority of SCM errors ranges between −10 and 10 percentage points, we observe a few points to be considerably lower, several of which represent the UK. This illustrates that

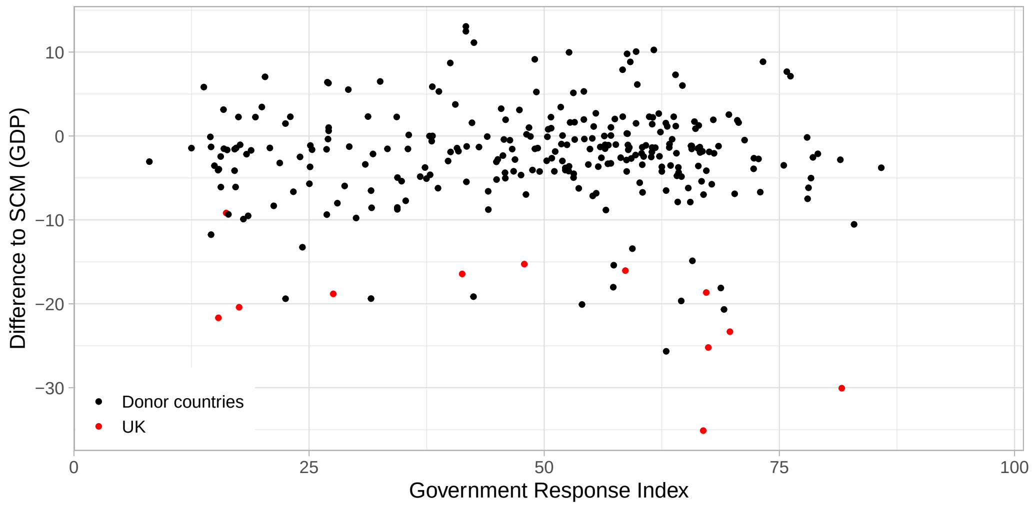

Figure 2: Scatterplot of the difference between the estimated and the observed GDP and the corresponding GRI, for all countries.

while the pandemic-related restrictions in the UK are comparable to those in other countries, the observed GDP strongly deviates from the SCM estimate. Taking the simplifying assumption that time dependency is negligible, a simple regression can be performed to confirm the relative distance of the UK SCM errors:

$$Y_{i,t} = \beta_0 + \beta_1 \times \mathrm{GRI}_{i,t} + \beta_2 \times D_i + \varepsilon_{i,t}, \quad D_i = \begin{cases} 1, & i = \mathrm{UK} \\ 0, & \mathrm{else} \end{cases} \tag{1}$$

where $Y_{i,t}$ is the difference in the trajectories and $\varepsilon_{i,t}$ is a random noise term. This regression leads to a highly significant coefficient β_2 (see Table 1), indicating that the UK doppelganger heavily deviates compared to the non-intervention countries.

Together with the SCM results in Section 2, the analysis of these two pandemic-related indices suggests that Brexit has had lasting effects throughout the pandemic leading to additional economic losses compared to other countries.

4. Conclusion

Our analysis of the recent development of the UK economy shows that the effects of Brexit are still visible throughout the COVID-19 pandemic.

Coefficient	Estimate	Std. error	p-value
β_0	-1.766	0.988	0.075
β_1	-0.007	0.019	0.722
β_2	-18.756	1.685	<2e-16

Table 1: The table shows the results for the regression using the GRI index, as described in Equation 1.

While Britain was clearly affected by the pandemic, our results suggest that the significantly larger economic losses in the UK compared to other countries since 2020 must be attributed to Brexit. Using a robust counterfactual estimator based on the synthetic control method, the average quarterly loss in UK GDP can be quantified to 3.3 billion pounds (-2.2%) in the period until COVID-19 (2016Q3-2019Q4) and 20.9 billion pounds (-13.9%) in the period thereafter (2020Q1 - 2022Q1).By comparing additional measures of pandemic impact and government policies, the results verify that Brexit is still significant through the times of the pandemic. Examining this scenario leads to the conclusion that increasing nationalism by exiting trade unions or other agreements has a long-lasting negative effect on a country's economic performance. This is an important lesson for governments that struggle to secure welfare during times of crises where it is challenging to keep an overview of negative effects and adapt policies appropriately.

References

Abadie, A., 2021. Using synthetic controls: Feasibility, data requirements, and methodological aspects. Journal of Economic Literature 59, 391–425.

Abadie, A., Diamond, A., Hainmueller, J., 2010. Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California's Tobacco Control Program. Journal of the American Statistical Association 105, 493–505.

Arkhangelsky, D., Athey, S., Hirshberg, D.A., Imbens, G.W., Wager, S., 2021. Synthetic Difference-in-Differences. American Economic Review 111, 4088–4118.

Bell, J.A., Nuzzo, J.B., 2021. Global Health Security Index: Advancing Collective Action and Accountability Amid Global Crisis. Technical Report.

Born, B., Mueller, G., Schularick, M., Sedláček, P., 2019. The costs of economic nationalism: Evidence from the brexit experiment. The Economic Journal 129, 2722–2744.

Chernozhukov, V., Wüthrich, K., Zhu, Y., 2021. An Exact and Robust Conformal Inference Method for Counterfactual and Synthetic Controls. Journal of the American Statistical Association 116, 1849–1864.

Ferguson, N., et al., 2020. Impact of non-pharmaceutical interventions (NPIs) to reduce COVID-19 mortality and healthcare demand.

Firpo, S., Possebom, V., 2018. Synthetic Control Method: Inference, Sensitivity Analysis and Confidence Sets. Journal of Causal Inference 6.

Hale, T., et al., 2021. A global panel database of pandemic policies (Oxford COVID-19 Government Response Tracker). Nature Human Behaviour 5, 529–538.

Kaul, A., Klößner, S., Pfeifer, G., Schieler, M., 2015. Synthetic Control Methods: Never Use All Pre-Intervention Outcomes Together With Covariates. MPRA Paper 83790. University Library of Munich, Germany.

Keogh-Brown, M.R., Jensen, H.T., Edmunds, W.J., Smith, R.D., 2020. The impact of Covid-19, associated behaviours and policies on the UK economy:

A computable general equilibrium model. SSM - Population Health 12, 100651.

Kosfeld, R., Mitze, T., Rode, J., Wälde, K., 2021. The Covid-19 containment effects of public health measures: A spatial difference-in-differences approach. Journal of Regional Science 61, 799–825.

OECD, 2022. Economic outlook no 111 - june 2022. URL: https://stats.oecd.org/Index.aspx?DataSetCode=EO.

United Nations, 2020. World Economic Situation and Prospects as of mid-2020. Technical Report. United Nations. New York.

Appendix A. Robustness and validation of doppelganger

This Appendix covers various robustness checks for the estimation of the doppelganger as well as a validation of the treatment effect.

The robustness of the Doppelganger construction is shown by first comparing the employed Doppelganger to two alternative Doppelgangers. The first alternative Doppelganger uses the same covariates, but only half of the pre-treatment lags of GDP (Kaul et al., 2015). The third Doppelganger is based on the synthetic difference in differences estimator (Arkhangelsky et al., 2021). While the country weightings for the alternative Doppelgangers vary substantially (see Table A.2, the resulting estimators obtain a very similar trajectory for the GDP development (see left plot in Figure A.3).

Country	**Estimator 1**	**Estimator 2**	**Synthetic DID**
Japan	0.313	0.429	0.115
Canada	0.292	0.441	0.069
Denmark	0.138	0	0.085
New Zealand	0.103	0	0.057
Ireland	0.066	0.057	0.065
Italy	0.056	0	0.082
Greece	0.025	0.040	0
Estonia	0.005	0	0
Luxembourg	0.001	0	0
Spain	0	0.017	0
Germany	0	0	0.076
USA	0	0	0.069
France	0	0	0.063
Norway	0	0	0.062
Portugal	0	0	0.053
Belgium	0	0	0.039
Austria	0	0	0.031
Sweden	0	0	0.030
Switzerland	0	0	0.027

Table A.2: Country weights for the different estimators. Only countries with nonzero weights are shown in the table.

Next, the validity of the Doppelgangers is confirmed by using them to replicate other characteristics, namely the unemployment rate and the short-term interest rate. As can be seen in Figure A.4 the dynamics of both validation series is well represented by all three Doppelgangers.

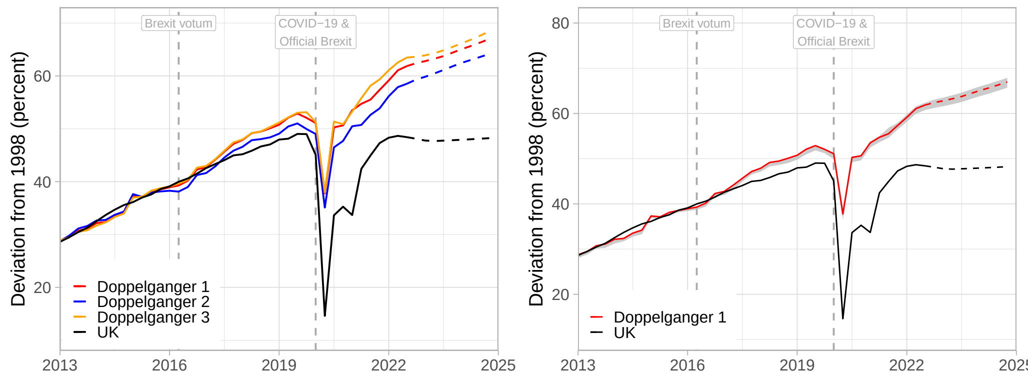

Figure A.3: The figure shows the trajectories for the alternatively estimated Doppelgangers (left) and the originally estimated Doppelganger in comparison to backdated estimators (right), where the grey area corresponds to the range of their values.

We show that our estimator is robust to the timing of the intervention date using backdating (Abadie, 2021) for all quarters between 2013Q2 and 2016Q2. As illustrated in the right panel of Figure A.3,the estimators of backdated Doppelgangers closely replicate the original trajectory until 2016Q4 with a significant deviation occurring around 2017, indicating the presence of a treatment effect.

Verifying the significance of the treatment effect requires proper statistical evaluation. For this purpose, Abadie et al. (2010) propose permutation studies which are based on treating each unit as if it had received treatment, resulting in a "placebo effect". Similarly, Chernozhukov et al. (2021) propose an inference method then uses permutations across the time series domain. For both approaches a null hypothesis of no treatment effect can be tested (Firpo and Possebom, 2018). Table A.3 summarizes the results for both significance tests, showing small p-values for both approaches and thus confirming the significance of the treatment effect.

	SCM 1	SCM 2	Synthetic DID
Placebo studies	0.0345	0.0345	0.0345
Permutation tests	0.0093	0.1481	0.0185

Table A.3: The table shows the p-values corresponding to the null hypothesis that no treatment effect is present in the post-treatment period for all three Doppelganger estimators.

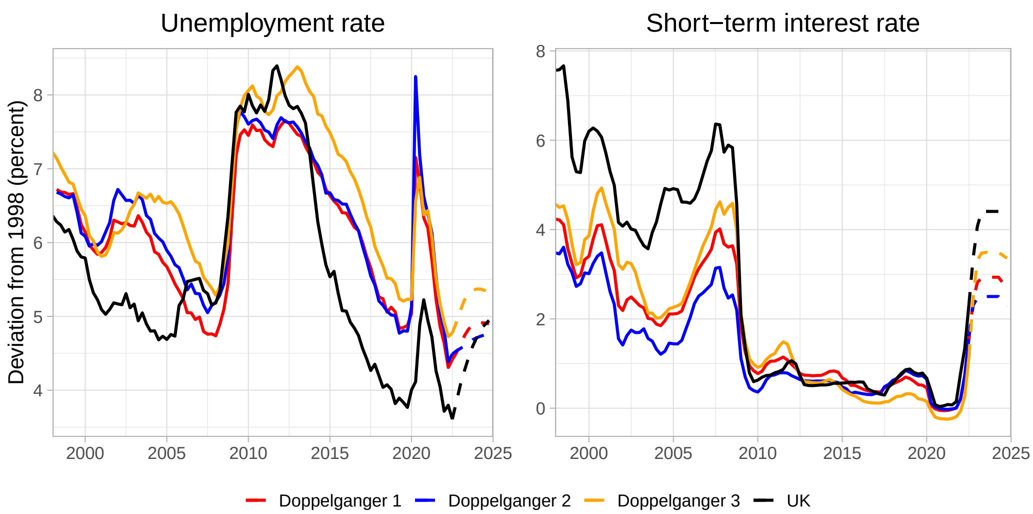

Figure A.4: The figure shows the three different Doppelgangers and the actual development of the validation timeseries.

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