

Has COVID-19 caused a change in the dynamics of the unemployment rate? The case of North America and continental Europe

Judit Kapas

Department of Economics
Faculty of Economic and Social
Sciences
Budapest University of
Technology and Economics,
Hungary
E-mail: kapas.judit@gtk.bme.hu

This study raises the question of whether the COVID-19 pandemic will have a long-lasting impact on the dynamics of the unemployment rate. More specifically, this problem implies an analysis of whether any sign of a structural break is detectable in the time series of the unemployment rate. To obtain some „first-hand” estimates on whether it is likely that a structural break will occur in the labour market, this study performs several one-step-ahead forecasts based on the best ARIMA model on the time series of the unemployment rate, which takes advantage of the availability of the unemployment rate data for five quarters following the pandemic outbreak. Interestingly, the results document practically no difference in the impact of the pandemic on the labour market in countries with different labour market flexibility. Neither North America (United States of America and Canada) with a flexible labour market nor continental Europe (Germany and Austria) with a regulated labour market experienced any regime change in the unemployment rate time series.

Keywords:
pandemic,
unemployment,
structural break,
ARIMA model,
forecast

Introduction

The economic analysis of the COVID-19 pandemic’s various negative impacts on economies and societies is an ongoing process. The labour market is one of the most researched economic areas within pandemic related subjects, and a relatively large body of literature has accumulated in the field, with a wide range of focuses. Some scholars have analysed how the pandemic increased unemployment in various countries (e.g., Su et al. 2021, Coibion et al. 2020); findings show that the unemployment rate has increased significantly, but to different extents in various countries. Interestingly, the labour market’s recovery has quickly gained popularity

as a research area (e.g., Gregory et al. 2020) not only in terms of the speed of recovery, but also in terms of possible scenarios (e.g., Petrosky-Nadeau–Valletta 2020). Another crucial issue has centred on a change in unemployment benefits, exploring various aspects of the problem, such as the optimal unemployment benefit (Mitman–Rabinovich 2020), lost earnings due to the pandemic (Acs–Karpman 2020), and how unemployment benefits could compensate for income loss (Ganong et al. 2020). Of course, many have investigated how shutdown policies have affected the unemployment rate (e.g., Kong–Prinz 2020a, 2020b), and it has been shown that, for instance, in Germany, 60% of the inflow into unemployment in April 2020 was due to shutdown measures (Bauer–Weber 2021). Several studies focused on how entrepreneurship was affected by the pandemic, an issue indirectly related to employment (e.g., Nyikos et al. 2021). Besides the economic aspects of unemployment caused by COVID-19 mentioned above, sociologists and psychologists, too have been investigating the issue (for an overview of various psychology-related aspects of unemployment, see Blustein et al. 2020).

However, less attention was paid to the question of whether the „behaviour” of the labour market is likely to change, a question concerning the topic whether the labour market will revert to its original pattern. In other words, retaining the same pattern could mean that COVID-19 has not exercised a long-lasting impact on the labour market, indicating no regime (structural) change. Of course, we can only detect a structural change in a time series retrospectively, that is, when we have sufficient data points after the hypothesised breaking time.¹ Since it has been around a year and a half since the start of the pandemic, we cannot conduct a traditional structural break analysis on the time series of the unemployment rate, although we can still be interested in whether the effect on unemployment rate will only be transitory or long-lasting. Given the shocks arising from past pandemics, this interest is of crucial importance. As demonstrated by Rodríguez-Caballero–Vera-Valdés (2020), previous pandemics suggest that without governmental policies designed to avoid massive job losses, and we should expect a higher unemployment rate. Accordingly, an implication of an „early” detection of a regime change in the unemployment rate is that it can advise policy makers in fine-tuning governmental policy in the field.

The contribution of this study is to propose an analysis able to detect signs of a possible structural break a couple of periods following the pandemic outbreak, which can serve as a basis for eventual changes in employment policy. More specifically, this study proposes to make multiple one-step-ahead forecasts, an approach taking advantage of the availability of data during the pandemic period. In terms of econometrics, the procedure is a simple method that can provide some first-hand „estimates” concerning whether or not it is likely that the labour market

¹ On the various econometrics methods to detect a structural break, see Rodríguez-Caballero–Vera-Valdés (2020).

will revert to its original pattern. After modelling the behaviour of the labour markets in each country of my interest, I will forecast the unemployment rate at time $t+1$ by using data from 1 to t , then at time $t+2$ by using data from 1 to $t+1$, etc., where t is time when the pandemic's impact first appeared. Then, I will calculate the prediction intervals and check whether the actual COVID-19 period data actually occurred within the interval. If the actual COVID-19 data are contained in the corresponding prediction interval a couple of periods after the pandemic started, I can claim that the overall structure of the unemployment rate captured by the model has not changed, and the COVID-19 has not caused regime change. If this is not the case, I will attempt to judge whether there is any sign indicating that the actual unemployment rates converge to some extent back to the original pattern, or alternatively, whether a new pattern is emerging, indicating a sign of a structural break.

In this study, I hypothesise that the capability of a labour market to retain its original pattern depends not only on policies but also on the characteristics of the given labour market. Flexible labour markets might translate the pandemic shock into large increases in the unemployment rate but they probably will quickly return to the original pattern when the economy returns to normality. However, countries where the labour market is shaped by governmental regulation and/or the involvement of social partners in labour bargaining might follow a different path: a quick return to the original pattern is not very likely, which might indicate either a regime change in the unemployment rate or a slow reversion. To investigate whether this difference between the two types of labour markets does indeed exist, I will take North America as an example of a flexible labour market, and continental Europe as an example of a regulated labour market. I will analyse two countries in both regions: the United States of America [USA] and Canada on one hand, and Germany and Austria on the other. Using two countries for each region for this analysis offers the advantage of obtaining more solid results, while remaining feasible within the framework of a single paper.

Interestingly, my results show practically no difference between countries with different labour market flexibility with regard to the impact of the pandemic on the labour market: neither North America nor Continental Europe have experienced regime change in the unemployment rate time series. In Canada, the labour market has already reverted to the previous pattern; however, in the USA, the actual rates have been outside the prediction intervals for all periods, but convergence is apparently taking place. The two continental European countries do not show a different movement from that observed in North America. Due to rapid and intense government actions, the German labour market has hardly diverted from its previous pattern, making Germany very similar to Canada in this respect; in Austria, the labour market seems to have left its original pattern for a while, although a slow reversion back to the previous behaviour of the market is already taking place. In

summary, multiple one-step-ahead forecasts suggest that the COVID-19 pandemic has not caused a structural break in the unemployment rate series, irrespective of the flexibility of the labour market.

In what follows, I will first look at the state of the labour market in the four countries during the pandemic era. Then, I will model the unemployment rate time series in the four countries and calculate the one-step-ahead forecasts manually with prediction intervals. In the last section, I will conclude the paper.

The state of the labour market at the outbreak of the pandemic in the four countries

The pandemic caused a sharp and unprecedented fall in employment across countries², but the extent of the increase in the unemployment rate has been quite different in the two regions. Table 1 summarises the quarterly unemployment rate data from 2020Q1 to 2021Q2. For all countries, the economic impact of COVID-19 manifested in 2020Q2, one quarter after the pandemic broke out.

Table 1

Unemployment rates

Country	2020				2021	
	Q1	Q2	Q3	Q4	Q1	Q2
USA	3.80	13.07	8.80	6.77	6.17	5.93
Canada	6.40	13.10	10.10	8.80	8.37	8.03
Germany	5.00	6.17	6.33	6.13	6.00	5.97
Austria	8.46	11.86	10.09	9.31	8.78	7.74 ^{a)}

a) Estimated value for the quarter based on available data for 2 months.

Data source: [1].

Comparing the countries in the first COVID-19 period leads me to the conclusion that the highest relative increase in the rate occurred in the USA³, followed by Canada, which is perfectly in line with our expectations based on the characteristics of their labour markets. The high level of labour freedom and low level of employment protection implies flexibility, leading to the fact that the impacts of the pandemic manifest fully on the labour market. In contrast, the relative increase in the unemployment rate in Germany and Austria was much lower, suggesting that the immediate intervention of the government on the labour

² Although we do not have much data from the outbreak of the pandemic, which hinders causality analysis, Su et al. (2021) performed a Fourier causality test whose results establish that COVID-19 caused unemployment in selected European economies, including Germany.

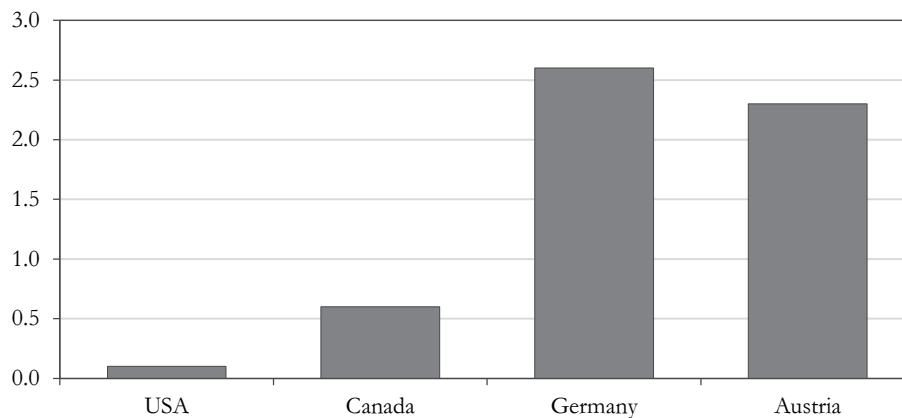
³ To illustrate the severity of the situation in the USA, note that initial unemployment insurance claims in the first month of the pandemic matched the cumulative claims during the worst nine-month period of the 2008 financial crisis (Petrosky-Nadeau–Valletta 2020). For more data on the USA labor market during the pandemic, see Acs–Karpman 2020.

market „has come to fruition”. Clearly, two factors contribute to the extent of the relative increase in the unemployment rate: (1) the flexibility of the labour market and (2) the volume and character of the stimulus introduced in a particular country.

When it comes to differences in flexibility across the two regions, it is worth looking at the Employment Protection Index of the Organisation for Economic Co-operation and Development (OECD) (Figure 1) which measures the procedures and costs involved in dismissing individuals or groups of workers and the procedures involved in hiring workers on fixed-term or temporary work agency contracts. The figure clearly shows that regulation is very strict in both Germany and Austria, while it is very easy for firms to hire and fire people in the USA and Canada.

Figure 1

Employment Protection Index, 2019



Source: [2].

The labour freedom component of the Index of Economic Freedom⁴ compiled by the Heritage Foundation (Miller et al. 2021) is another measure used to assess certain characteristics of the labour market, which explains the differences in the change in unemployment rates across countries. The data presented in Table 2 highlight that labour freedom is much higher in the USA and Canada, especially when looking at the average labour freedom in the period from 2005 to 2021.

⁴ This is a quantitative measure that considers various aspects of the legal and regulatory framework of a country's labour market, including the following six quantitative factors, equally weighted: ratio of the minimum wage to the average value added per worker, hindrance to hiring additional workers, rigidity of hours, difficulty of firing redundant employees, legally mandated notice period, and mandatory severance pay.

Table 2

Labour freedom component of the Index of Economic Freedom

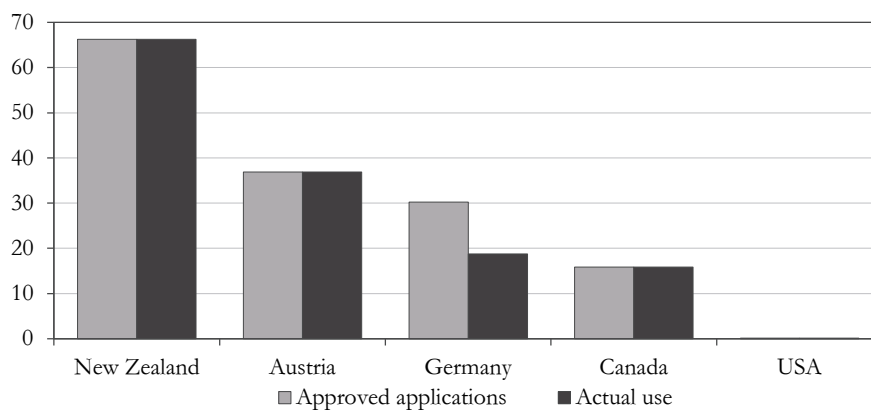
Country	2021	2020	2019	2018	2017	Mean (2005–2021)
USA	87.1	87.9	89.4	91.4	91.0	93.77
Canada	72.4	72.0	73.7	71.3	73.1	78.53
Germany	53.0	53.0	52.8	53.3	42.8	43.71
Austria	68.4	68.3	68.7	66.7	67.6	73.74

Source: Miller et al. (2021).

In addition to the cross-regional differences in labour market flexibility, as argued above, we should consider the differences in the policy mix the countries have applied to cushion the effects of COVID-19.

A very important part of the „stimulus” package introduced in continental Europe are job retention schemes, namely, short-time work (STW) (see Giupponi–Landais 2020 for more details) and wage subsidies (Schulten–Müller 2020), which have been somewhat in short supply in North America. Immediately after the start of the pandemic, as of May 2020, Germany and Austria introduced these schemes where the share of approved applications and actual participants as a part of dependent employees was about 30–40%, while in the USA, this share was practically 0%, as shown in Figure 2.⁵

Figure 2

Participation in job retention schemes, May 2020

Source: [3].

It is worth noting that Austria pioneered the development of SWT to mitigate the massive increase in unemployment, with the goal of preserving jobs at firms by

⁵ New Zealand is shown for the sake of comparison as the country whose level of job-retention participation was the highest.

temporarily reducing firms' labour costs. The Austrian model has allowed a temporary reduction in working hours up to 90% while maintaining the employment relationship and granting almost full public wage compensation. It has even included the possibility of a temporary reduction to as few as zero hours (Schnitzer et al. 2020).⁶ The government has provided remuneration for reduced hours up to predefined thresholds. In Germany, the regular net replacement rate has been a little lower (60% for a single individual and 67% for a married person) than in Austria (Bofinger et al. 2020a, 2020b).

In addition to SWT, the use of wage subsidies is not very important. This measure is much more in line with labour markets where layoffs are relatively less costly, which explains why Canada has applied them. Wage subsidies are easier to implement and more flexible for firms, but less targeted at firms.

In parallel with job retention schemes, many countries have provided liquidity support for firms, together with central banks' monetary measures. Moreover, at EU level, additional measures have been taken to support national efforts. The USA has focused on reducing the impact of income loss and, accordingly, has expanded unemployment benefits in various ways: improving access to unemployment benefits, extending their duration, and increasing their amount ([3], Fang et al. 2020, Ganong et al. 2020).

In summary, the volume and character of the stimulus packages differed between the regions. To express these differences, we can rely on an index developed by Elgin et al. (2020) and updated by the same scholars (update available at: [4]): the COVID-19 Economic Stimulus combines all adapted fiscal, monetary, and exchange rate measures. As argued by Elgin et al. (2020), the index may be used in a cross-country setting because it standardises the measures taken by governments. Table 3 summarises the components of the index for our countries. The most important conclusions are as follows.

Table 3

COVID-19 Economic Stimulus Index

Country	Fiscal, %/GDP		Rate cut, %		Macro-financial, %/GDP	
	March 2020	May 2021	March 2020	May 2021	March 2020	May 2021
USA	10.50	26.78	100	100	0.00	14.00
Canada	6.00	18.50	57.14	85.70	2.60	18.38
Germany	4.00	20.3	0.00	0.00	12.49	44.74
Austria	17.80	19.50	0.00	0.00	7.31	18.64

Source: Elgin et al. (2020) and [4].

⁶ The first version of this model was used during the 2008 financial crisis (Hijzen–Venn 2011). For an analysis of the rationale for STW benefits and their effects on labour adjustment during the 2008 recession, see Boeri–Bruecker 2011.

In Europe, an interest rate cut was not used, unlike in the USA and Canada. The volume of the fiscal measures as a percentage of gross domestic product (GDP) was more or less the same in the four countries, but the magnitude of macro-financial measures was extremely large in Germany. In addition, macro-financial measures came later in North America, while Austria and Germany had already introduced them by March 2020 ([3]).

Based on the above, it is clear that the labour markets have not been cushioned in the USA and Canada, implying that whether the labour market will revert back to its original behaviour depends mainly on the speed of the recovery of the economy: in case of quick recovery – and seemingly, this is what happens – we should expect a reversion. However, in Germany and Austria, the rigidity of the labour markets might hinder the reversion unless „good” governmental policies „overcompensate” it.

Modelling the unemployment rate series and multiple one-step-ahead forecasting

In what follows, I model the unemployment rate time series in the four countries and make several one-step-ahead forecasts, which allow me to conduct preliminary investigations regarding a possible structural break. When it comes to modelling, I select the best ARIMA model based on the Bayesian Information Criterion (BIC), and then, to validate the model, I thoroughly check the residuals to see whether they follow a white noise process.⁷ To check the stationarity of the series on which I fit ARIMA models: besides the traditional Augmented Dickey-Fuller (ADF) test of non-stationarity, I also perform the Kapetanios test (Kapetanios 2005).⁸ The reason for this is a well-known weakness of the ADF unit root test: it does not allow for the possibility of structural breaks for a stationary time series. In other words, the ADF test may fail to reject the unit root (non-stationarity) hypothesis if the series have structural breaks. By performing the Kapetanios test⁹, in which the null hypothesis is that the series has a unit root with m structural breaks, while the alternative hypothesis is that it is stationary with m breaks, one can avoid this risk.

Forecasting is performed manually, as follows. I forecast Y_{t+1} (the unemployment rate at time $t+1$) by using data from 1 to t , then Y_{t+2} by using data from 1 to $t+1$, etc. To calculate the prediction interval, we need the standard deviation of the forecast distribution. We know that for a one-step-ahead forecast, the standard deviation of the forecast distribution is equal to the standard deviation of the residuals. Since I make a one-step-ahead forecast, but carry it out several

⁷ I use R for all analyses.

⁸ The use of this test has been suggested by one of my reviewers, for which I am very thankful.

⁹ The Kapetanios tests will be performed in Gretl in the following setting: maximum number of breaks: 5, maximum number of lags: 5, type of break: level and trend.

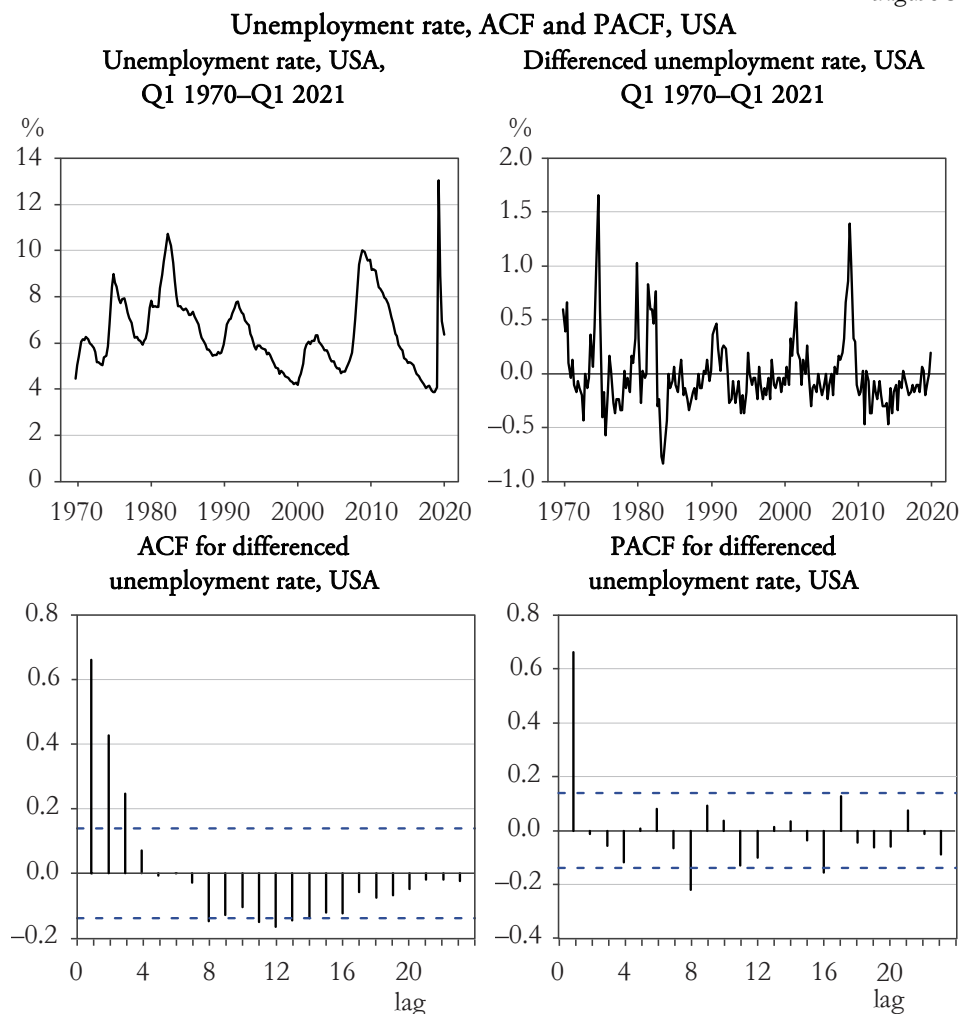
times, I can take the standard deviation as the same for each forecast. Since the first COVID-19 period is 2020Q2 (see Table 1), forecasts can be made for five periods.

Data were taken from the Federal Reserve Economic Data (FRED). I use quarterly seasonally adjusted data. The chosen period is from 1970Q1 to 2021Q1 for the USA and Germany, and from 1980Q1 to 2021Q1 for Canada and Austria.

The United States of America

Figure 3 shows the time series of the unemployment rate for the entire period, and the first difference of the time series together with ACF and PACF for the training dataset.

Figure 3



The data do not show any trend; instead, it seems that there is a constant long-run mean (about 6–7%). The spread of the data also seems to be within the same boundary, except for the COVID-19 starting period when the spike was very large. The time-constant mean, time-constant variance, and time-reversibility of the data suggest that the USA unemployment rate is stationary. I use more sophisticated tools to check this. The formal test of non-stationarity (ADF test) indicates that the series is stationary, since the p-value of the test statistic is 0.05, at lag 1, suggesting that we are at the border, at a 5% significance level, of rejecting the null hypothesis that the series is not stationary. However, the Kapetanios test suggests otherwise; I cannot reject the null hypothesis because the test statistic is -7.308 , while the critical value at a 10% significance level is -7.426 .

Taking the first difference of the USA unemployment rate time series makes me conclude that the series is stationary, based on both tests (the p-value in the ADF test is 0.01 at lag 1, and the test statistic in the Kapetanios test is -9.449 which is significant at the 1% level). The ACF and PACF for the first difference of the series in Figure 3 show that the data are autocorrelated, which is further corroborated by the Box-Ljung test up to lag 6 (p-value $< 2.2e-16$). The slow decay of the ACF indicates a typical AR process.

Therefore, since the first difference of the time series of the unemployment rate is stationary, I can fit ARIMA models on the training data set (1970Q1–2020Q1), and determine the best model relying on BIC as the model selection criterion. (I prefer BIC to the Akaike information criterion because it selects a simpler model.) ARIMA(1,1,0) is selected as the best model, the equation for which is as follows:

$$Y_t - Y_{t-1} = \phi_1(Y_{t-1} - Y_{t-2}) + u_t$$

where $u_t \sim N(0, \sigma_u^2)$.

After rearranging the equation:

$$Y_t = (1 + \phi_1)Y_{t-1} - \phi_1Y_{t-2} + u_t$$

where $u_t \sim N(0, \sigma_u^2)$.

In the above equations and in all that follow, y_t is the unemployment rate at time t , and u_t is the error term at time t . Table 4 presents the estimation results.

Table 4

Estimations for ARIMA(1,1,0), USA

	ar1
Estimate	0.668***
Standard error	0.0529

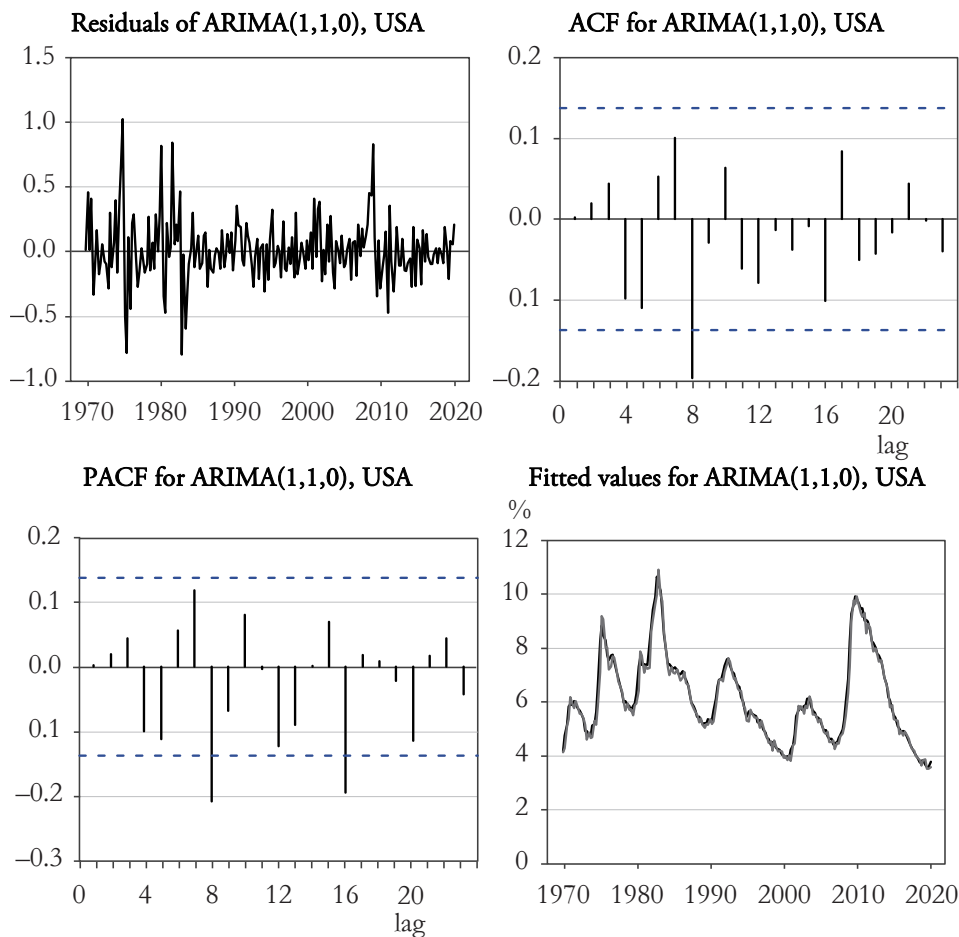
*** Significance at 0%.

Now, I check whether the residuals of this model follow a white noise process (Figure 4).

ACF seems to be appropriate, with only one bar being slightly outside the boundary at lag 8; the same can be said for PACF with two bars outside at high lags. Overall, we can accept that there is no autocorrelation at least up to lag 6 because the Box-Ljung test statistic is not significant ($p\text{-value}=0.4653$). The $p\text{-value}$ of the test statistic (0.01) in the ADF test indicates high significance, meaning that we can reject the hypothesis that the residuals are not stationary. Based on the above, I can conclude that the residuals of the model follow a white noise process, meaning that the model can be used for forecasting.

Figure 4

Residual diagnostics for ARIMA(1,1,0), USA



Based on the above estimations, I use the following equation for forecasting:

$$\hat{Y}_t = 1.668Y_{t-1} - 0.668Y_{t-2}$$

Table 5 shows the forecasts, together with the 95% prediction intervals.

Table 5

Forecasted unemployment rates and prediction intervals for the USA

Period	One-step-ahead forecasts			Actual unemployment rate
	forecast	low	upper	
2020Q2	3.93	3.44	4.42	13.07
2020Q3	19.26	18.77	19.75	8.80
2020Q4	5.95	5.46	6.47	6.77
2021Q1	5.41	4.92	5.90	6.17
2021Q2	5.05	4.56	5.54	5.93

Forecasts based on previous patterns have been very far from the actual values in the first two periods¹⁰, while in the second half of the pandemic period, these two have been much closer to one another, which might indicate that the unemployment rate reverts to the original pattern. Overall, the USA labour market behaved as expected: the increase in the rate was extremely high in the beginning because the government let the market work, which then started to recover quite quickly when the USA economy started stabilising and returning to normal. In 2021Q2, the upper limit of the prediction interval was 5.54, while the actual rate was 5.93; it seems that these two values not very far from one another.

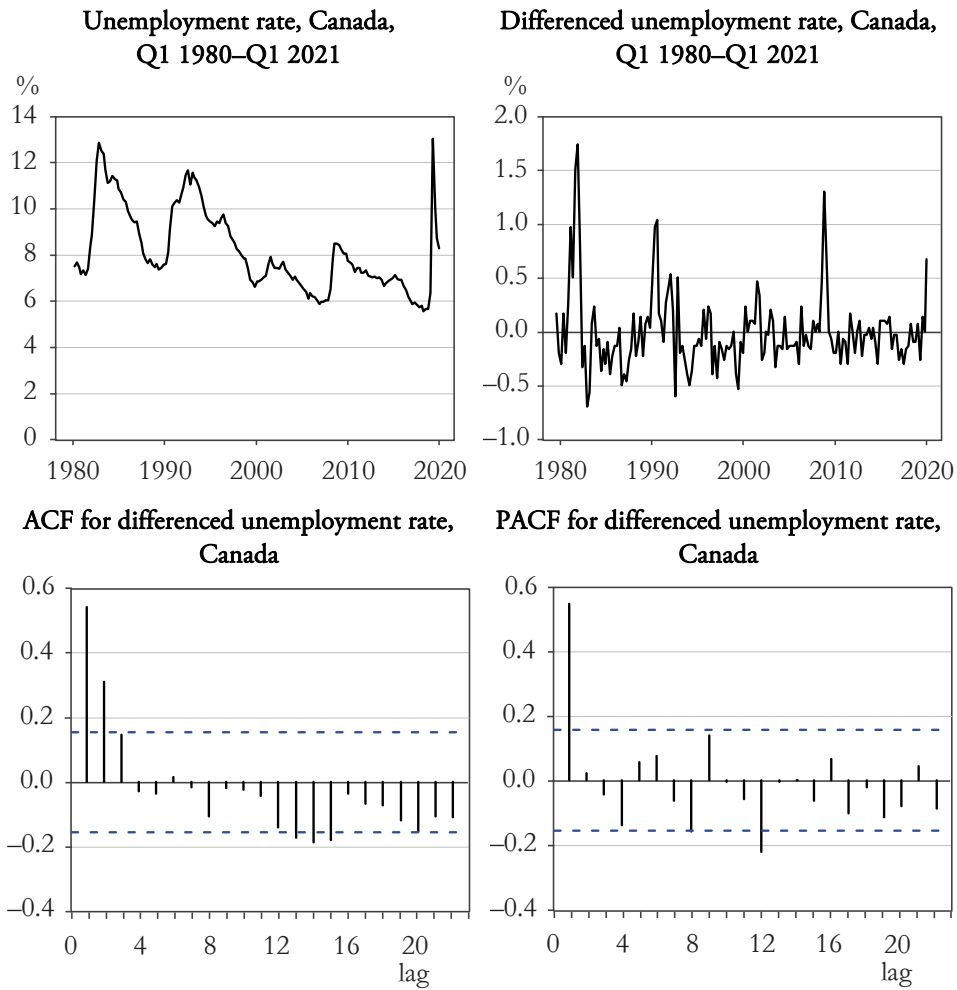
Canada

The time series of the unemployment rate for Canada for the period between 1980Q1 and 2020Q1 has proven to be stationary based on the ADF test (the p-value is 0.03 at lag 1), but non-stationary based on the Kapetanios test (the test statistic is -6.42 , while the critical value at a 10% significance level is -6.686). Accordingly, I take the differenced time series, which can be considered stationary based on both tests (the p-value in the ADF test is 0.01 at lag 1, and the test statistic in the Kapetanios test is -6.968). Figure 5 shows the time series for Canada.

¹⁰ As mentioned earlier, unemployment insurance became more generous immediately after the pandemic started. Fang et al. (2020) have shown in their calibrated model that unemployment insurance policies in the USA led to a 3.7 percentage point increase in the unemployment rate between April and December of 2020. This negative association between the unemployment rate and the generosity of unemployment insurance in the USA has been corroborated by Finamor–Scott (2021), too.

Figure 5

Unemployment rate, ACF and PACF for Canada



Data source: [1].

Proceeding in the same way as before, the best ARIMA model is (1,1,0), as in the case of the USA, whose equation is as follows:

$$Y_t = (1 + \phi_1)Y_{t-1} - \phi_1 Y_{t-2} + u_t$$

where $u_t \sim N(0, \sigma_u^2)$.

Estimation results are shown in Table 6.

Table 6

Estimations for ARIMA(1,1,0), Canada

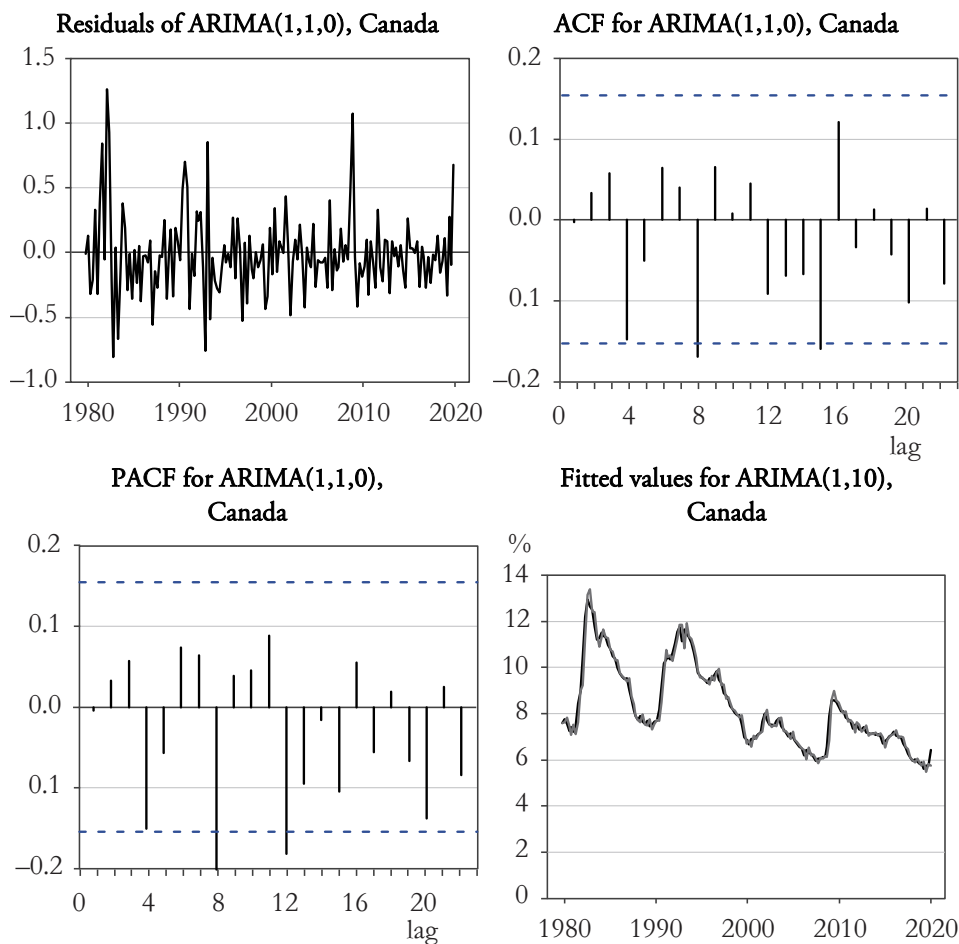
	ar1
Estimate	0.5530***
Standard error	0.0664

*** Significance at 0%.

Residual diagnostics validate the model, since the residuals are proven to follow a white noise process: the p-value of the test statistic in the ADF test is 0.01 at lag 1, it is 0.4702 in the Box-Ljung, and as shown in Figure 6, ACF and PACF suggest that there is no autocorrelation in the residuals, and the model fit is seemingly very good.

Figure 6

Residual diagnostics for ARIMA(1,1,0), Canada



One-step-ahead forecasts for the COVID-19 period are given in Table 7 based on the following equation:

$$\hat{Y}_t = 1.553Y_{t-1} - 0.553Y_{t-2}$$

Table 7

Forecasted unemployment rates and prediction intervals for Canada

Period	One-step-ahead forecasts			Actual unemployment rate
	forecast	low	upper	
2020Q2	6.77	6.19	7.35	13.10
2020Q3	16.81	16.23	17.38	10.10
2020Q4	8.44	7.86	9.02	8.80
2021Q1	8.08	7.50	8.66	8.37
2021Q2	7.88	7.30	8.46	8.03

The pandemic’s first impact was enormous in Canada, as in the USA, but starting from 2020Q4 the market reverted remarkably to its original pattern: the actual unemployment rate happens to be in the prediction intervals in 2020Q4, 2021Q1, and 2021Q2. Briefly, it is very likely that the pandemic has not exercised long-lasting effects on the dynamics of the Canadian labour market.

Germany

Figure 7 includes four panels for Germany, starting with the one showing the time series of the unemployment rate. There are ups and downs in the rate, with a positive trend until about 2008, after which the trend is decreasing. Looking at the difference in the unemployment rate might suggest stationarity, which I formally test with the ADF test (the p-value is 0.01 at lag 1) and the Kapetanios test (the test statistic is -9.3421 , while the critical value at a 1% significance level is -8.243), both confirming stationarity. ACF indicates an autoregressive process of the differenced unemployment rate.

The best model, based on BIC, which describes the process in Germany is an ARIMA(2,1,0) model, whose estimations are shown in Table 8, and the equation is as follows:

$$Y_t - Y_{t-1} = \phi_1(Y_{t-1} - Y_{t-2}) + \phi_2(Y_{t-2} - Y_{t-3}) + u_t$$

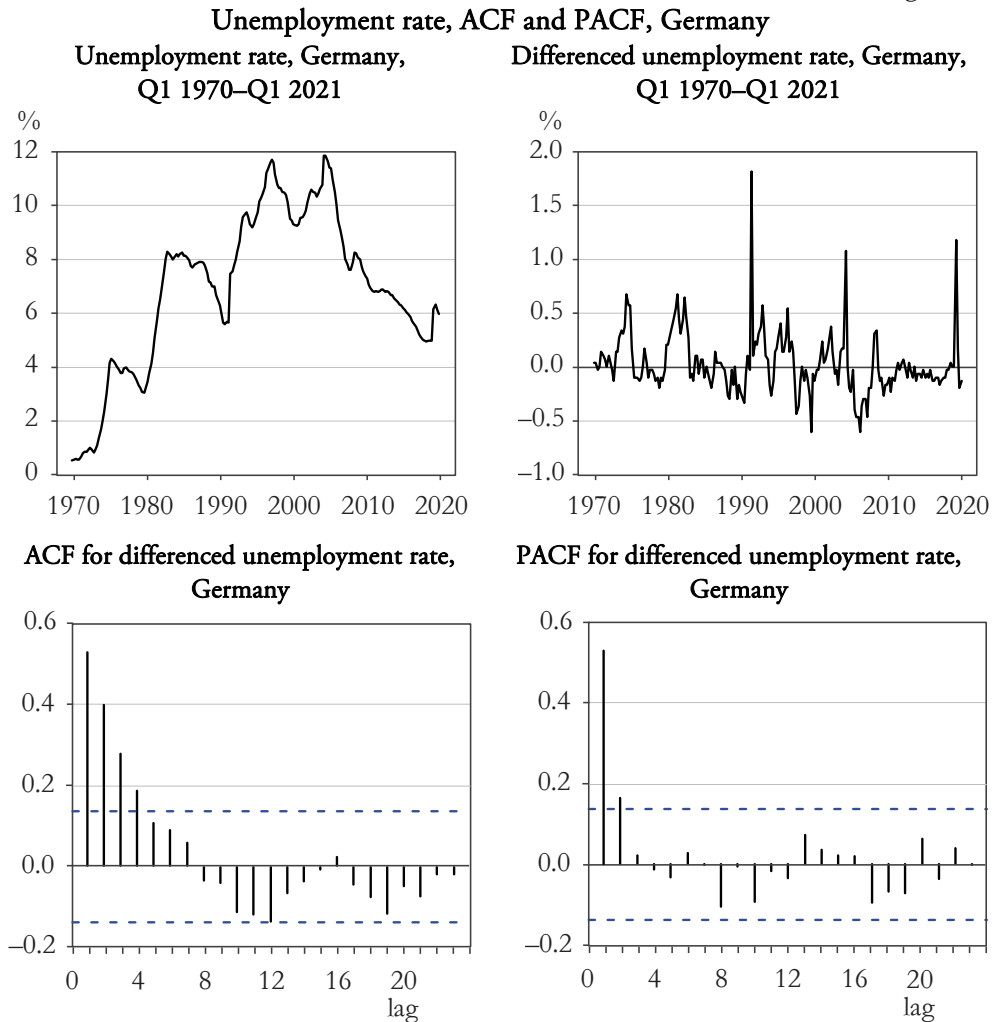
where $u_t \sim N(0, \sigma_u^2)$.

After rearrangement, the equation becomes:

$$Y_t = (1 + \phi_1)Y_{t-1} + (\phi_2 - \phi_1)Y_{t-2} - \phi_2Y_{t-3} + u_t$$

where $u_t \sim N(0, \sigma_u^2)$.

Figure 7



Data source: [1].

Table 8

Estimations for ARIMA(2,1,0), Germany

	ar1	ar2
Estimate	0.4583***	0.1947**
Standard error	0.0690	0.0690

*** Significance at 0%; ** Significance at 1%.

After performing residual diagnostics, I can conclude that the residuals are the realisation of a white noise process because the ADF test shows the stationarity of the residuals (p-value=0.01 at lag 1), as indicated by Figure 8; there is no

autocorrelation in the residuals (ACF and PACF are perfect), which is further corroborated by the Box-Ljung test (p-value=0.97).

Now, I use this model for forecasting. The specific equation I can apply based on my estimation is the following:

$$\hat{Y}_t = 1.4583Y_{t-1} - 0.2636Y_{t-2} - 0.1947Y_{t-3}$$

Forecasts, together with the prediction intervals, are shown in Table 9.

Figure 8

Residual diagnostics for ARIMA(2,1,0), Germany

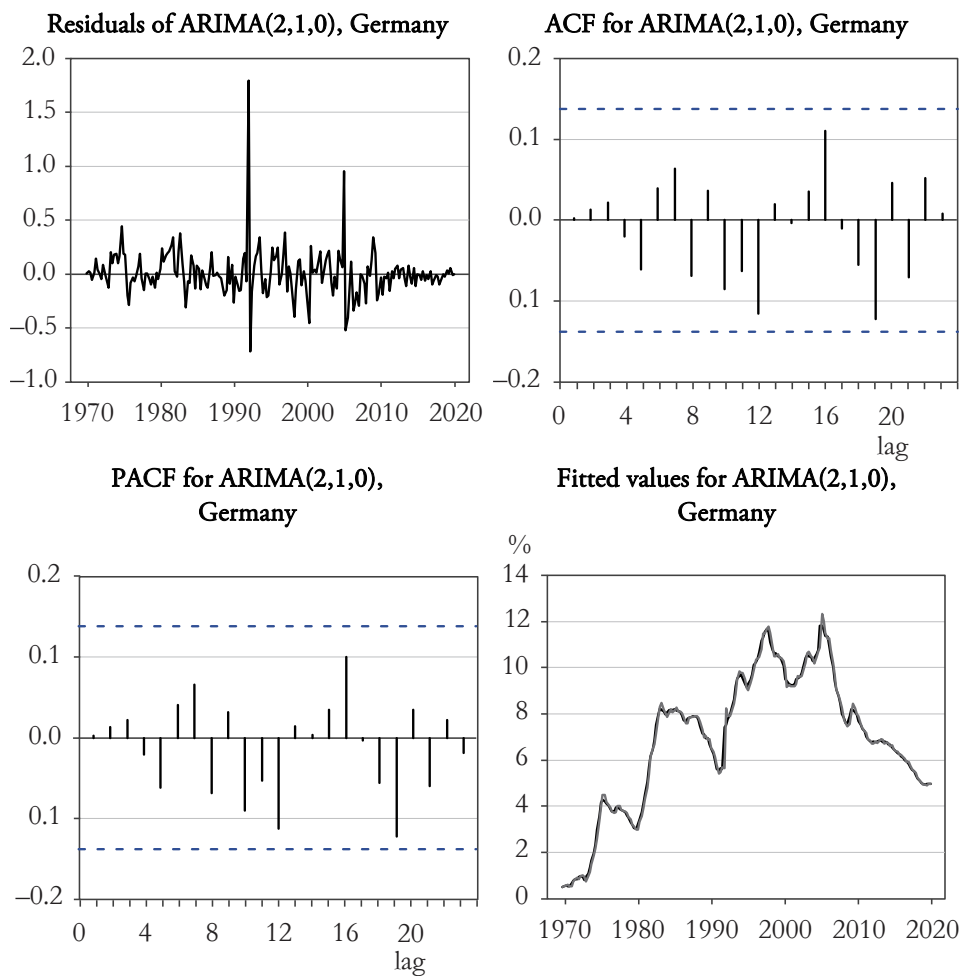


Table 9

Forecasted unemployment rates and prediction intervals for Germany

Period	One-step-ahead forecasts			Actual unemployment rate
	forecast	low	upper	
2020Q2	5.00	4.57	5.43	6.17
2020Q3	6.70	6.28	7.13	6.33
2020Q4	6.64	6.21	7.02	6.13
2021Q1	6.07	5.65	6.50	6.00
2021Q2	5.90	5.47	6.33	5.97

As seen from the above table, Germany is unique in terms of how the labour market has behaved; in the first pandemic period, the actual unemployment rate was only about 25% above the forecasted one, and then, starting from the second period, the actual rates are practically within the prediction intervals, meaning that the market is behaving in the same way as before the pandemic.¹¹ This suggests that, despite the rigidity of the labour market, governmental intervention has been so rapid and important in terms of magnitude that the actual unemployment rate has been „disciplined”; it seems that the labour market was not very disturbed by COVID-19. This dynamics of the labour market is the opposite of what I have hypothesised based on the character of the labour market (see introduction). Despite the heavy governmental regulation, the labour market has surprisingly reverted, and behaved similarly to the very flexible Canadian labour market.

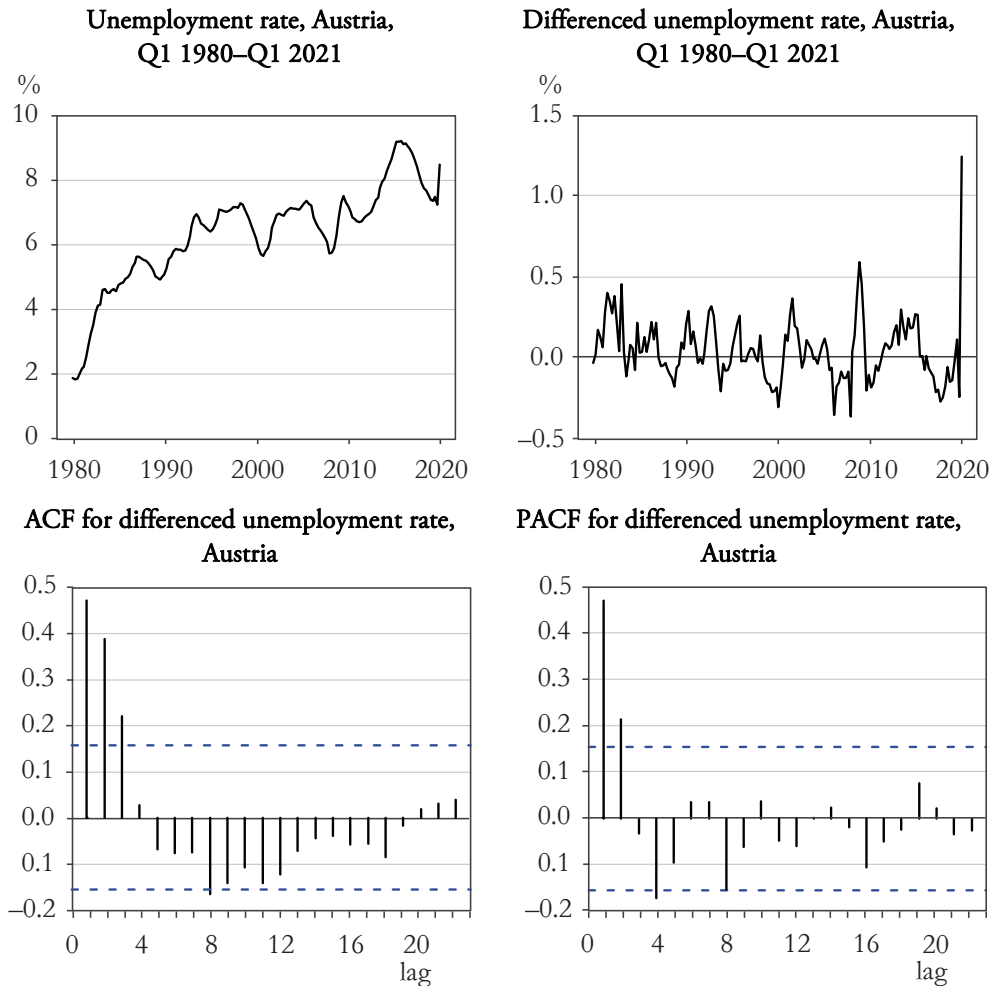
Austria

As shown in Figure 9, the time series of the unemployment rate for Austria has a positive trend, but differencing the unemployment rate leaves me with a stationary but autocorrelated series. The p-value of the test statistic in the ADF test is 0.02 at lag 1, and the corroboration of stationarity with the Kapetanios test (the test statistic is -5.1362) makes me reject the null hypothesis that there is a unit root at a 5% significance level (the critical value is -5.081).

¹¹ The only exception is the third period in which the actual rate is a little outside the interval. However, I do not consider this deviation crucial since one period before and after the actual rate is contained in the interval.

Figure 9

Unemployment rates, ACF and PACF, Austria



Data source: [1].

After fitting the ARIMA models, the best one based on BIC is ARIMA(1,1,2), the equation of which is as follows:

$$Y_t - Y_{t-1} = \phi_1(Y_{t-1} - Y_{t-2}) + \theta_1 u_{t-1} + \theta_2 u_{t-2} + u_t$$

where $u_t \sim N(0, \sigma_u^2)$.

After rearrangement, the equation becomes:

$$Y_t = (1 + \phi_1)Y_{t-1} - \phi_1 Y_{t-2} + \theta_1 u_{t-1} + \theta_2 u_{t-2} + u_t$$

where $u_t \sim N(0, \sigma_u^2)$.

Estimation results are shown in Table 10.

Table 10

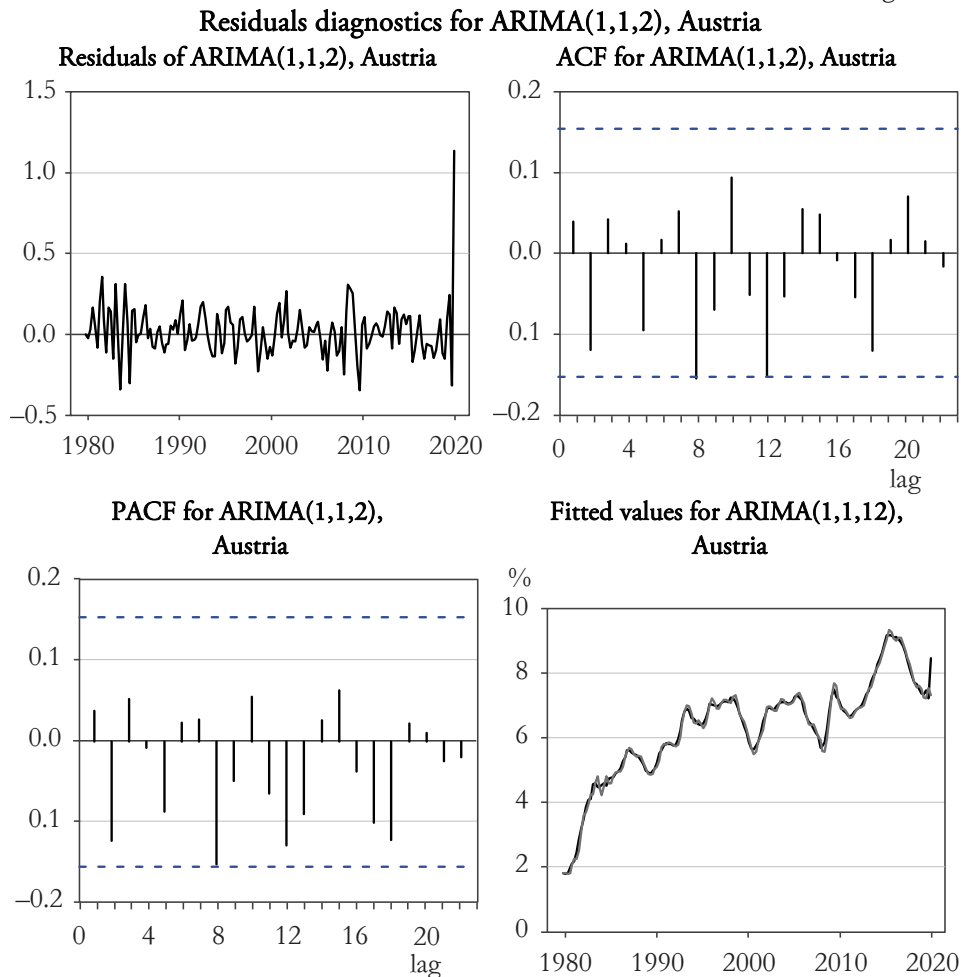
Estimations for ARIMA(1,1,2), Austria

	ar1	ma1	ma2
Estimate	0.4676**	-0.1739**	0.6680**
Standard error	0.1466	0.0664	0.2078

** Significance at 1%.

The residual diagnostics shown in Figure 10 lead me to conclude that the residuals follow a white noise process because the ADF test indicates the stationarity of the residuals (the p-value=0.01 at lag 1) and, as indicated by ACF and PACF, there is no autocorrelation in the residuals, which is further corroborated by the Box-Ljung test (p-value=0.5976).

Figure 10



Now, I make several one-step-ahead forecasts based on the following equation and show the results in Table 11.

$$\hat{Y}_t = 1.4676Y_{t-1} - 0.4676Y_{t-2} - 0.1739u_{t-1} + 0.668u_{t-2}$$

Table 11

Forecasted unemployment rates and prediction intervals for Austria, regression

Period	One-step-ahead forecasts			Actual unemployment rate
	forecast	low	upper	
2020Q2	8.63	8.33	8.94	11.86
2020Q3	13.65	13.34	13.95	10.09
2020Q4	12.04	11.74	12.35	9.31
2021Q1	7.04	6.74	7.35	8.78
2021Q2	6.40	6.09	6.70	7.74 ^{a)}

a) Estimated value for the quarter based on available data for 2 months.

The Austrian case is different from the German one. In the first pandemic period, the relative increase in the unemployment rate was higher in Austria than in Germany, and in the second half of the period, the market is converging to its previous dynamics. This means that it is not very likely that a regime change will occur in Austria; instead, one can argue that the Austrian government has managed to cushion the impact of COVID-19 on the labour market almost as well as the German government.

Conclusions

This study raises the question of whether the COVID-19 pandemic has changed the dynamics of the labour market, a problem that has not received much attention so far. A traditional analysis of a possible structural break in the unemployment time series is not yet feasible because the pandemic is still present and we do not have data for a sufficiently long period after the potential break. However, as I have suggested, making several one-step-ahead forecasts by taking advantage of the availability of data for the pandemic periods allows us to make some „first-hand” estimates about a possible regime change in unemployment rates.

I hypothesised that the degree of flexibility of the labour market might have an impact on whether a regime change due to COVID-19 is likely to occur. In this regard, I have taken two countries from two regions where the labour markets differ considerably in terms of flexibility, namely, North America (United States of America and Canada), where the market is flexible, and continental Europe (Germany and Austria), where it is regulated. My one-step-ahead forecasts for five periods during the pandemic do not indicate differences between the two regions with regard to the question if the labour market is going to revert to the original pattern. Somewhat surprisingly, irrespective of the character of the labour market, no sign of a structural break has been detected in any of the countries. More

precisely, the labour markets in Canada (a flexible market) and Germany (a regulated market) quickly reverted to previous dynamics. However, the labour markets in the USA and Austria have behaved somewhat differently. After an important spike in 2020Q2, it seems that a kind of convergence is taking place, but not a full reversion.

Overall, what we can conclude is basically the same in all four countries, and it is very likely that the COVID-19 pandemic has not caused a structural break in the unemployment rate time series.¹² This result, in the case of continental Europe, confirms the findings of Rodríguez-Caballero–Vera-Valdés (2020) in the sense that a careful design and implementation of policies aimed at minimising the incidence of companies firing workers during the pandemic have contributed to the fact that the COVID-19's impact on unemployment rate seems to be transitory. In North America, however, the flexibility of the labour market has been a key factor in the quick reversion back to the original dynamics of the market, at least in Canada. In the USA, due to some special features (see Footnotes 3 and 11), it takes more time for the market to gain the original dynamics back.

The above suggests that the flexible labour market is not superior to the regulated one during the pandemic: well-designed governmental policies can substitute the „virtues” of a free labour market.

REFERENCES

- BAUER, A.–WEBER, E. (2021): COVID-19: how much unemployment was caused by the shutdown in Germany? *Applied Economics Letters* 28 (12): 1053–1058.
<https://doi.org/10.1080/13504851.2020.1789544>
- BLUSTEIN, D. L.–DUFFY, R.–FERREIRA, J. A.–COHEN-SCALI, V.–CINAMON, R. G.–ALLAN, B. A. (2020): Unemployment in the time of COVID-19: A research agenda *Journal of Vocational Behavior* 119: 103436.
<https://doi.org/10.1016/j.jvb.2020.103436>
- BOERI, T.–BRUECKER, H. (2011): Short-time work benefits revisited: some lessons from the Great Recession *Economic Policy* 26 (68): 697–765.
<https://doi.org/10.1111/j.1468-0327.2011.271.x>
- BOFINGER, P.–DULLIEN, S.–FELBERMAYR, G.–FUEST, C.–HÜTHER, M.–SÜDEKUM, J.–WEDER DI MAURO, B. (2020a): Economic implications of the COVID-19 crisis for Germany and economic policy measures. In: BALDWIN, R.–WEDER DI MAURO, B. (eds.): *Mitigating the COVID Economic Crisis: Act Fast and Do Whatever It Takes* pp. 167–178., VoxEU.org eBook, CEPR Press, London.

¹² Note that Rodríguez-Caballero–Vera-Valdés (2020) found several structural breaks due to past pandemics (the Great Pandemic of 1870–1875, the Russian flu, the Spanish flu) on the time series of the United Kingdom unemployment rate. However, in my opinion, this does not contradict my findings, for several reasons. First, they took a very long historical period (1854–2016); second, they used traditional structural break tests where not all tests indicate the same structural breaks, and third, labour markets in different countries might behave differently, reflecting other features of the economy, as well.

- BOFINGER, P.–DULLIEN, S.–FELBERMAYR, G.–FUEST, C.–HÜTHER, M.–SÜDEKUM, J.–WEDER DI MAURO, B. (2020b): Wirtschaftliche Implikationen der Corona-Krise und wirtschaftspolitische Maßnahmen *Wirtschaftsdienst* 100: 259–265.
- COIBION, O.–GORODNICHENKO, Y.–WEBER, M. (2020): *Labor markets during the COVID-19 crisis: A preliminary view* Working Paper No. 27017. National Bureau of Economic Research Cambridge, MA. <https://doi.org/10.1080/10.3386/w27017>
- ELGIN, C.–BASBUG, G.–YALAMAN, A. (2020): Economic policy responses to a pandemic: developing the COVID-19 Economic Stimulus Index *COVID Economics Vetted and Real-Time Papers* (3): 40–53.
- FANG, L.–NIE, J.–XIE, Z. (2020): *Unemployment insurance during a pandemic* Working Paper No. 20-07. Federal Reserve Bank of Kansas City, Kansas City.
- FINAMOR, L.–SCOTT, D. (2021): Labor market trends and unemployment insurance generosity during the pandemic *Economics Letters* 199: 109722. <https://doi.org/10.1016/j.econlet.2020.109722>
- GANONG, P.–NOEL, P.–VAVRA, J. (2020): US unemployment insurance replacement rates during the pandemic *Journal of Public Economics* 191: 104273. <https://doi.org/10.1016/j.jpubeco.2020.104273>
- GREGORY, V.–MENZIO, G.–WICZER, D. G. (2020): *Pandemic recession: L or V-shaped?* NBER Working Paper No. 27105. National Bureau of Economic Research, Cambridge, MA. <https://doi.org/10.3386/w27105>
- HIJZEN, A.–VENN, D. (2011): *The role of short-time work schemes during the 2008-09 Recession* OECD Social, Employment and Migration Working Papers, No. 115., OECD, Washington.
- KAPETANIOS, G. (2005): Unit-root testing against the alternative hypothesis of up to m structural breaks *Journal of Time Series Analysis* 26 (1): 123–133. <https://doi.org/10.1111/j.1467-9892.2005.00393.x>
- KONG, E.–PRINZ, D. (2020a): Disentangling policy effects using proxy data: Which shutdown policies affected unemployment during the COVID-19 pandemic? *Journal of Public Economics* 189: 104257. <https://doi.org/10.1016/j.jpubeco.2020.104257>
- KONG, E.–PRINZ, D. (2020b): The impact of shutdown policies on unemployment during a pandemic *COVID Economics Vetted and Real-Time Papers* (17): 24–72.
- MILLER, T.–KIM, A. B.–ROBERTS, J. M.–TYRREL, P. (2021): *2021 Index of Economic Freedom* The Heritage Foundation, Washington, DC.
- MITMAN, K.–RABINOVICH, S. (2020): *Optimal unemployment benefits in the pandemic* CEPR Discussion Paper No. DP14915. CEPR Centre for Economic Policy Research, London.
- NYIKOS, GY.–SOHA, B.–BÉRES, A. (2021): Entrepreneurial resilience and firm performance during the COVID-19 crisis. Evidence from Hungary *Regional Statistics* 11 (3): 29–59. <https://doi.org/10.15196/RS110307>

- RODRÍGUEZ-CABALLERO, C. V.–VERA-VALDÉS, J. E. (2020): Long-lasting economic effects of pandemics: Evidence on growth and unemployment *Econometrics* 8 (3): 37.
<https://doi.org/10.3390/econometrics8030037>
- SCHULTEN, T.–MÜLLER, T. (2020): *Kurzarbeitergeld in der Corona-Krise: Aktuelle Regelungen in Deutschland und Europa* Policy Brief WSI, Nr. 38. Hans-BöcklerStiftung, Wirtschafts- und Sozialwissenschaftliches Institut (WSI), Düsseldorf.
- SU, C-W.–DAI, K.–ULLAH, S.–ANDLIB, Z. (2021): COVID-19 pandemic and unemployment dynamics in European economies *Economic Research-Ekonomska Istraživanja*
<https://doi.org/10.1080/1331677X.2021.1912627>

INTERNET SOURCES

- ACS, G.–KARPMAN, M. (2020): *Employment, income, and unemployment insurance during the COVID-19 pandemic. Findings from the May 14–27 Coronavirus Tracking Survey* Urban Institute, Washington.
<https://www.urban.org/sites/default/files/publication/102485/employment-income-and-unemployment-insurance-during-the-covid-19-pandemic.pdf>
 (downloaded: June 2021)
- GIUPPONI, G.–LANDAIS, C. (2020): *Building effective short-time work schemes for the COVID-19 crisis*
<https://voxeu.org/article/building-effective-short-time-work-schemes-covid-19-crisis> (downloaded: June 2021)
- PETROSKY-NADEAU, N.–VALLETTA, R. G. (2020): *Unemployment paths in a pandemic economy* Working Paper 2020/18. Federal Reserve Bank of San Francisco, San Francisco.
<https://www.frbsf.org/economic-research/publications/working-papers/2020/18/> (downloaded: June 2021)
- SCHNETZER, M.–TAMESBERGER, D.–THEURL, S. (2020): *Mitigating mass layoffs in the COVID-19 crisis: Austrian short-time work as international role model*
<https://voxeu.org/article/mitigating-mass-layoffs-covid-19-crisis-austrian-short-time-model> (downloaded: June 2021)

DATABASES/WEBSITES

- [1] FEDERAL RESERVE BANK OF ST. LOUIS (FRED): <https://fred.stlouisfed.org>
 (downloaded: June and August 2021)
- [2] OECD Employment database:
<https://www.oecd.org/els/emp/onlineoecdemploymentdatabase.htm>
 (downloaded: June 2021)
- [3] ILO (2020): *The impact of the COVID-19 pandemic on jobs and incomes in G20 economies*
https://www.ilo.org/global/about-the-ilo/how-the-ilo-works/multilateral-system/g20/reports/WCMS_756331/lang--en/index.htm
 (downloaded: June 2021)
- [4] COVID-19 ECONOMIC STIMULUS INDEX: updated data at:
<http://www.ceyhunelgin.com/> (downloaded: June 2021)