Unemployment fluctuations and currency returns in the United Kingdom: Evidence from over one and a half century of data

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Online Appendix

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A1 Introduction

The data for the expected exchange rate movements and the unemployment growth rate, which are displayed in Figure 1, suggest that there may be a few extreme outliers, which could potentially influence the results. To ensure that this is not the case, we have repeated the analysis after we initially consider the case where there is a single outlier in each variable, before proceeding to consider the case of several potential outliers in each variable.

A2 Removal of single outlier

For the purposes of this investigation, the most likely single outlier, is deemed to be the observation that is furthest away from the mean value of the time series. For the unemployment growth rate this observation arises in April 1947 (shortly after World War II), while for the exchange rate excess return this observation arises in November 1857 (during the Commercial Crisis of 1857). After replacing these observations with the sample mean, we display the data in Figure A1 and the results in Figures A2 – A9. These results are almost identical to the results that are provided in the paper, as their are a number of outliers

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that arise in close proximity to the single most likely outlier. Therefore, in what follows, we consider the case of multiple potential outliers.

A3 Removal of multiple outliers

The methodology of Grubbs (1950) is used to identify multiple potential outliers, which are defined as observations that are extremely far away from the sample mean of the variable. Given the nature of the data, we make use of the two-side test statistic that is applied to each of the univariate time series variables. This test statistic may be represented as:

$$G = \frac{\max_{i=1,\ldots,T} |y_i - \bar{y}|}{\sqrt{\sigma}} \tag{1}$$

where $\bar{y}$ and $\sqrt{\sigma}$ denoting the sample mean and standard deviation, respectively. Hence, this test statistic identifies the observation that is responsible for the largest absolute deviation from the sample mean in units of the sample standard deviation.

The hypothesis of no outliers is rejected at significance level α if,

$$G > \frac{T-1}{\sqrt{T}} \sqrt{\frac{t^2_{\alpha/(2T),T-2}}{T-2+t^2_{\alpha/(2T),T-2}}} \tag{2}$$

with $t^2_{\alpha/(2T),T-2}$ denoting the upper critical value of the t-distribution with $T-2$ degrees of freedom and a significance level of $\alpha/(2T)$.

In our particular case, we are interested in the identification of extreme outliers, which are replaced with the sample mean. Therefore, we make use of a recursive application of the Grubbs (1950) methodology, where after initially replace the most likely outlier before repeating the analysis to identify the most likely outlier within the remaining data. This application continues until the accompanying p-value from the test statistic is different from zero.

A3.1 Outliers in unemployment and exchange rate data

Table A1 contains the dates and the values for the multiple potential outliers that were identified in the unemployment growth rate. Note that most of these arise towards the end or immediately after the periods of World War I, the roaring twenties, and World War II.

After performing the same exercise on the data for excess returns we note that most of the extreme outliers arise during the early part of the sample, following the period of the Commercial Crisis of 1857, which is described in Hughes (1956). In addition, there is also a potential outlier that follows World War II. These results are contained in Table A2. After adjusting the data for these potential outliers we display the result in Figure A10, where the potential outliers have been replaced by an appropriate sample mean.

A4 Empirical findings

After applying the DCC-MGARCH and the rolling GARCH models to the dataset that has been adjusted for multiple potential outliers, we note that results are highly similar to what was produced when using the dataset that was not adjusted for potential outliers.

Figures A11–A13 present the results of Hong tests based on the estimated DCC-MGARCH model, where at least one of the variables is expressed in the form of lagged values. All of these results were produced with the use of the dataset that does not include the potential outliers. Figures A11 and A12 present causality results in the direction of unemployment growth and currency excess returns, respectively, while Figure A13 presents the findings for bidirectional causality. In each figure, we show the value for the Hong test statistic, while the grey lines in the background indicate the results for Granger causation, allowing us to consider the relative size of the test statistic when compared to the maximum value at each point in time. The bars below each plot indicate time points during which the test statistic is above the critical values that correspond to the 5% and 1% levels of significance.

After adjusting the data for the outliers, the findings overall indicate significant spillovers in each direction for the majority of the sample period. For example, when examining causality in the direction of unemployment growth from currency excess returns, 1,758 (1,735) are found to be above the critical value at the 5% (1%) level of significance. This is similar, although slightly lower, than what was obtained before we replaced the outliers. In addition, the findings reported in Figure A12 suggest the presence of similar causality running from unemployment to currency excess returns as well. In this case, the value of the estimated test statistics are significant on 1,860 (1,846) occasions at the 5% (1%) level of significance. Once again, this is similar, although slightly lower, than what was obtained before we replaced the outliers.

Given these results, it is not surprisingly to note that there is significant bidirectional causality during much of the sample period, where 1,912 (1,910) test statistics are above

the critical values at both the 5% and 1% levels of significance. These findings are again similar although slightly lower than what was produced when using the dataset that included potential outliers.

Finally, the results for instantaneous causation are contained in Figures A17 and A18, which tests for a causal effect of the readily available exchange rate series on unemployment. Consistent with the earlier findings, we observe 1,741 and 1,707 significant test statistics, above the 5% and 1% levels of significance respectively, for the DCC-MGARCH model, while the rolling GARCH model yields 1,740 and 1,712 test statistics that are above the 5% and 1% levels of significance, respectively.

A5 Conclusion

After removing the influence of either a single or multiple potential extreme outliers from the dataset, we note that results are consistent with what was reported without these adjustments to the dataset. In addition, while the number of test statistics which suggest that there is causation in each and both direction has reduced slightly, when making adjustments to the data for multiple potential outliers, the vast majority of these statistics confirm the original findings. It is also worth noting that it is extremely difficult to distinguish between the results of the three estimation exercises, when we consider the figures that seek to summarise the output from the respective models.

Table A1: Potential outliers in the unemployment growth rate

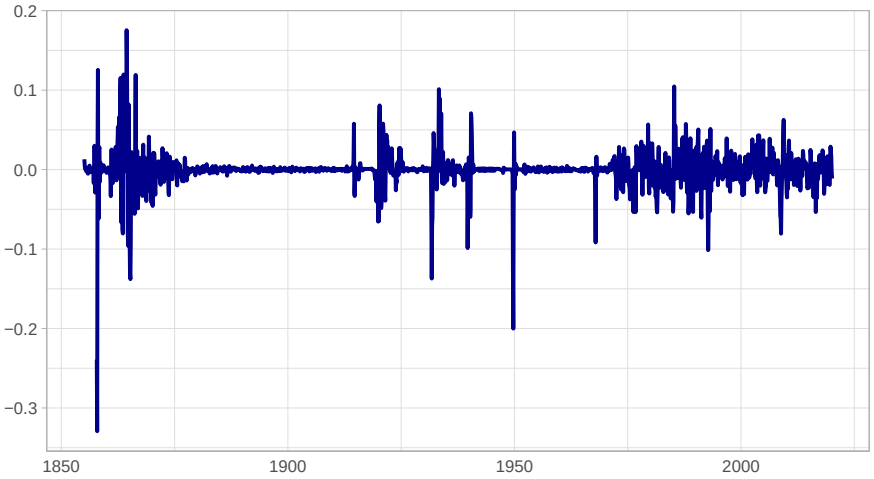
Date	Unemployment growth	p-value
1919-11-01	1.80	0
1919-12-01	3.57	0
1920-01-01	5.18	0
1920-02-01	6.12	0
1920-03-01	6.32	0
1920-04-01	6.00	0
1920-05-01	7.01	0
1920-06-01	6.09	0
1920-07-01	6.03	0
1920-08-01	4.69	0
1920-09-01	3.62	0
1920-10-01	2.56	0
1922-02-01	3.76	0
1922-03-01	6.71	0
1922-04-01	12.72	0
1922-05-01	14.58	0
1922-06-01	13.69	0
1922-07-01	9.46	0
1922-08-01	6.61	0
1922-09-01	4.06	0
1922-10-01	3.35	0
1922-11-01	3.04	0
1946-10-01	3.39	0
1946-11-01	6.17	0
1946-12-01	8.09	0
1947-01-01	17.30	0
1947-02-01	43.84	0
1947-03-01	104.51	0
1947-04-01	108.25	0
1947-05-01	52.48	0
1947-06-01	18.77	0
1947-07-01	8.21	0
1947-08-01	4.70	0
1947-09-01	2.45	0

Table A2: Potential outliers in the exchange rate excess returns

Date	Exchange rate excess returns	p-value
1857-11-01	0.65	0
1857-12-01	-0.24	0
1858-01-01	-0.33	0
1864-07-01	0.18	0
1865-05-01	-0.14	0
1949-11-01	-0.20	0

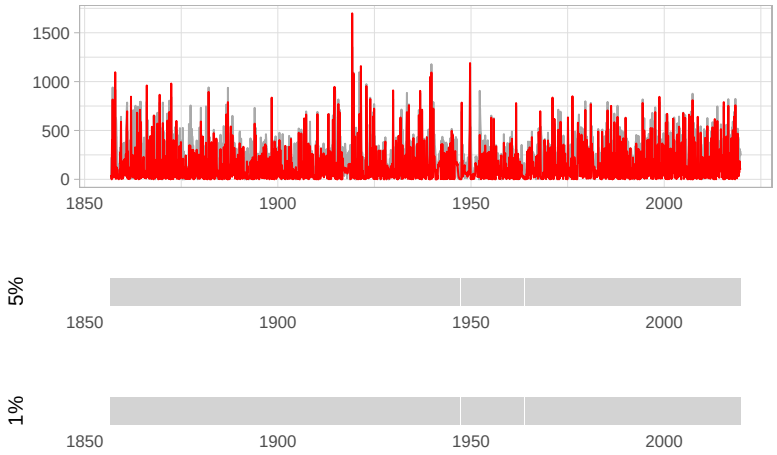
Figure A1: Monthly exchange rate and unemployment series (Single outlier)

(a) Expected exchange rate movements



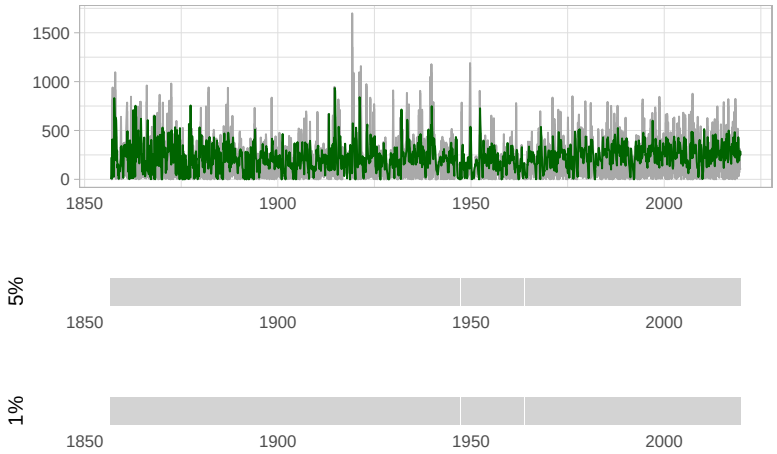
(b) Unemployment growth

Figure A2: Time varying causality from exchange rate to unemployment – *DCC-MGARCH Hong test* (Single outlier)



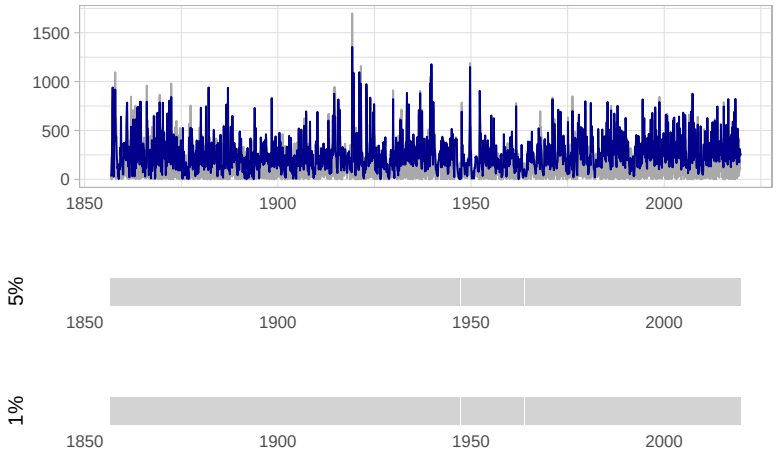
Note: The figure presents the tests statistics for causality in the direction of unemployment growth from exchange rates based on the DCC-MGARCH Hong test.

Figure A3: Time varying causality from unemployment to exchange rate – *DCC-MGARCH Hong test* (Single outlier)



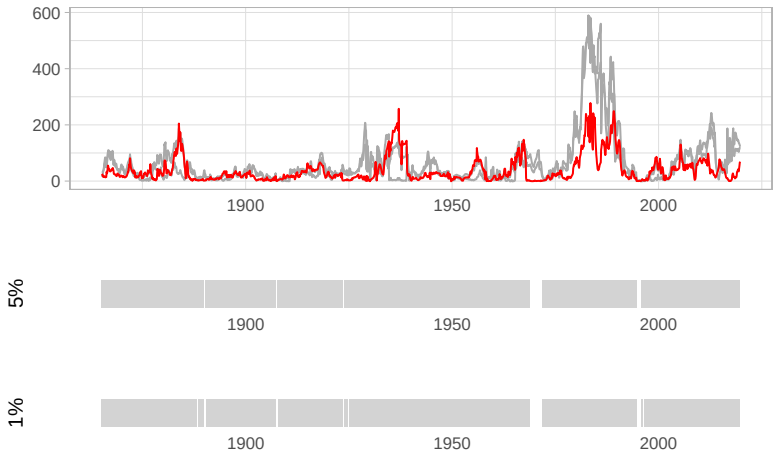
Note: The figure presents the tests statistics for causality in the direction of exchange rates from unemployment growth based on the DCC-MGARCH Hong test.

Figure A4: Time varying bidirectional Granger causality – *DCC-MGARCH Hong test* (Single outlier)



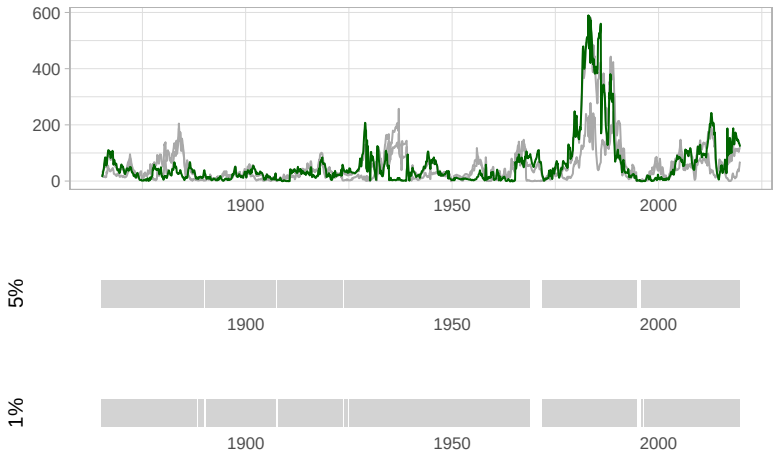
Note: The figure presents the tests statistics for bidirectional causality between exchange rates and unemployment growth based on the DCC-MGARCH Hong test.

Figure A5: Time varying causality from exchange rate to unemployment – *Rolling GARCH Hong test* (Single outlier)



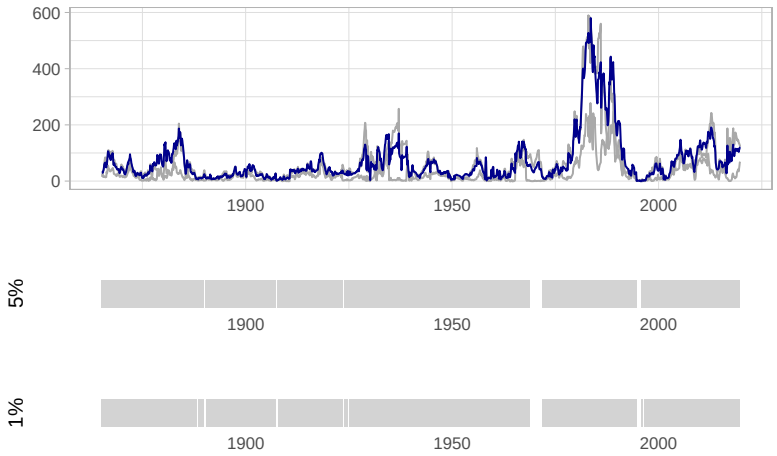
Note: The figure presents the tests statistics for causality in the direction of unemployment growth from exchange rates based on the rolling GARCH Hong test.

Figure A6: Time varying causality from unemployment to exchange rate – *Rolling GARCH Hong test* (Single outlier)



Note: The figure presents the tests statistics for causality in the direction of exchange rate from unemployment growth based on the rolling GARCH Hong test.

Figure A7: Time varying bidirectional causality between unemployment and exchange rate – *Rolling GARCH Hong test* (Single outlier)



Note: The figure presents the tests statistics for bidirectional causality between exchange rate and unemployment growth based on the rolling GARCH Hong test.

Figure A8: Instantaneous spillovers from exchange rate to unemployment – *DCC-MGARCH Hong test* (Single outlier)

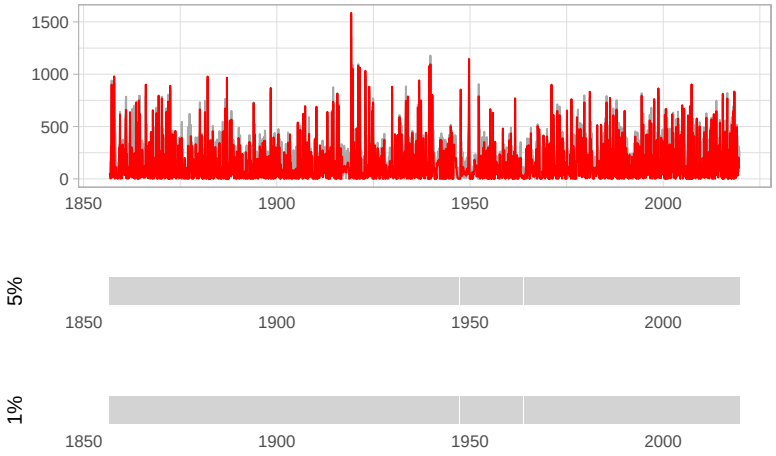


Figure A9: Instantaneous spillovers from exchange rate to unemployment – *Rolling GARCH Hong test* (Single outlier)

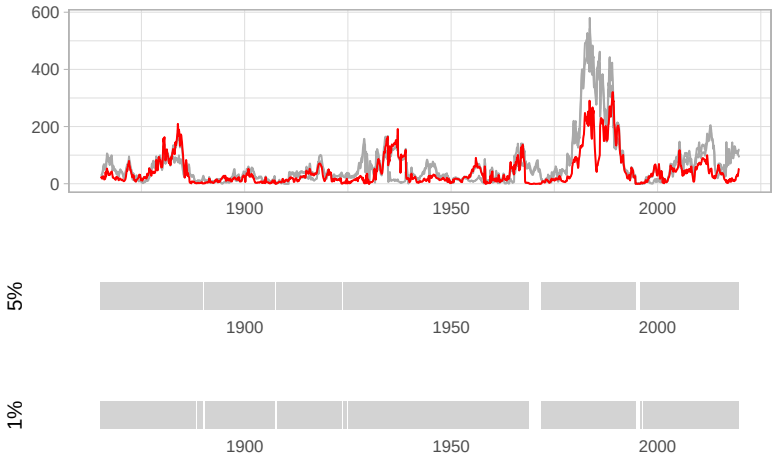
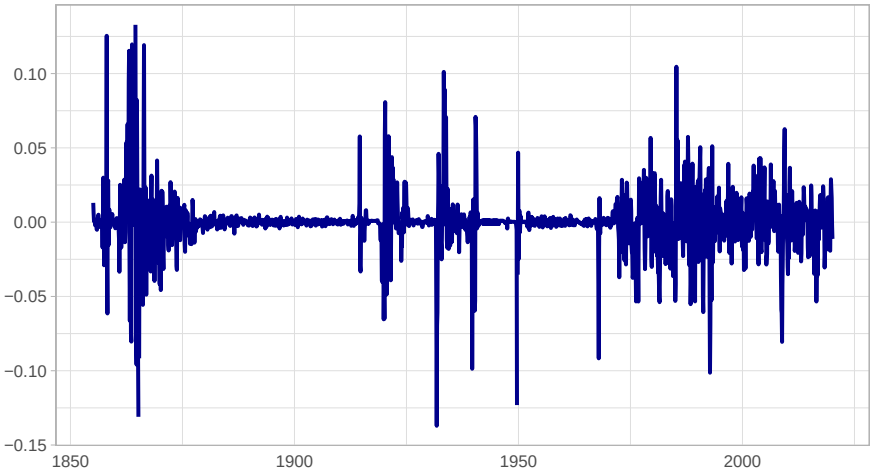


Figure A10: Monthly exchange rate and unemployment series (Multiple outliers)

(a) Expected exchange rate movements



(b) Unemployment growth

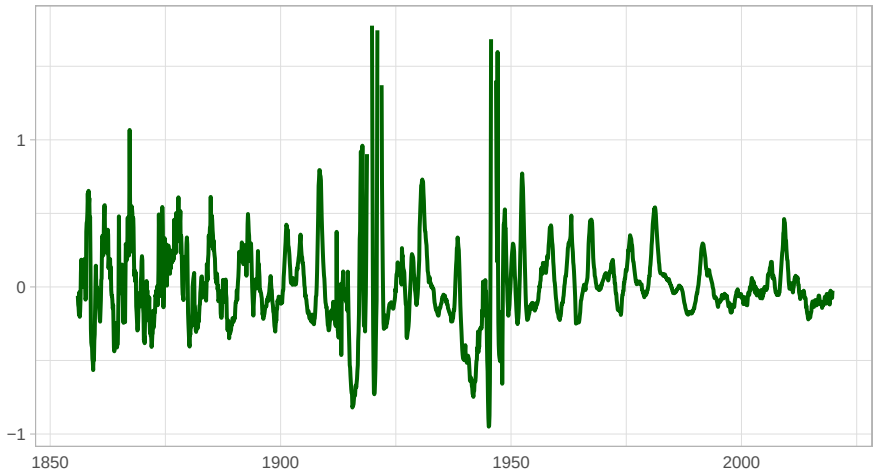
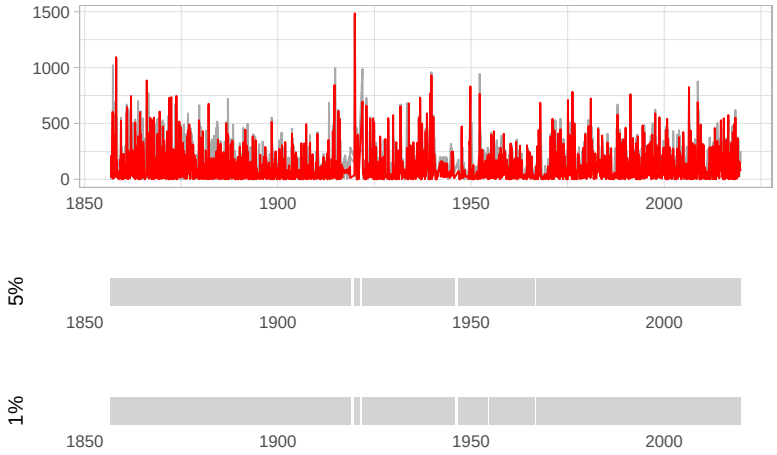
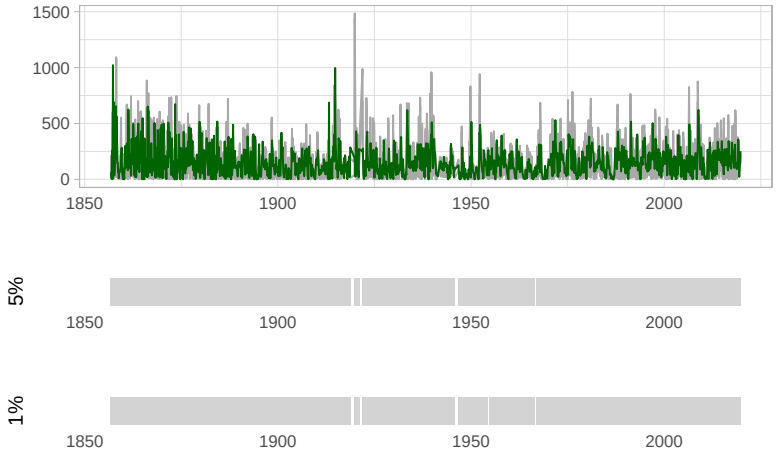


Figure A11: Time varying causality from exchange rate to unemployment – *DCC-MGARCH Hong test* (Multiple outliers)



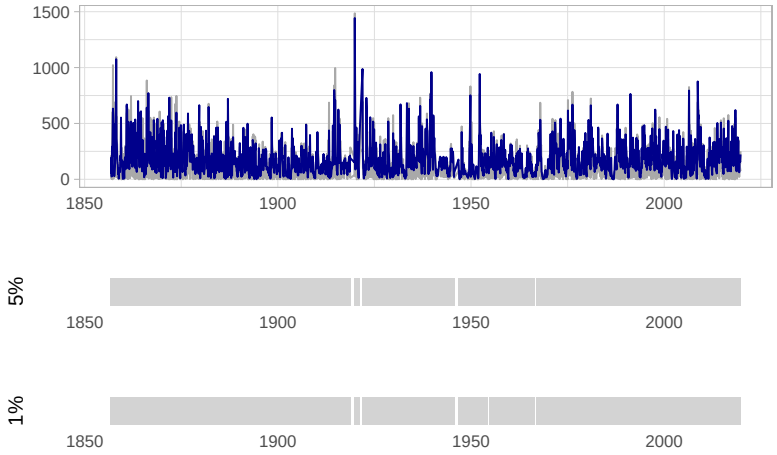
Note: The figure presents the tests statistics for causality in the direction of unemployment growth from exchange rates based on the DCC-MGARCH Hong test.

Figure A12: Time varying causality from unemployment to exchange rate – *DCC-MGARCH Hong test* (Multiple outliers)



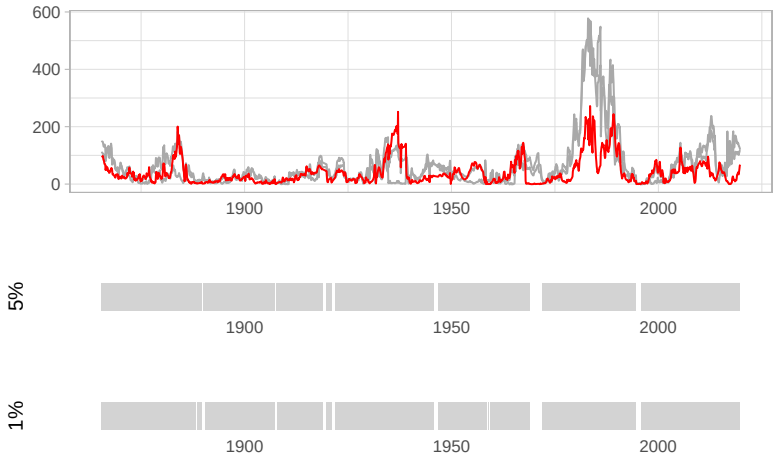
Note: The figure presents the tests statistics for causality in the direction of exchange rates from unemployment growth based on the DCC-MGARCH Hong test.

Figure A13: Time varying bidirectional Granger causality – *DCC-MGARCH Hong test* (Multiple outliers)



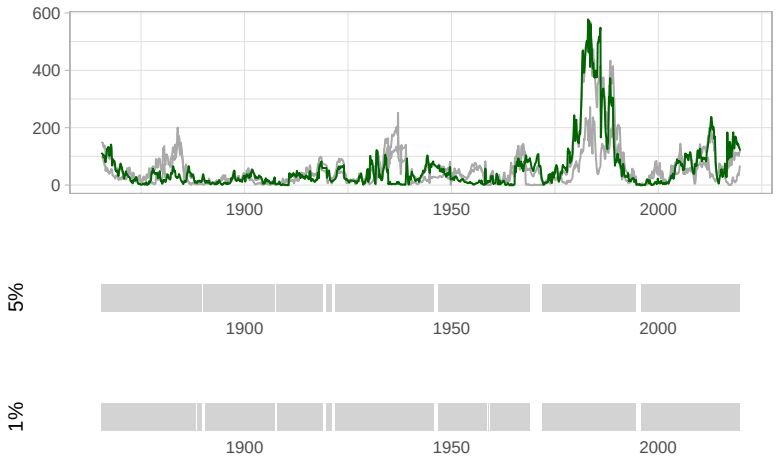
Note: The figure presents the tests statistics for bidirectional causality between exchange rates and unemployment growth based on the DCC-MGARCH Hong test.

Figure A14: Time varying causality from exchange rate to unemployment – *Rolling GARCH Hong test* (Multiple outliers)



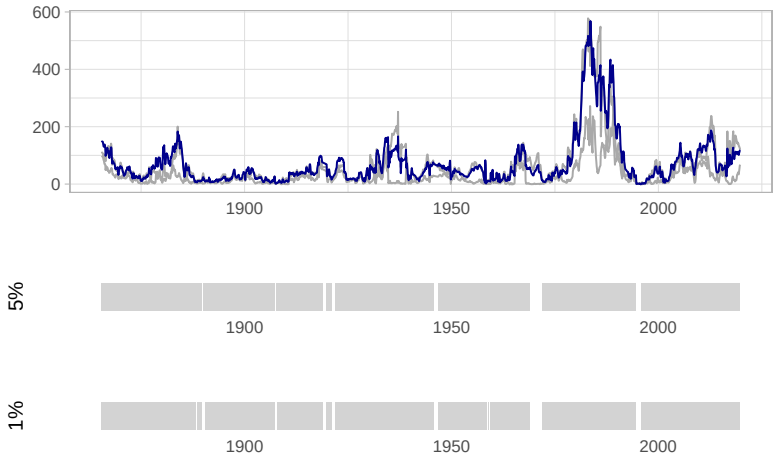
Note: The figure presents the tests statistics for causality in the direction of unemployment growth from exchange rates based on the rolling GARCH Hong test.

Figure A15: Time varying causality from unemployment to exchange rate – *Rolling GARCH Hong test* (Multiple outliers)



Note: The figure presents the tests statistics for causality in the direction of exchange rate from unemployment growth based on the rolling GARCH Hong test.

Figure A16: Time varying bidirectional causality between unemployment and exchange rate – *Rolling GARCH Hong test* (Multiple outliers)



Note: The figure presents the tests statistics for bidirectional causality between exchange rate and unemployment growth based on the rolling GARCH Hong test.

Figure A17: Instantaneous spillovers from exchange rate to unemployment – *DCC-MGARCH Hong test* (Multiple outliers)

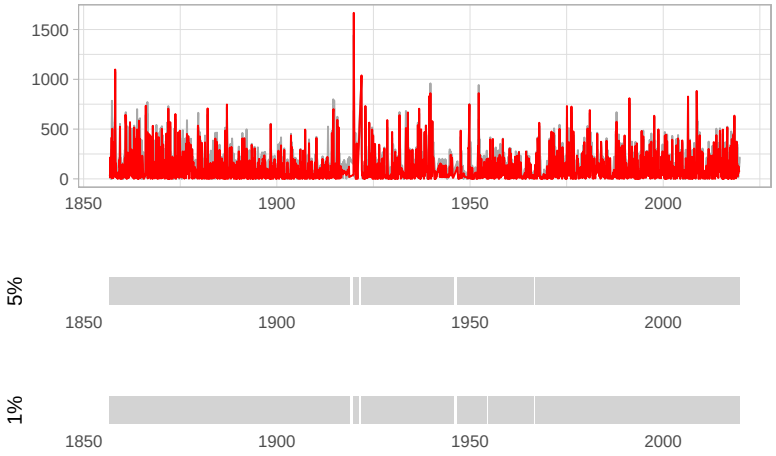
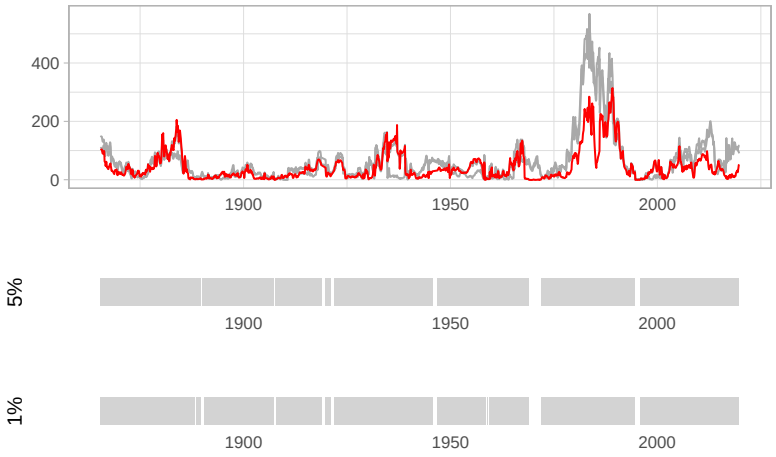


Figure A18: Instantaneous spillovers from exchange rate to unemployment – *Rolling GARCH Hong test* (Multiple outliers)



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