Online Appendix for:

Tracking GDP in real-time using electricity market data: insights from the first wave of COVID-19 across Europe

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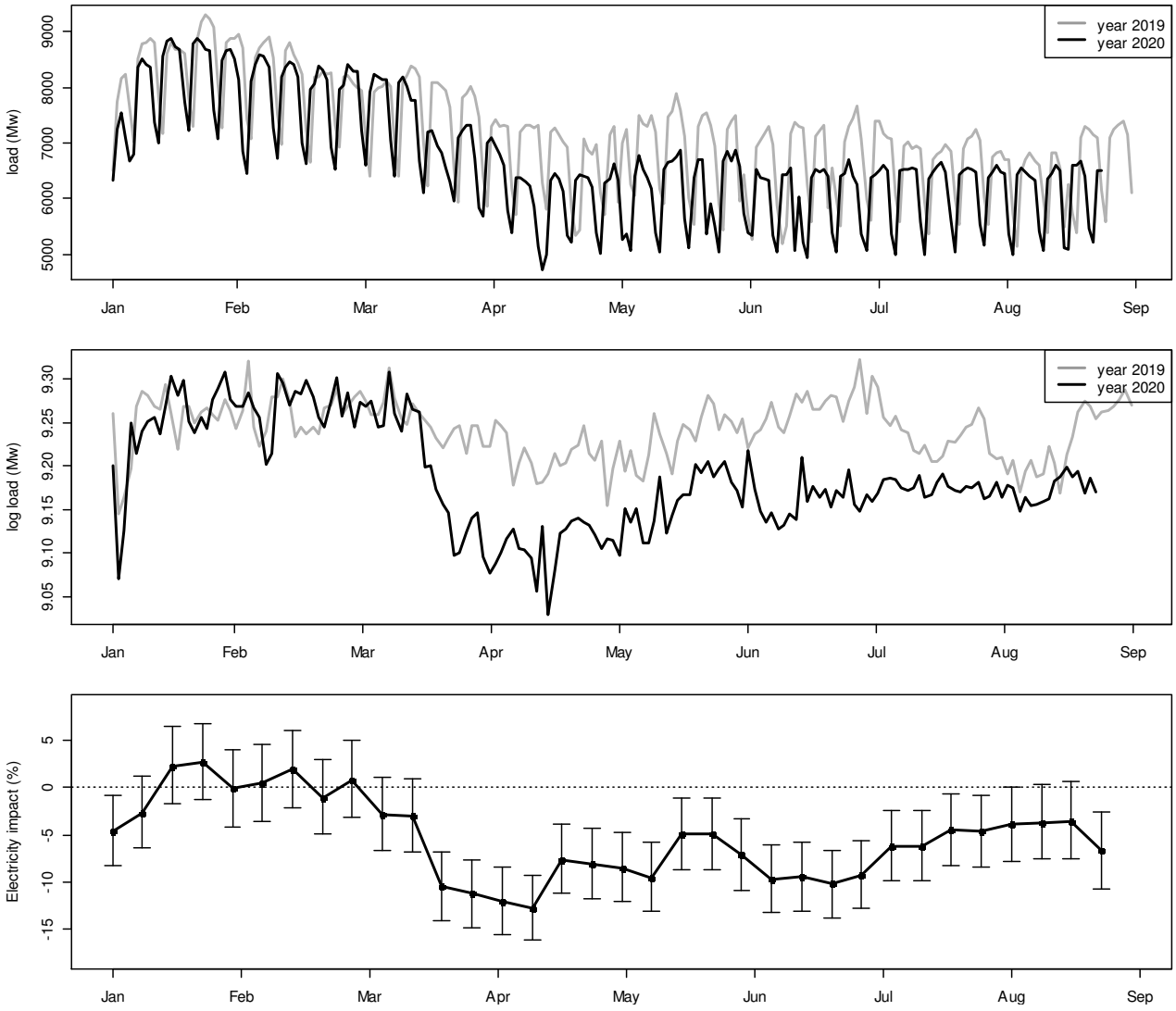
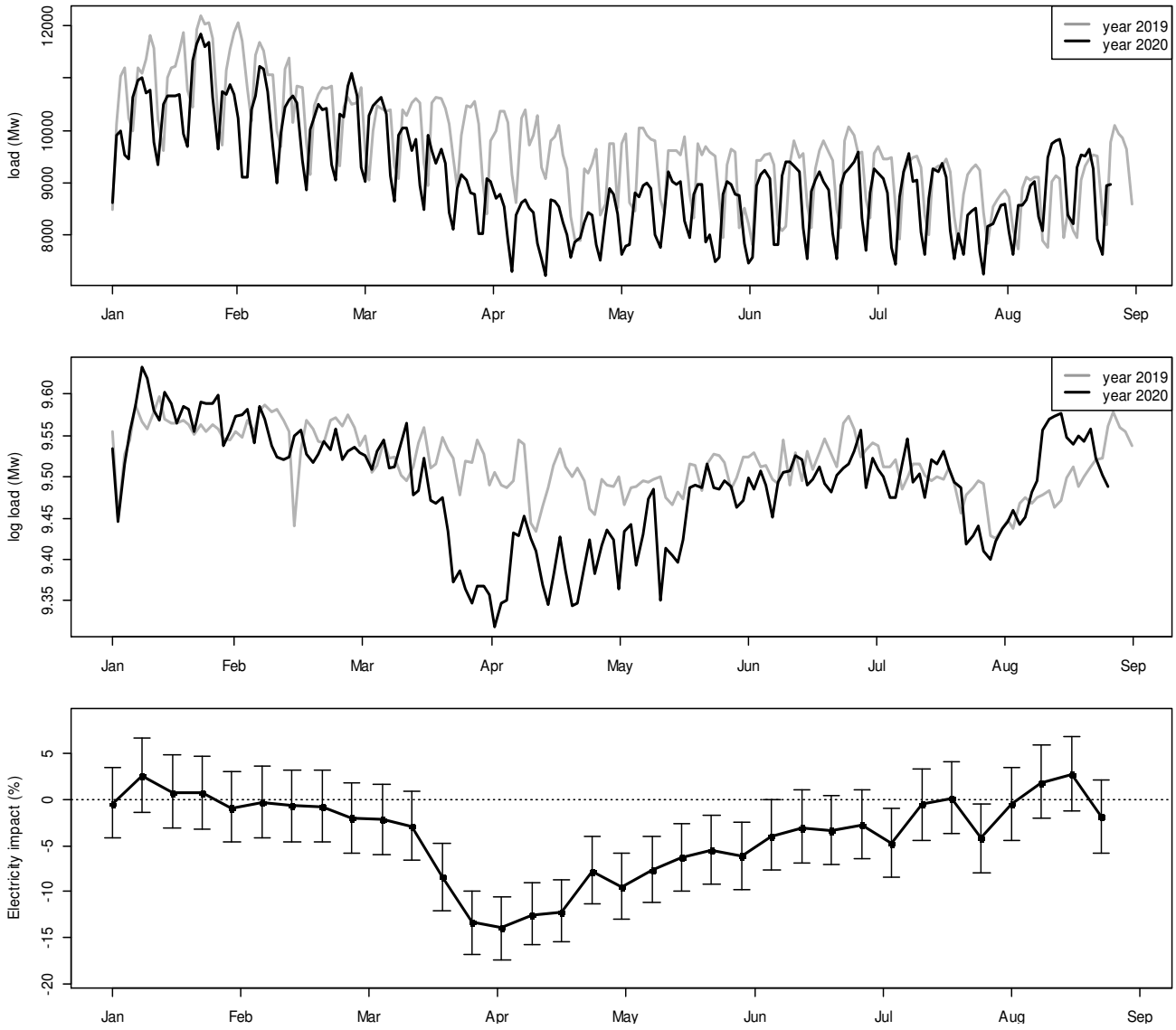
A1: Electricity time series plots and impacts

Here we replicate Figure 1 for all the countries included in our analysis. The top panel presents the original electricity consumption time-series, the middle panel presents the same time-series after prefiltering and the bottom panel presents the estimated impacts of electricity consumption, with the vertical lines indicating 95% confidence intervals.

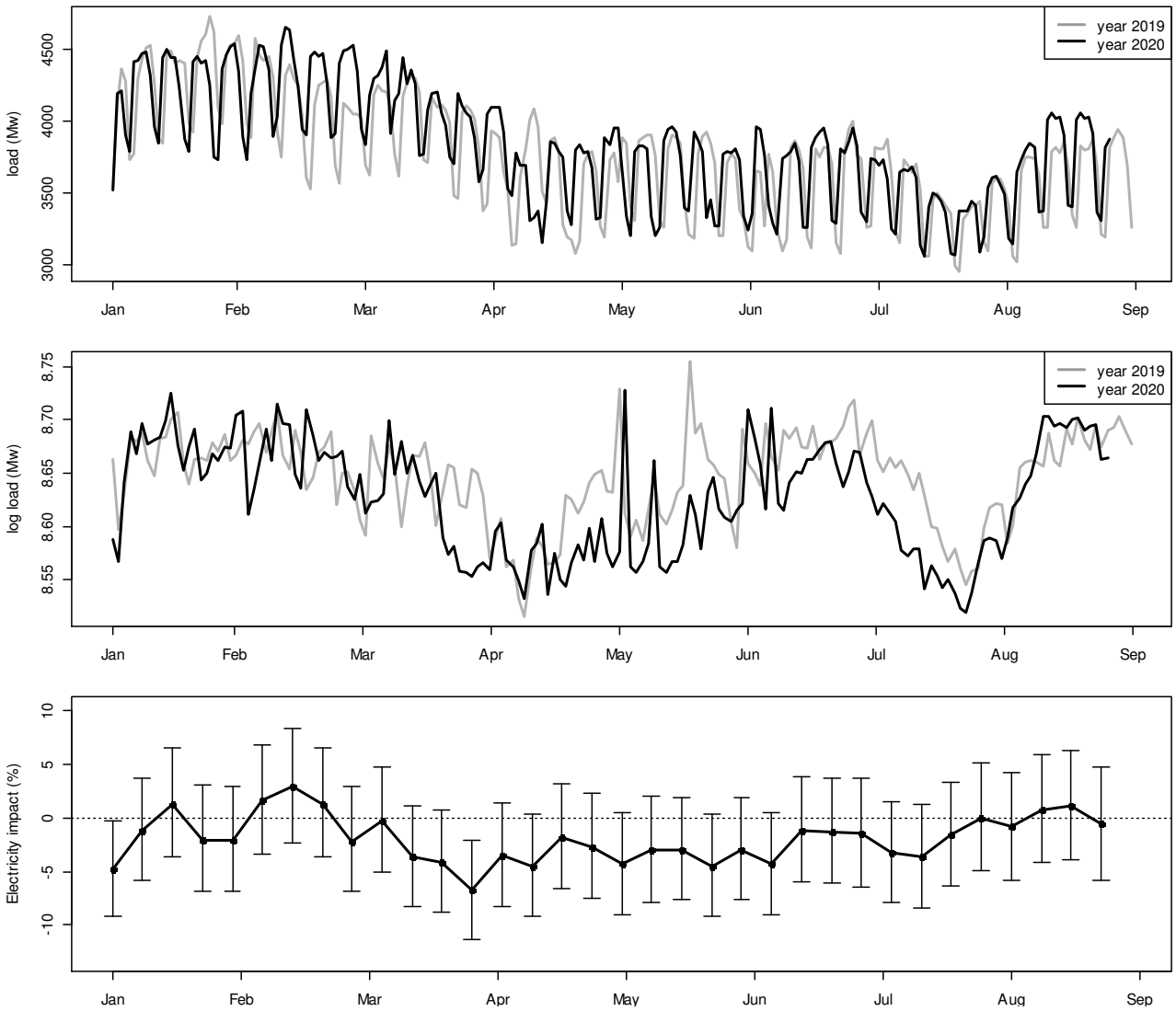
A1.1 Austria



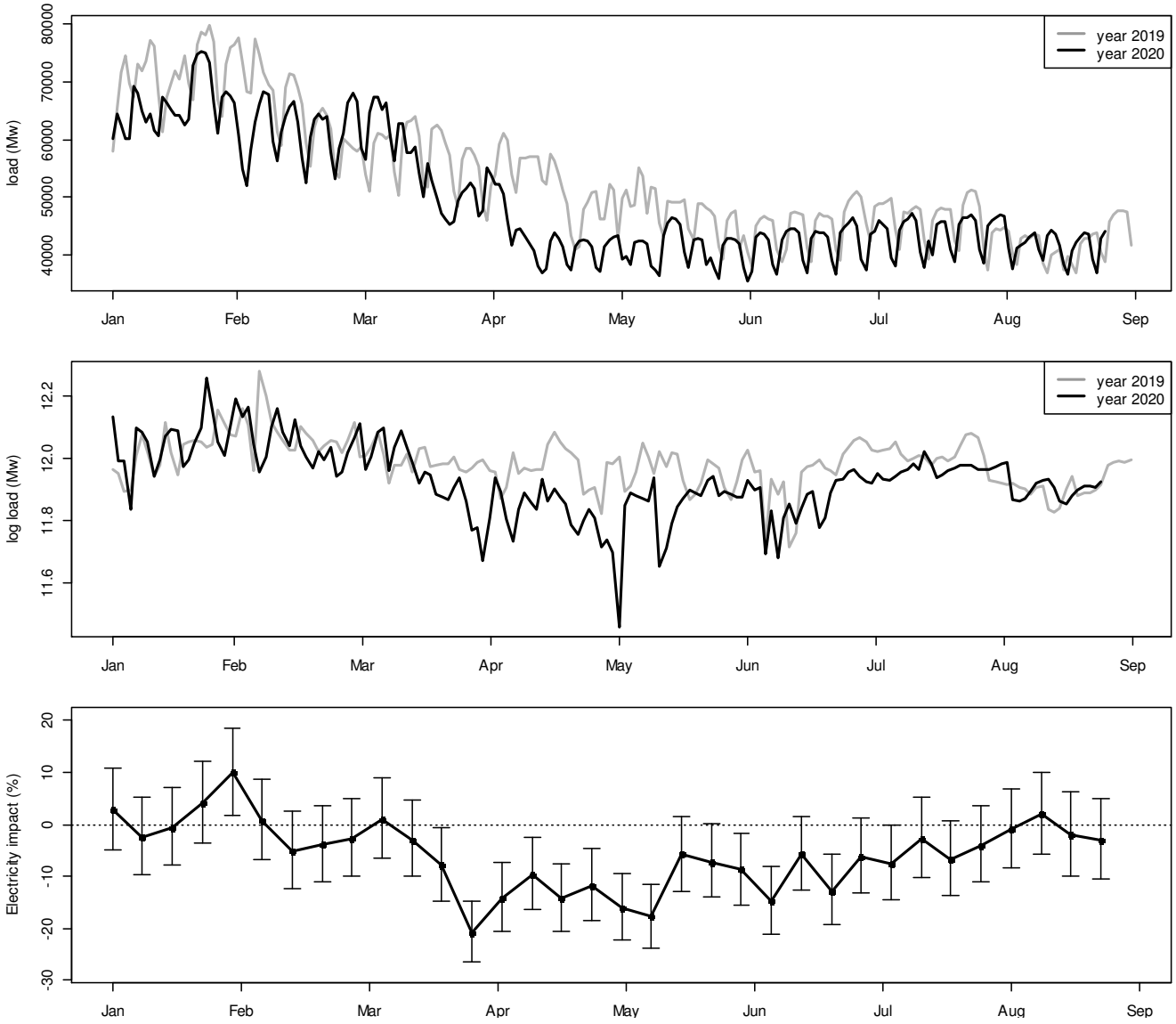
A1.2 Belgium


year 2019
year 2020
load (Mw)
8000
9000
10000
12000
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
log load (Mw)
9.35
9.40
9.45
9.50
9.55
9.60
Electricity impact (%)
-20
-15
-10
-5
0
5

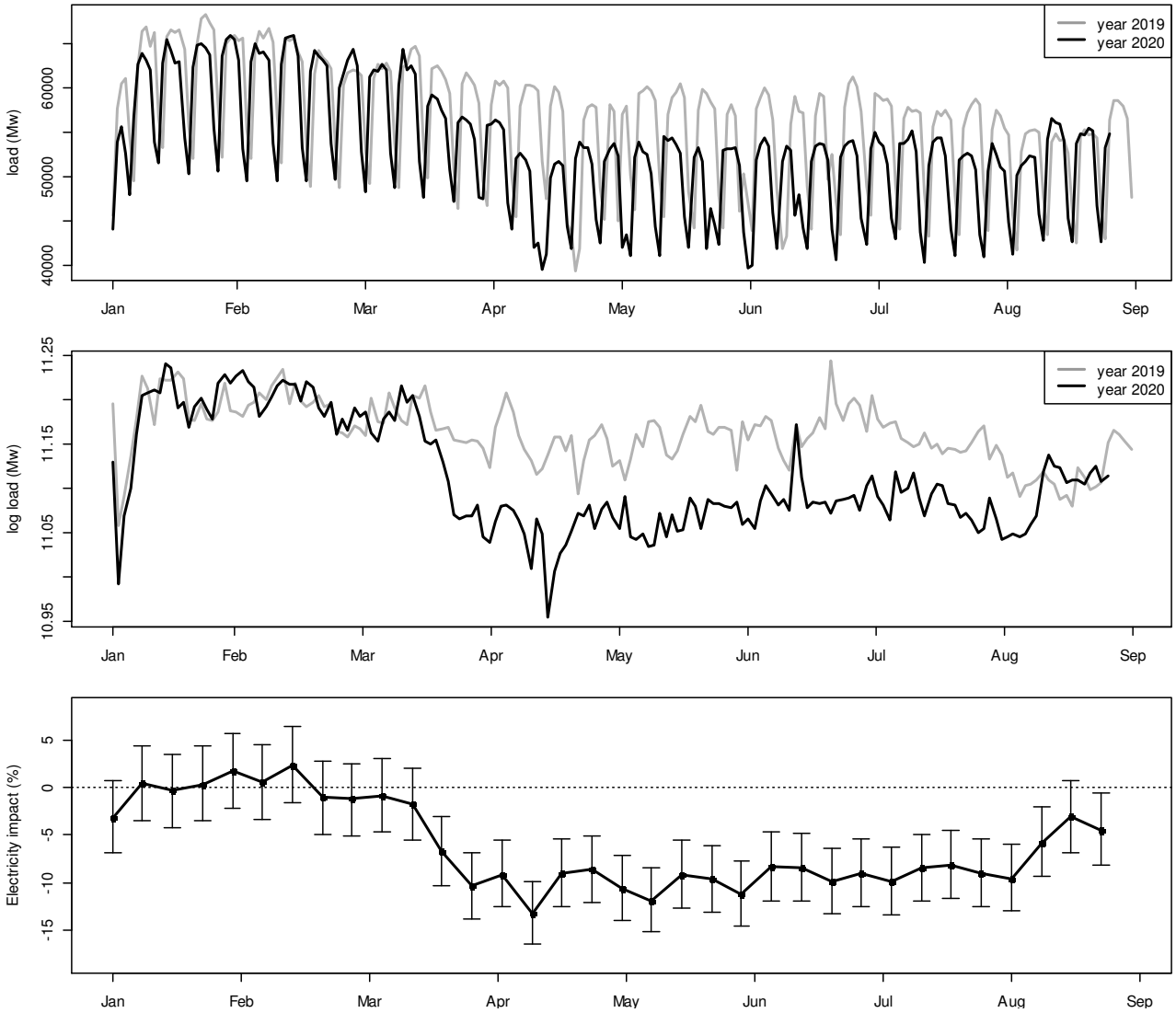
A1.3 Denmark


year 2019
year 2020
load (Mw)
3000
3500
4000
4500
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
log load (Mw)
8.55
8.60
8.65
8.70
8.75
Electricity impact (%)
-10
-5
0
5
10

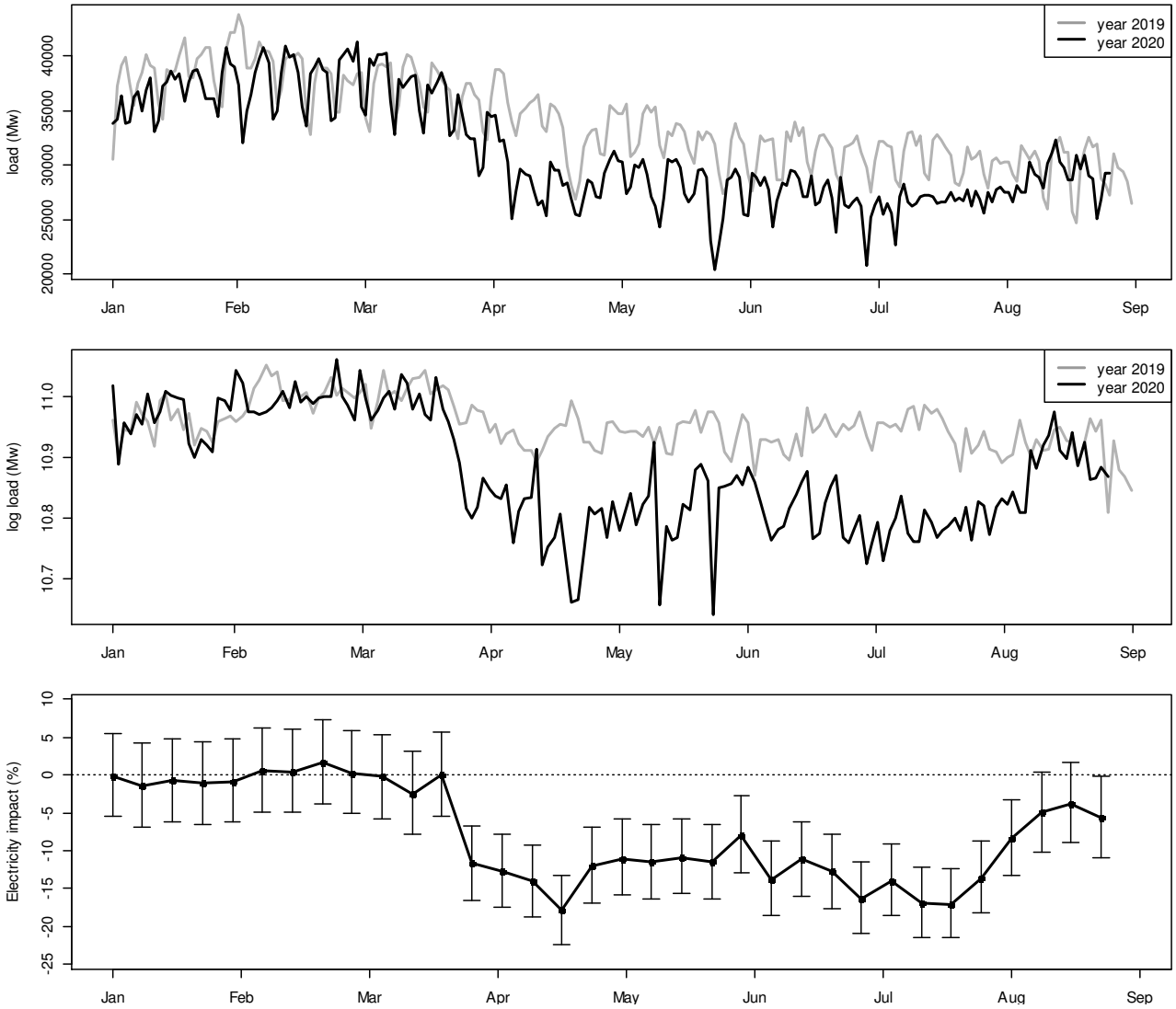
A1.4 France


load (Mw)
40000
50000
60000
70000
80000
year 2019
year 2020
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
log load (Mw)
11.6
11.8
12.0
12.2
Electricity impact (%)
-30
-20
-10
0
10
20

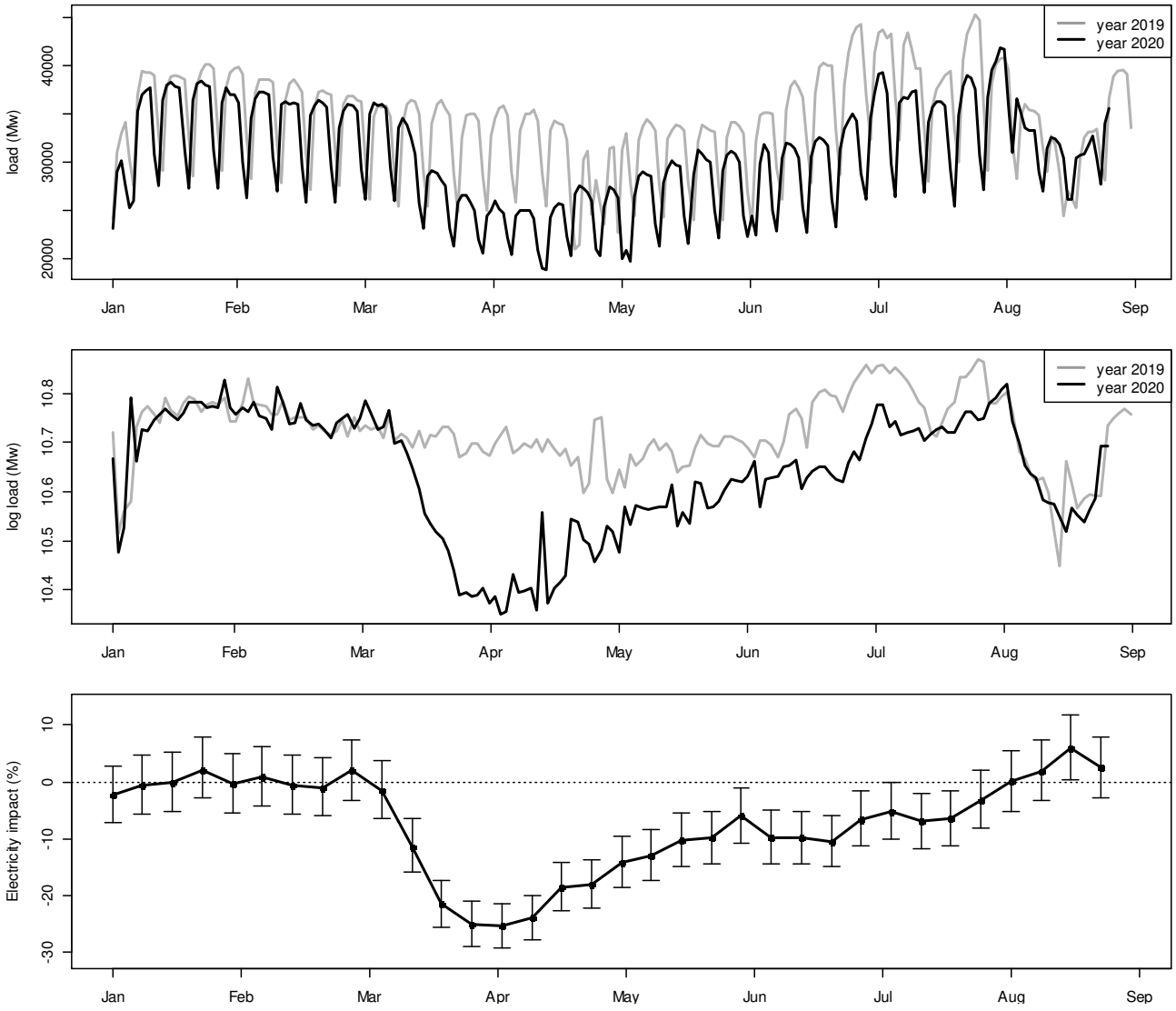
A1.5 Germany


year 2019
year 2020
load (Mw)
40000
50000
60000
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
log load (Mw)
10.95
11.05
11.15
11.25
Electricity impact (%)
-15
-10
-5
0
5

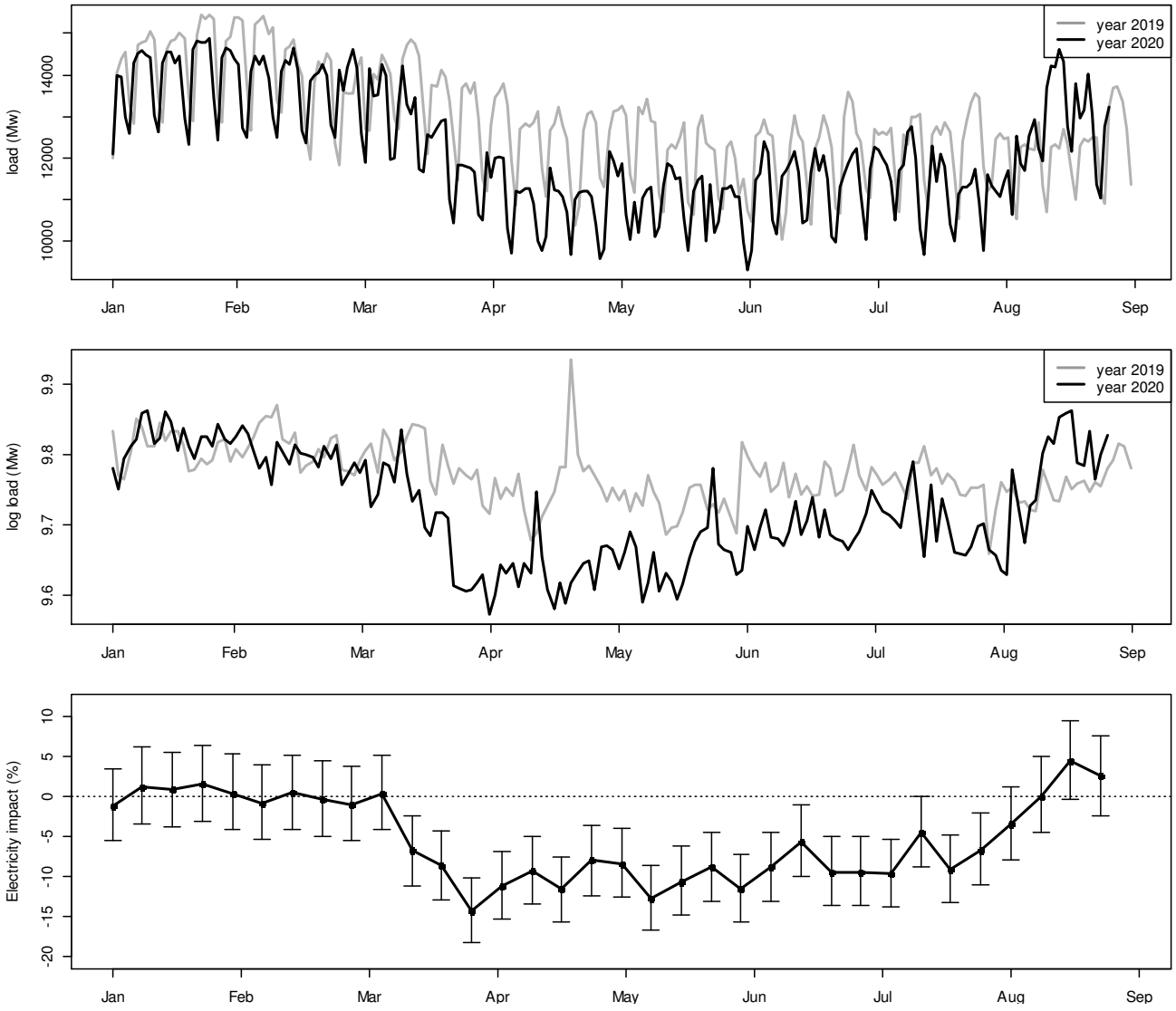
A1.6 Great Britain



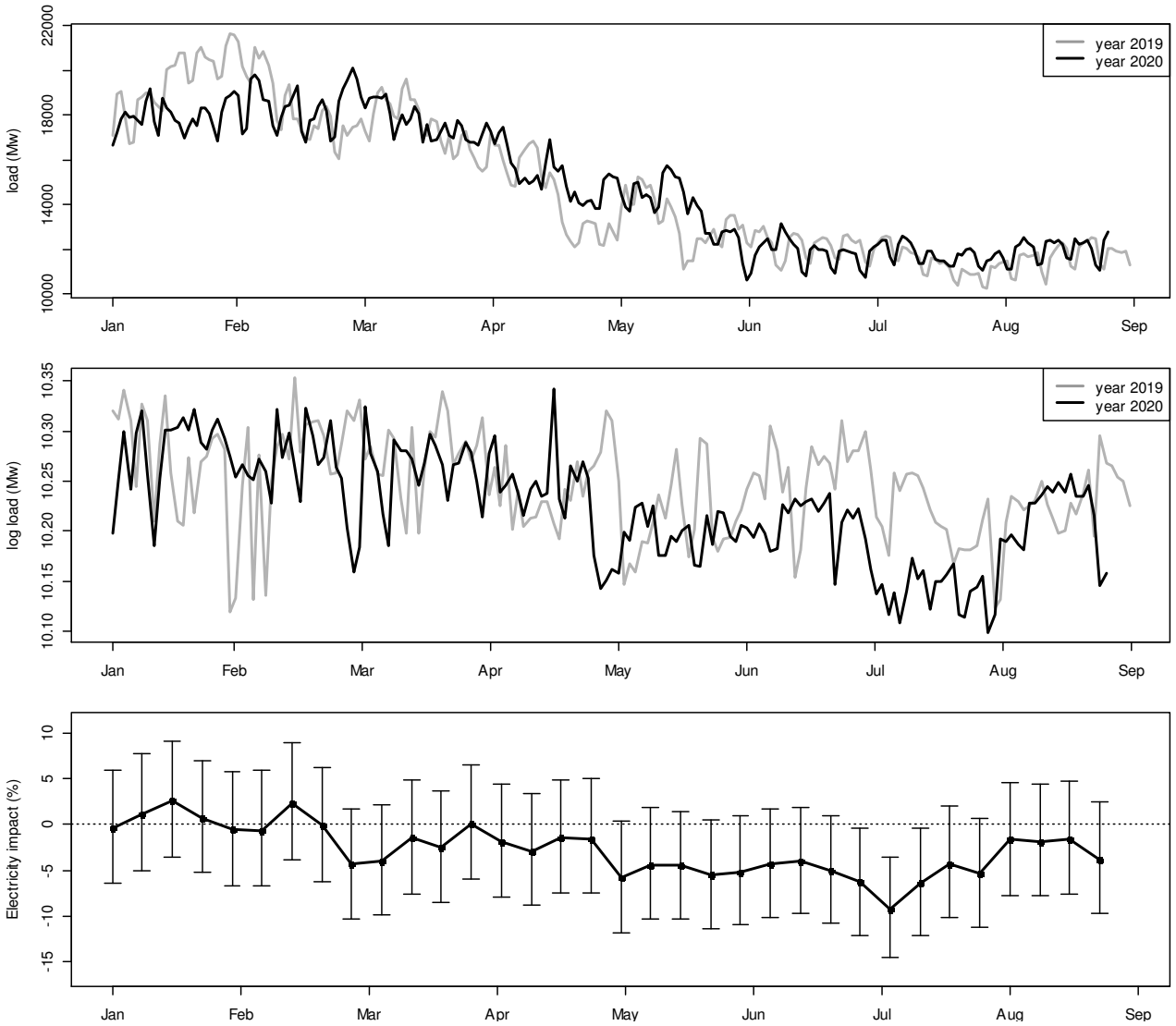
A1.7 Italy


year 2019
year 2020
load (Mw)
20000
30000
40000
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
log load (Mw)
10.4
10.5
10.6
10.7
10.8
Electricity impact (%)
-30
-20
-10
0
10

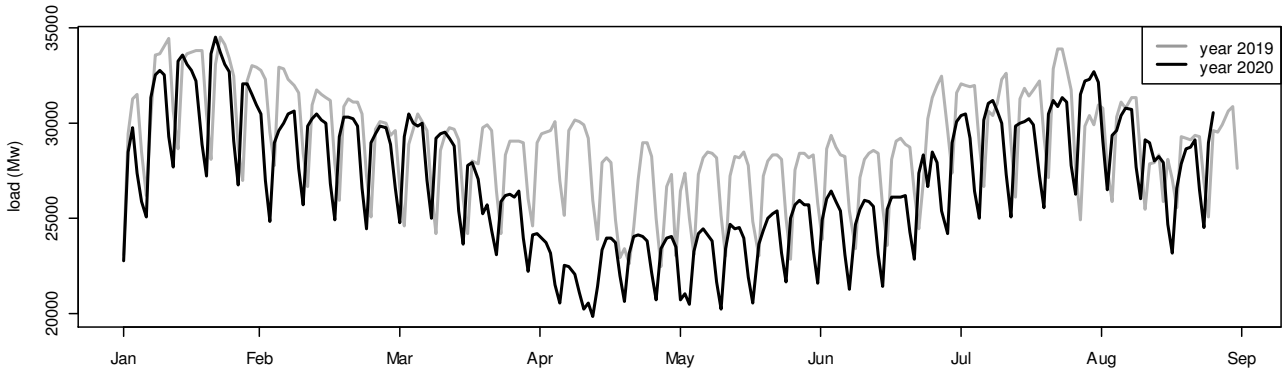
A1.8 Netherlands

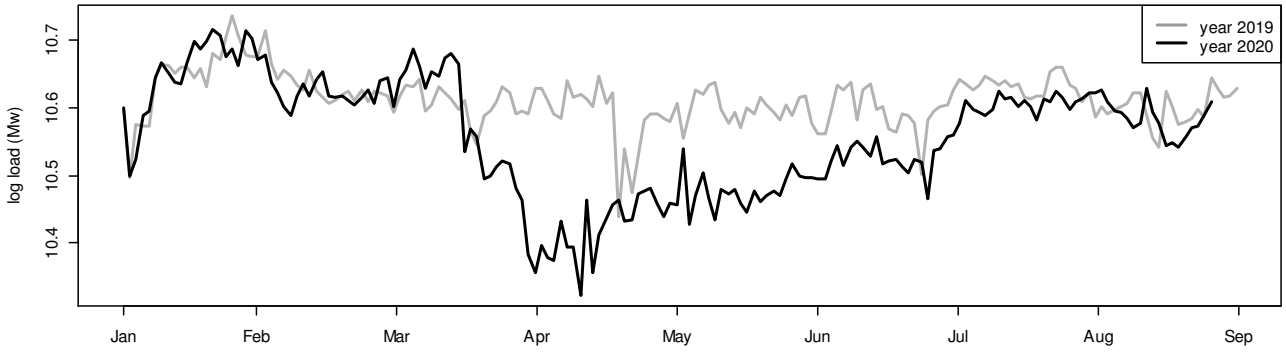


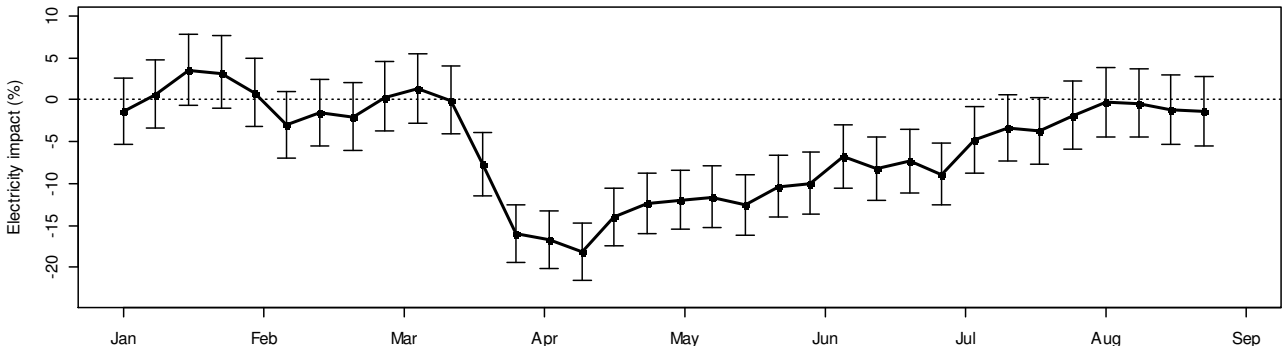
A1.9 Norway


load (Mw)
22000
18000
14000
10000
year 2019
year 2020
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
log load (Mw)
10.35
10.30
10.25
10.20
10.15
10.10
Electricity impact (%)
10
5
0
-5
-10
-15

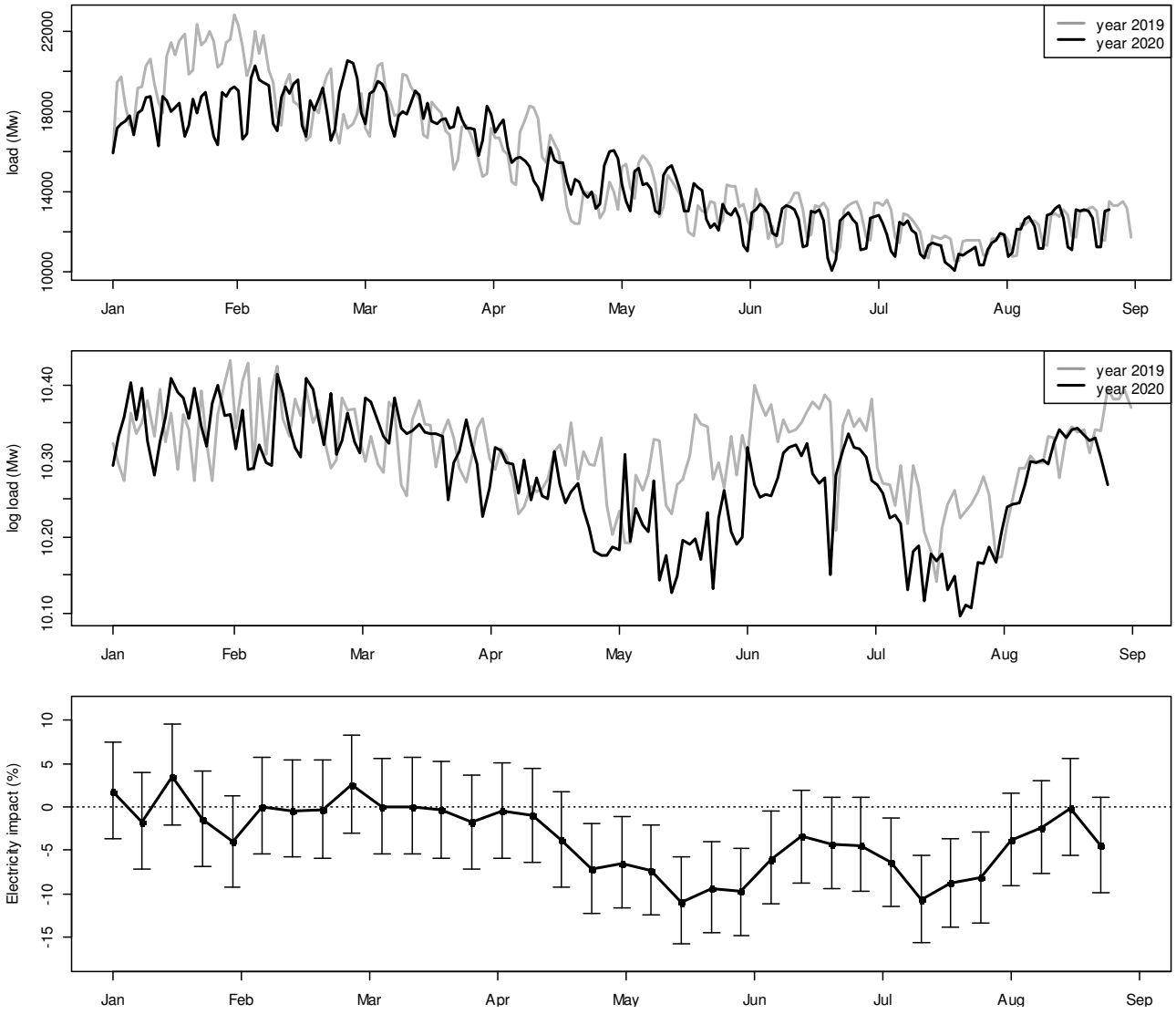
A1.10 Spain


load (Mw)
35000
30000
25000
20000
year 2019
year 2020
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep

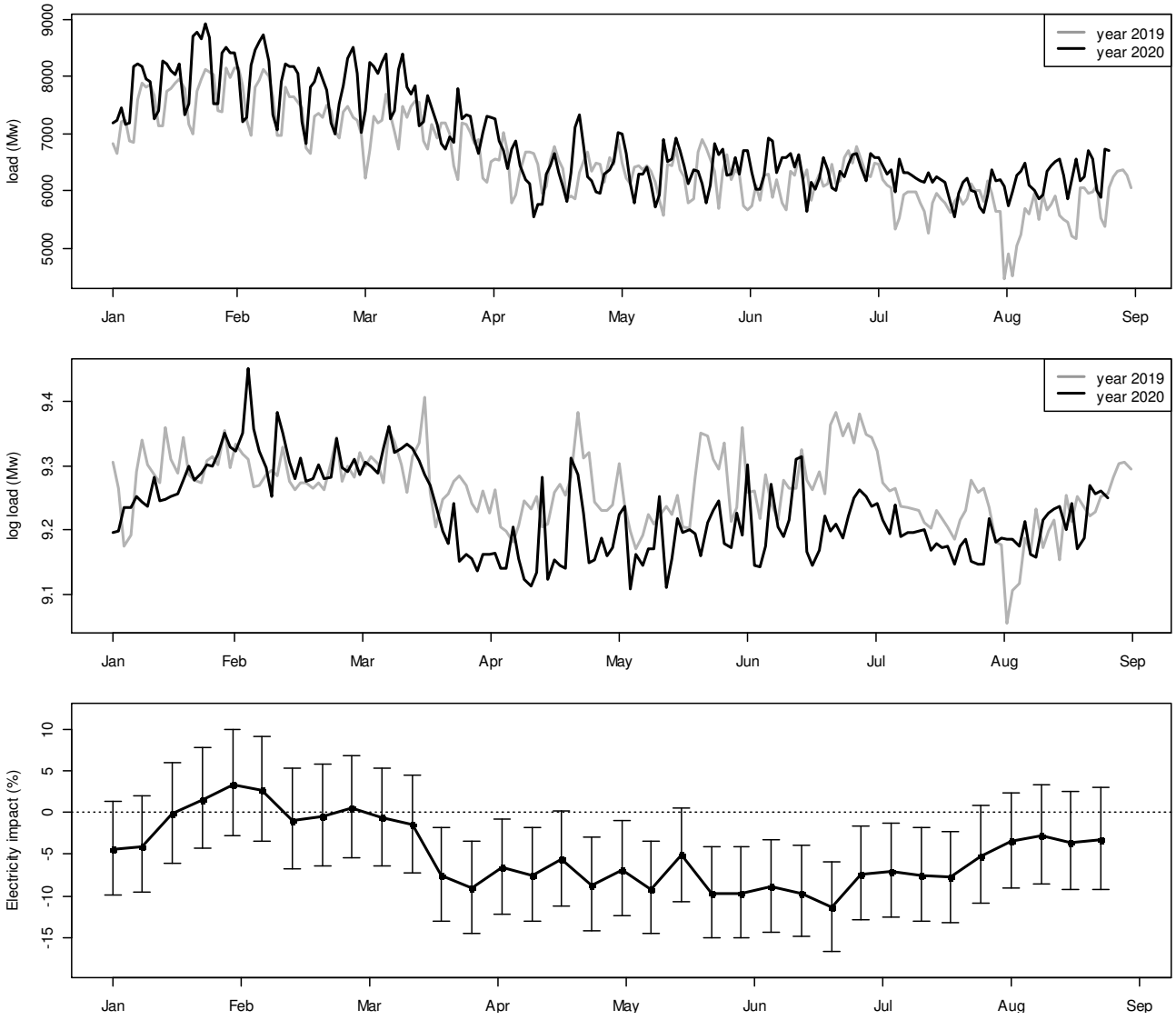

log load (Mw)
10.7
10.6
10.5
10.4
year 2019
year 2020
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep


Electricity impact (%)
10
5
0
-5
-10
-15
-20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep

A1.11 Sweden


load (Mw)
10000
14000
18000
22000
year 2019
year 2020
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
log load (Mw)
10.10
10.20
10.30
10.40
year 2019
year 2020
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Electricity impact (%)
-15
-10
-5
0
5
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep

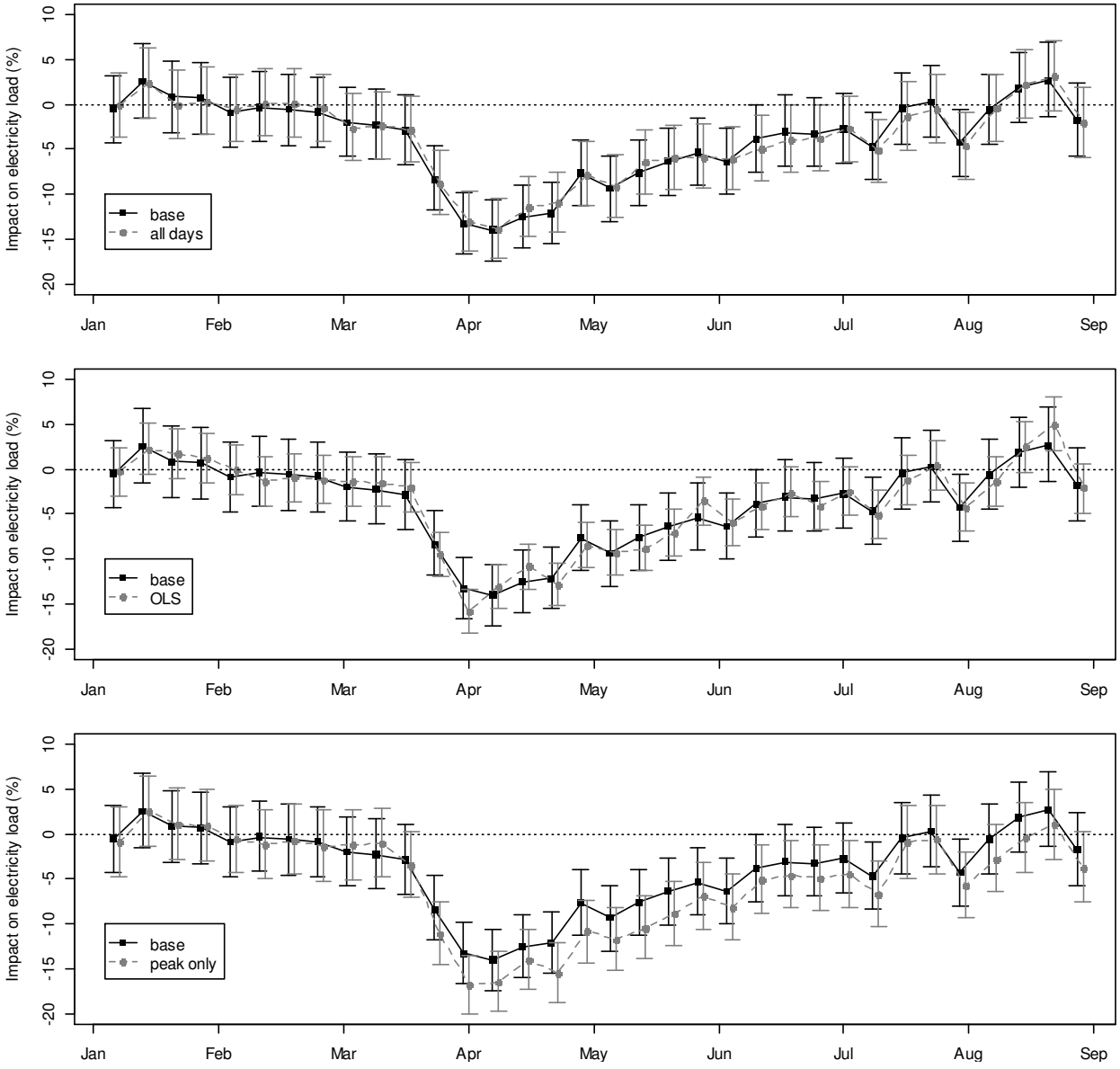
A1.12 Switzerland



A2: Robustness tests

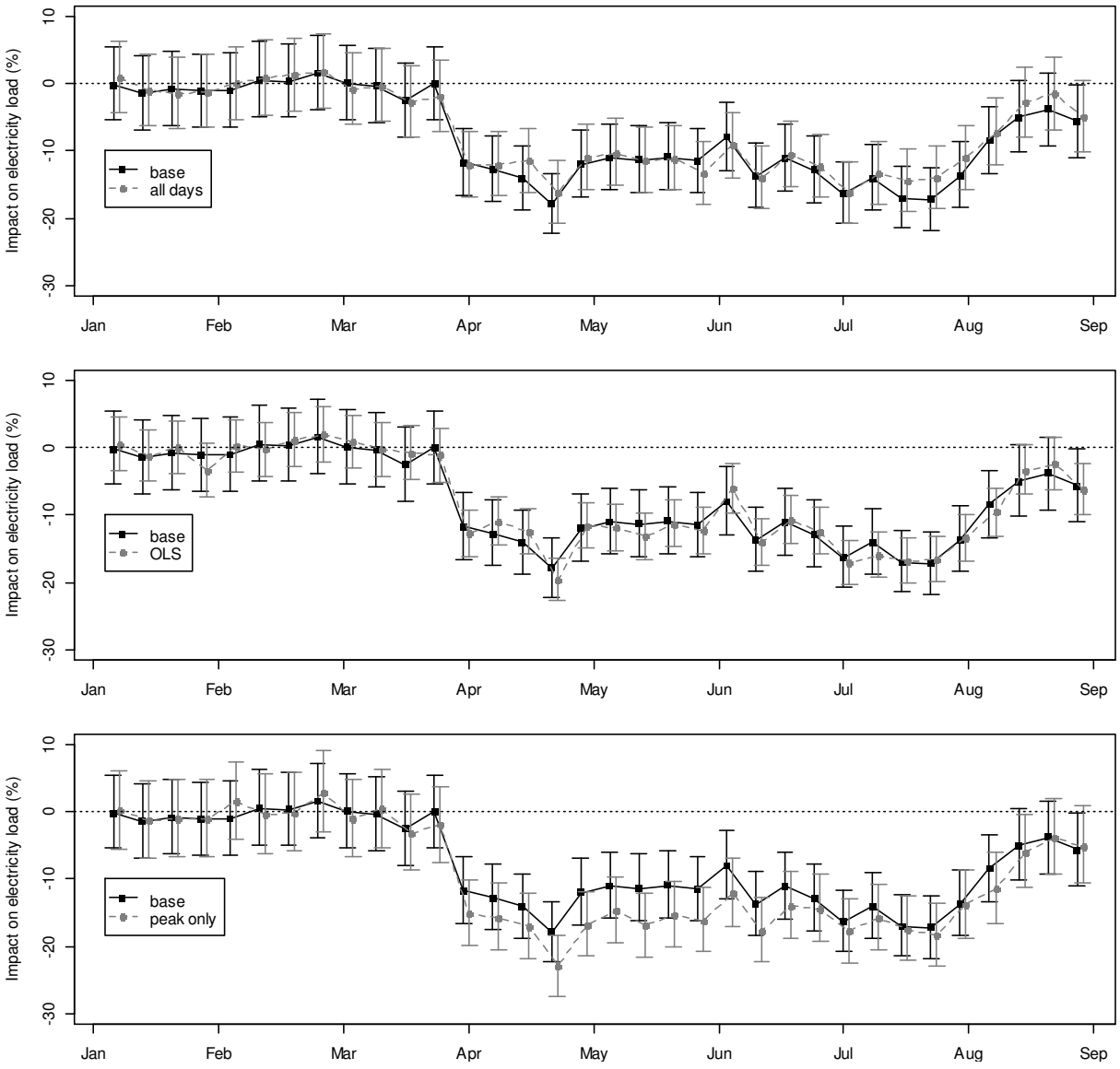
In our main model we calculate daily electricity load by averaging all hourly (or intra-hourly) information of each day, we excluded weekends and estimated our model via maximum likelihood to allow the error term to have an ARMA component. Here, we compare the estimated electricity load impacts in our main specification with three alternatives: 1) considering all days, including weekends, 2) estimating the main model with OLS with HAC standard errors, 3) focusing only on weekday peak hours, i.e. hours between 8am and 6pm. In order to preserve space, we present results only for the four countries included in Figure 3, i.e. Belgium, Denmark, Great Britain and Sweden. In general, confidence intervals from considering all days are slightly smaller because the fixed effect parameters are estimated on 7 observations instead of 5. Also, the OLS estimator generates smaller confidence intervals. Finally, using peak-only hours estimates a somewhat more intense reduction during the lockdown, since the peak represents the moment when working activities consume the highest percentage of electricity consumption. Despite these differences, the three alternative specification generate results that are consistent with those provided by our main model.

Figure A2.1: Alternative specifications for Belgium



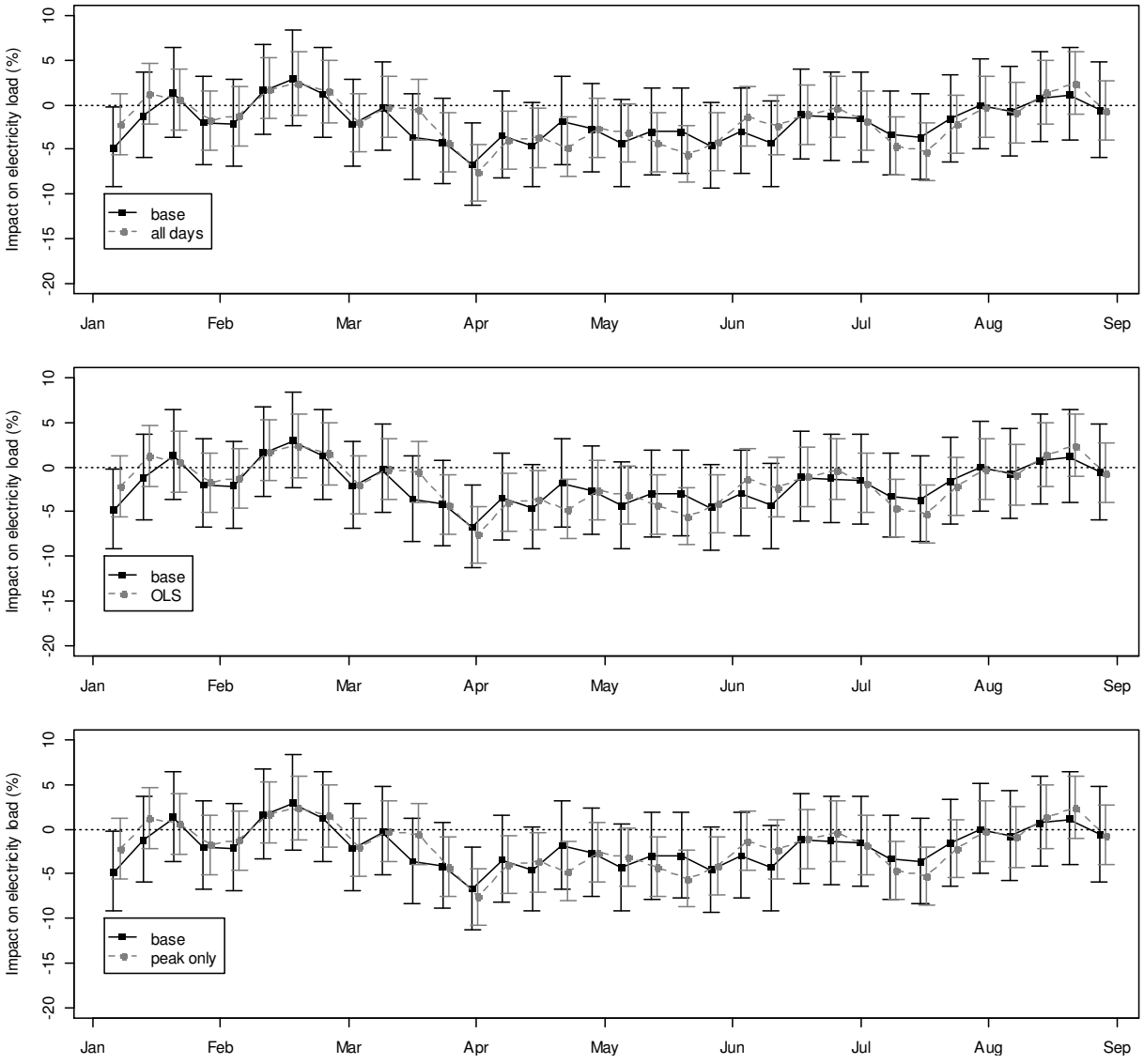
Notes: the plots compare the estimated impact of COVID-19 on electricity consumption according to our base model and three alternative specifications: "all days" = including weekdays and weekends, "OLS" = estimating the model with OLS instead of ML, "peak only" = estimating the model using only peak hourly data, i.e. from 8am to 6pm). Vertical bars are 95% confidence intervals.

Figure A2.2: Alternative specifications for Great Britain



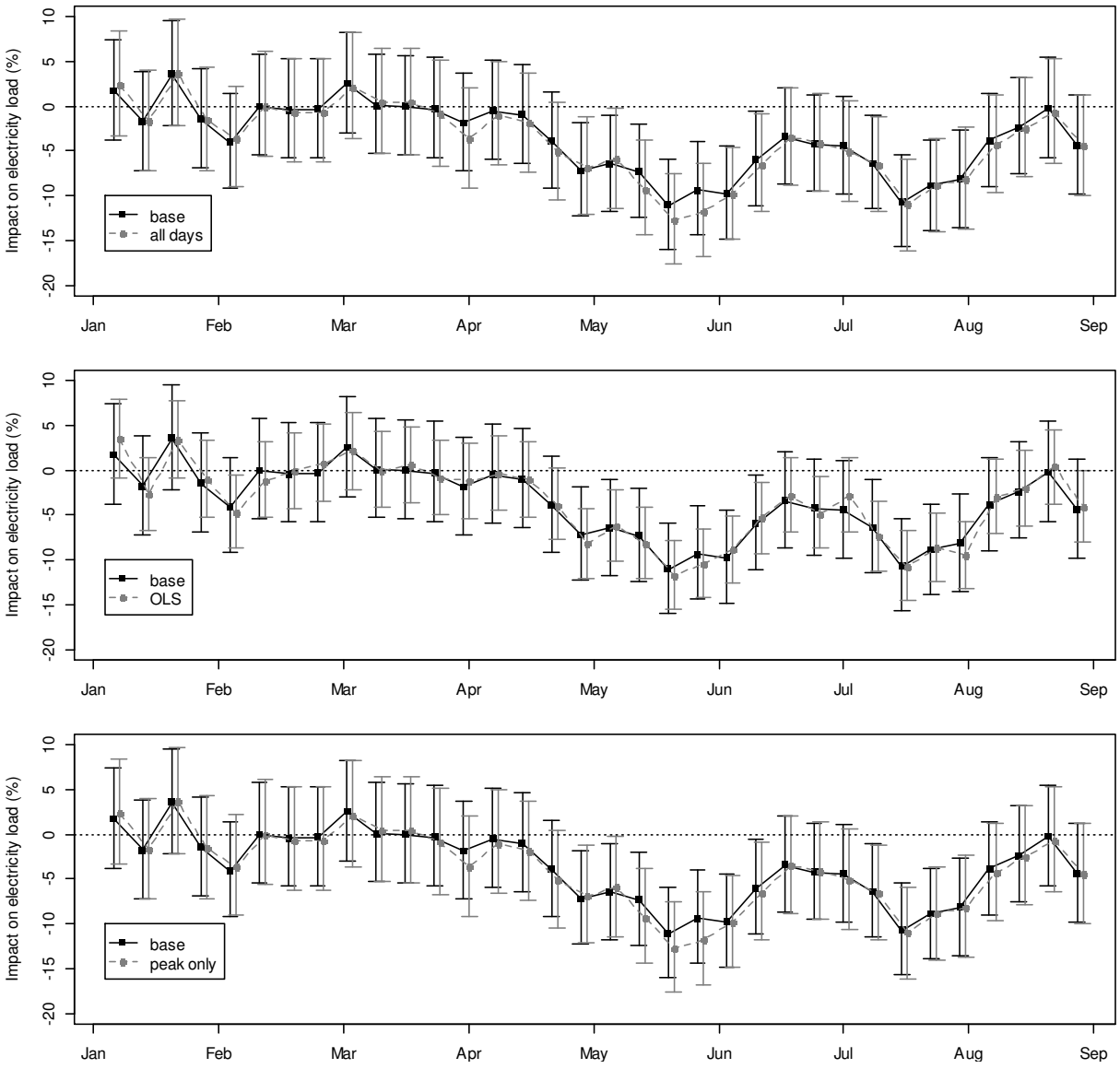
Notes: the plots compare the estimated impact of COVID-19 on electricity consumption according to our base model and three alternative specifications: "all days" = including weekdays and weekends, "OLS" = estimating the model with OLS instead of ML, "peak only" = estimating the model using only peak hourly data, i.e. from 8am to 6pm). Vertical bars are 95% confidence intervals.

Figure A2.3: Alternative specifications for Denmark



Notes: the plots compare the estimated impact of COVID-19 on electricity consumption according to our base model and three alternative specifications: "all days" = including weekdays and weekends, "OLS" = estimating the model with OLS instead of ML, "peak only" = estimating the model using only peak hourly data, i.e. from 8am to 6pm). Vertical bars are 95% confidence intervals.

Figure A2.4: Alternative specifications for Sweden



Notes: the plots compare the estimated impact of COVID-19 on electricity consumption according to our base model and three alternative specifications: "all days" = including weekdays and weekends, "OLS" = estimating the model with OLS instead of ML, "peak only" = estimating the model using only peak hourly data, i.e. from 8am to 6pm). Vertical bars are 95% confidence intervals.

A3: Estimated GDP impacts

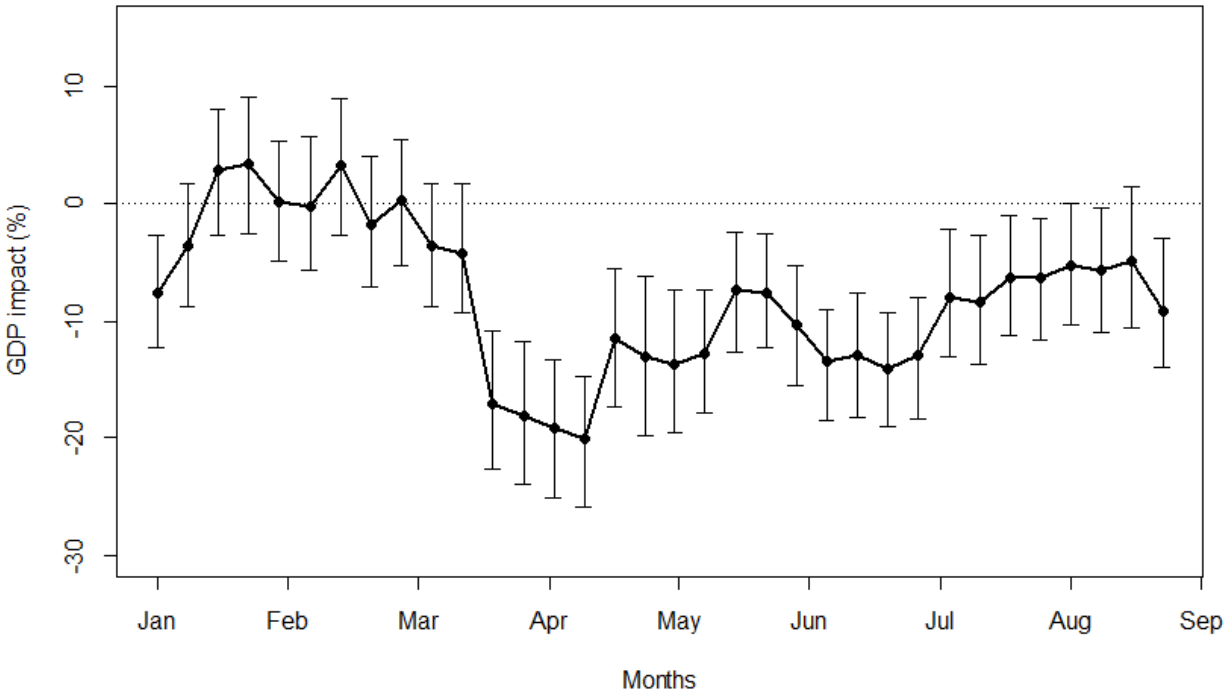
Austria

Monthly GDP impacts

Month	GDP impact	Lower bound	Upper bound	Significance
March	-9.23	-12.61	-6.00	***
April	-15.98	-19.60	-12.55	***
May	-9.60	-12.89	-6.39	***
June	-13.18	-16.06	-9.99	***
July	-7.16	-10.66	-4.01	***
August	-6.27	-9.61	-2.54	***

Notes: lower and upper bounds indicate 95% confidence intervals obtained with 5000 Monte Carlo repetitions. Stars indicate significance as follows: *** = 1%, ** = 5%, * = 10%.

Weekly GDP impact plot



Notes: vertical lines indicate 95% confidence intervals.

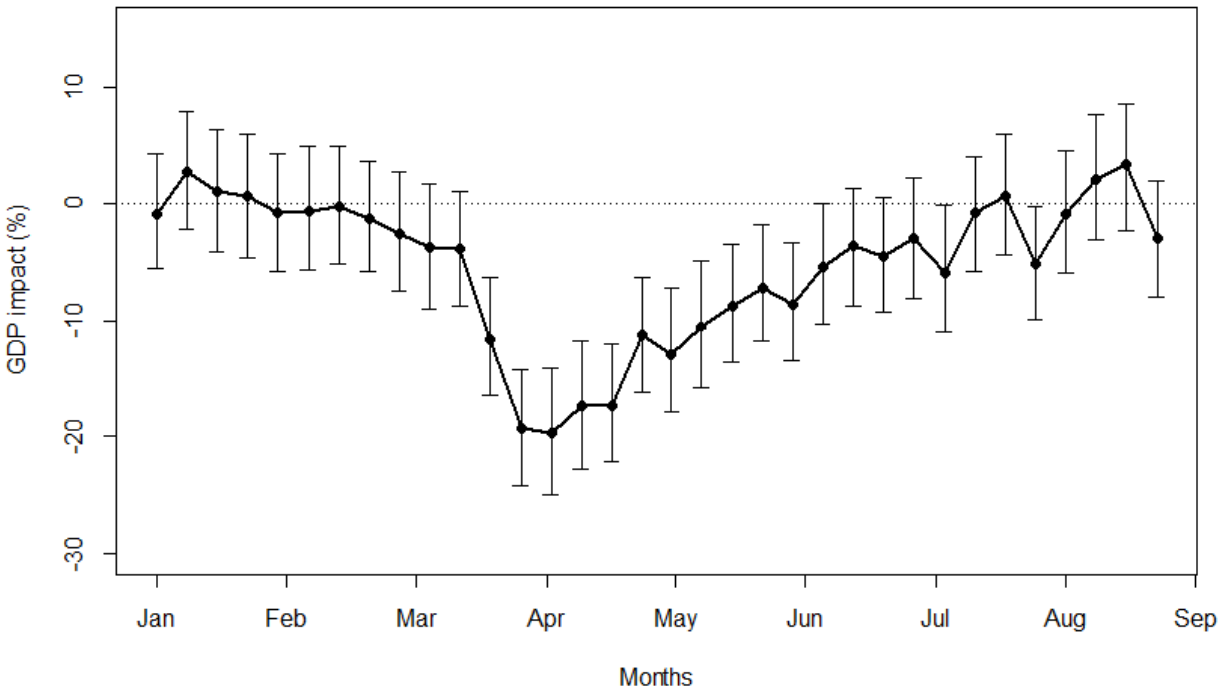
Belgium

Monthly GDP impacts

Month	GDP impact	Lower bound	Upper bound	Significance
March	-8.54	-11.78	-5.47	***
April	-16.22	-19.87	-12.69	***
May	-9.13	-12.39	-5.87	***
June	-4.44	-7.55	-0.77	**
July	-2.63	-6.14	0.80	*
August	0.75	-3.19	4.65	

Notes: lower and upper bounds indicate 95% confidence intervals obtained with 5000 Monte Carlo repetitions. Stars indicate significance as follows: *** = 1%, ** = 5%, * = 10%.

Weekly GDP impact plot



Notes: vertical lines indicate 95% confidence intervals.

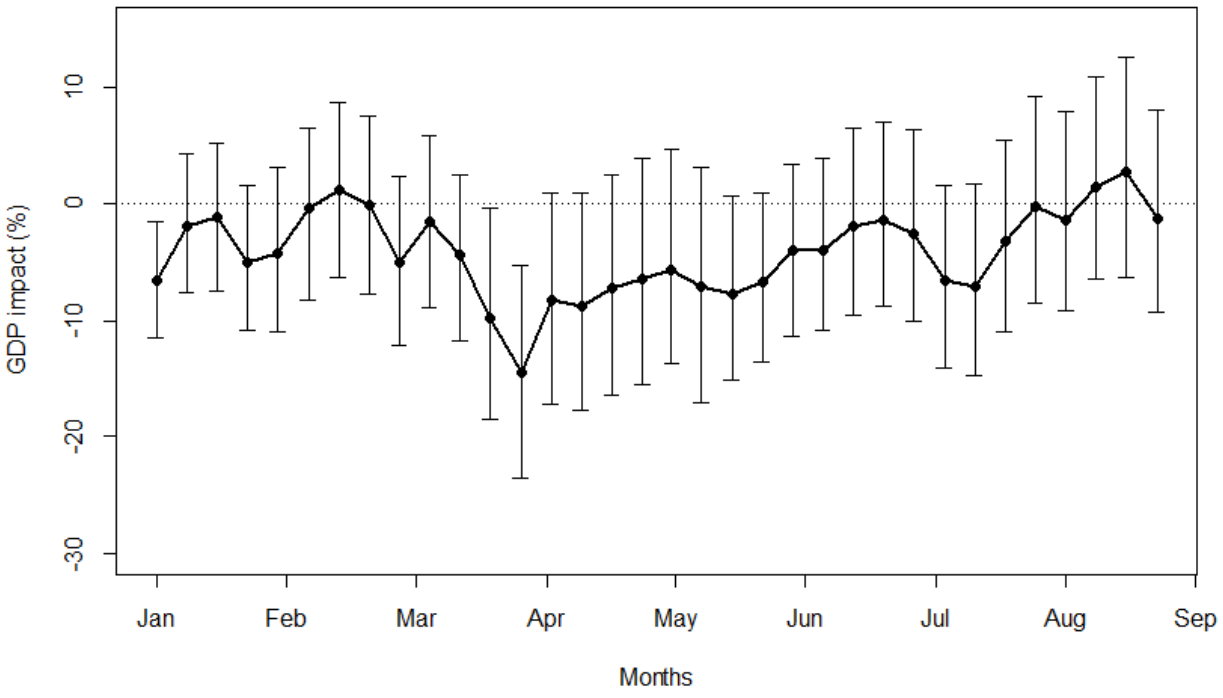
Denmark

Monthly GDP impacts

Month	GDP impact	Lower bound	Upper bound	Significance
March	-6.82	-13.96	0.75	*
April	-7.5	-15.09	1.08	*
May	-6.46	-13.43	0.72	*
June	-2.61	-8.91	4.29	
July	-3.99	-10.56	2.40	
August	0.48	-6.78	7.65	

Notes: lower and upper bounds indicate 95% confidence intervals obtained with 5000 Monte Carlo repetitions. Stars indicate significance as follows: *** = 1%, ** = 5%, * = 10%.

Weekly GDP impact plot



Notes: vertical lines indicate 95% confidence intervals.

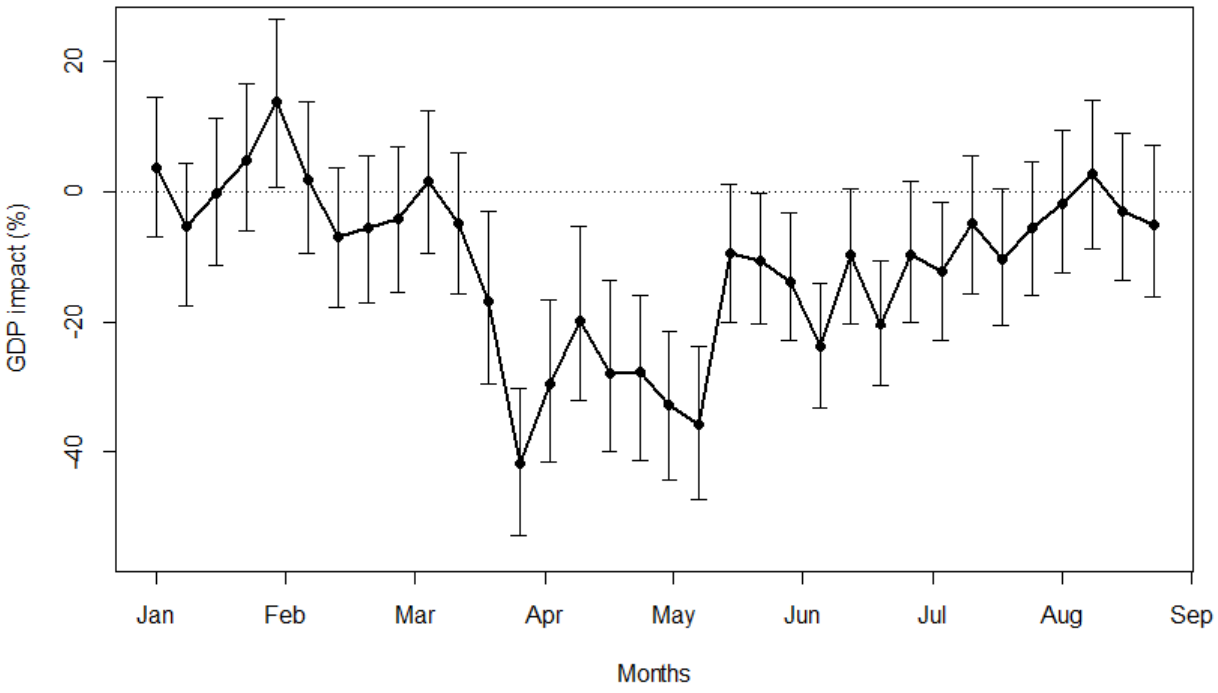
France

Monthly GDP impacts

Month	GDP impact	Lower bound	Upper bound	Significance
March	-12.90	-18.13	-8.14	***
April	-26.52	-32.29	-19.53	***
May	-18.52	-24.26	-13.25	***
June	-15.95	-20.66	-10.59	***
July	-7.27	-11.88	-2.24	**
August	-1.76	-8.09	4.91	

Notes: lower and upper bounds indicate 95% confidence intervals obtained with 5000 Monte Carlo repetitions. Stars indicate significance as follows: *** = 1%, ** = 5%, * = 10%.

Weekly GDP impacts plot



Notes: vertical lines indicate 95% confidence intervals.

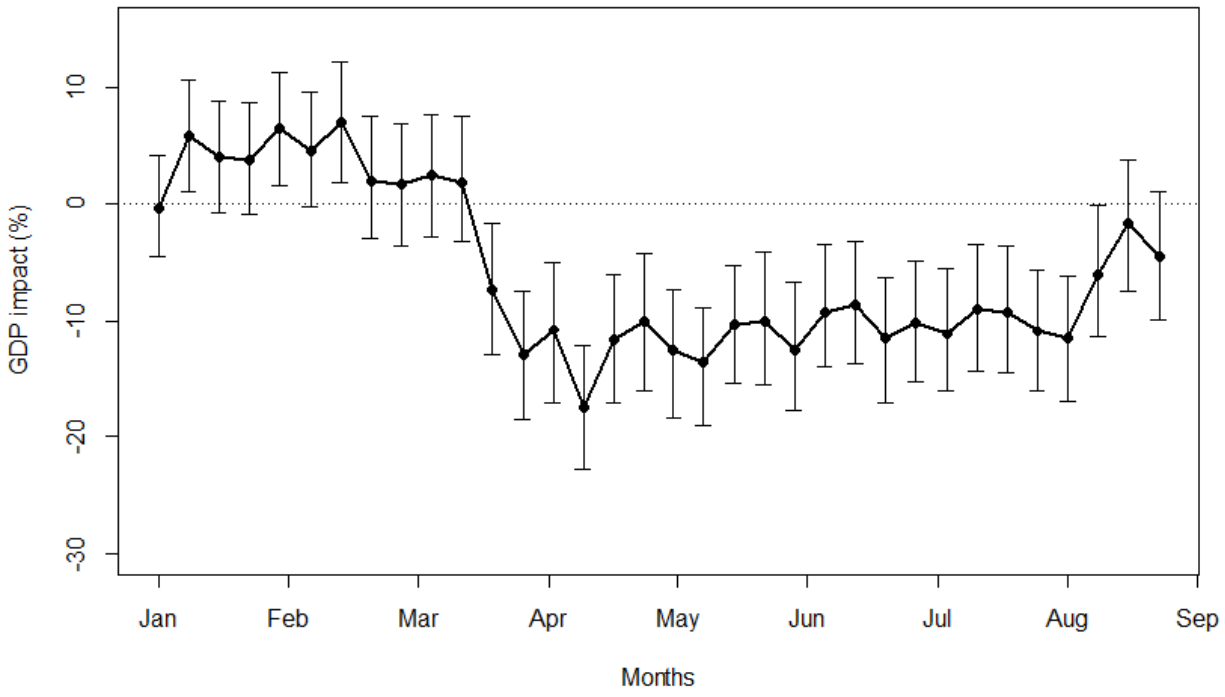
Germany

Monthly GDP impacts

Month	GDP impact	Lower bound	Upper bound	Significance
March	-3.08	-7.17	0.87	*
April	-12.55	-16.73	-8.4	***
May	-11.76	-15.92	-7.35	***
June	-10.15	-14.41	-5.47	***
July	-10.28	-14.77	-5.73	***
August	-4.93	-9.62	-0.29	**

Notes: lower and upper bounds indicate 95% confidence intervals obtained with 5000 Monte Carlo repetitions. Stars indicate significance as follows: *** = 1%, ** = 5%, * = 10%.

Weekly GDP impacts plot



Notes: vertical lines indicate 95% confidence intervals.

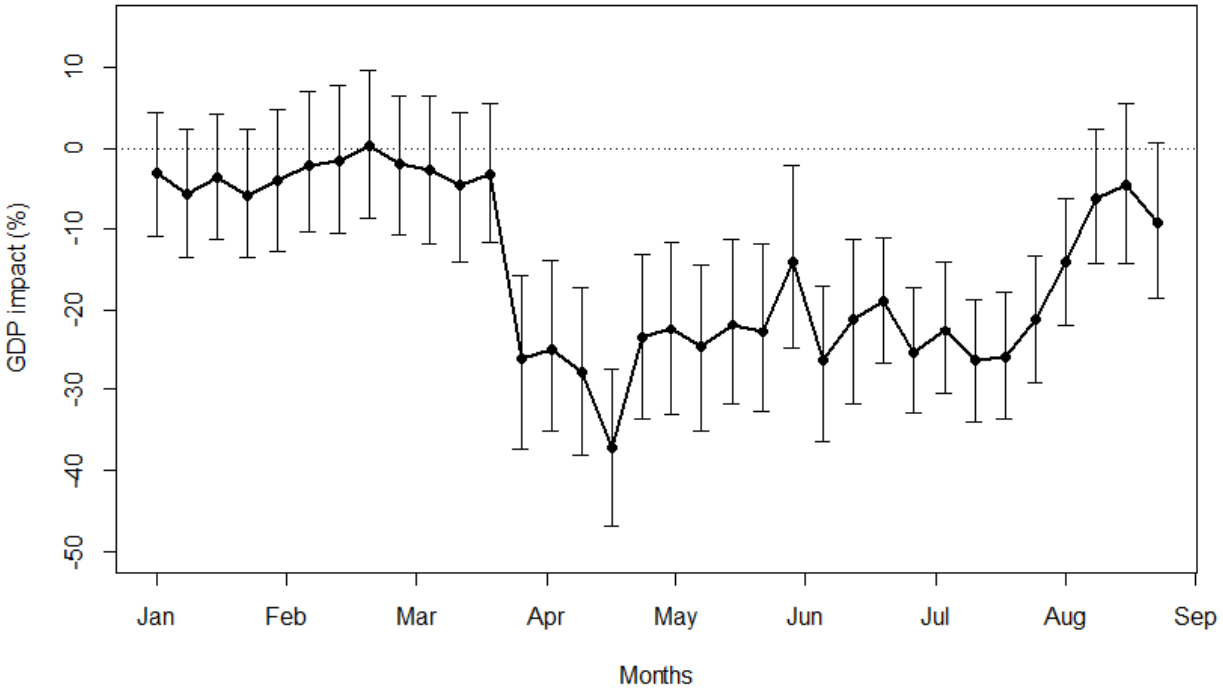
Great Britain

Monthly GDP impacts

Month	GDP impact	Lower bound	Upper bound	Significance
March	-7.55	-14.39	-0.24	**
April	-27.74	-35.43	-20.51	***
May	-21.79	-29.63	-13.56	***
June	-22.15	-28.94	-15.54	***
July	-22.65	-28.66	-16.25	***
August	-7.92	-14.56	-0.62	*

Notes: lower and upper bounds indicate 95% confidence intervals obtained with 5000 Monte Carlo repetitions. Stars indicate significance as follows: *** = 1%, ** = 5%, * = 10%.

Weekly GDP impacts plot



Notes: vertical lines indicate 95% confidence intervals.

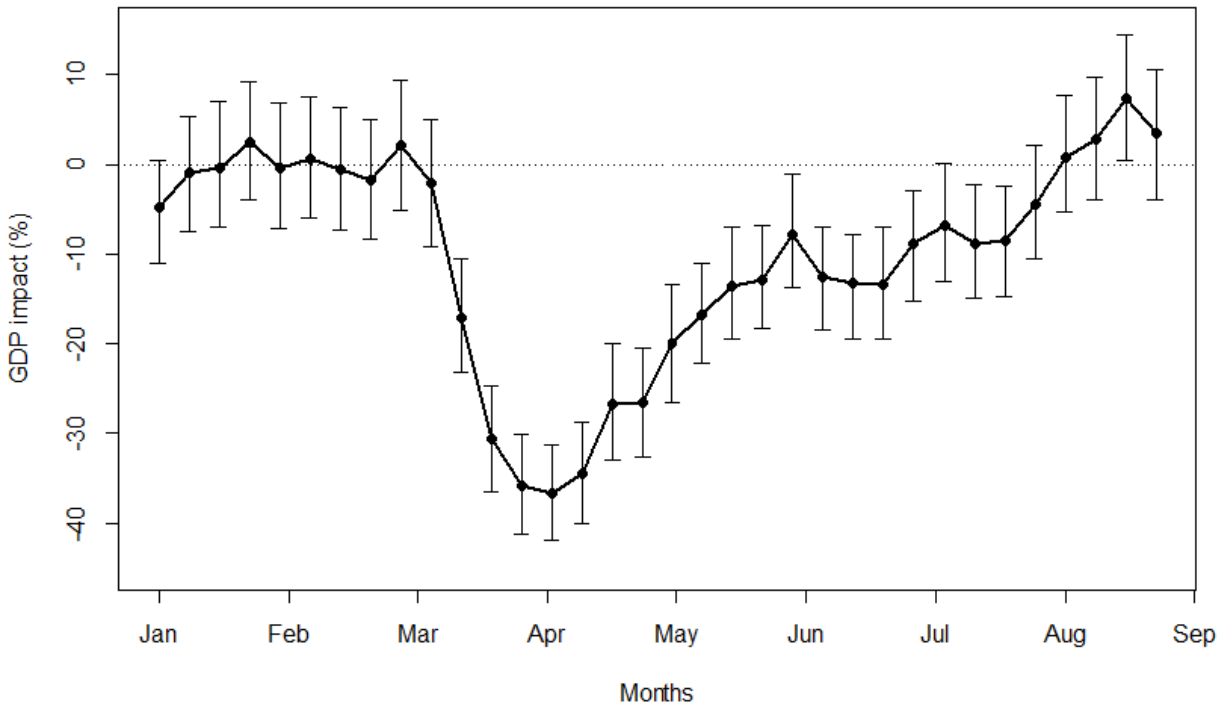
Italy

Monthly GDP impacts

Month	GDP impact	Lower bound	Upper bound	Significance
March	-18.68	-22.65	-15.00	***
April	-30.2	-34.1	-26.58	***
May	-14.04	-17.52	-9.96	***
June	-11.56	-15.3	-7.77	***
July	-6.10	-9.55	-2.41	***
August	4.07	-0.79	8.58	

Notes: lower and upper bounds indicate 95% confidence intervals obtained with 5000 Monte Carlo repetitions. Stars indicate significance as follows: *** = 1%, ** = 5%, * = 10%.

Weekly GDP impacts plot



Notes: vertical lines indicate 95% confidence intervals.

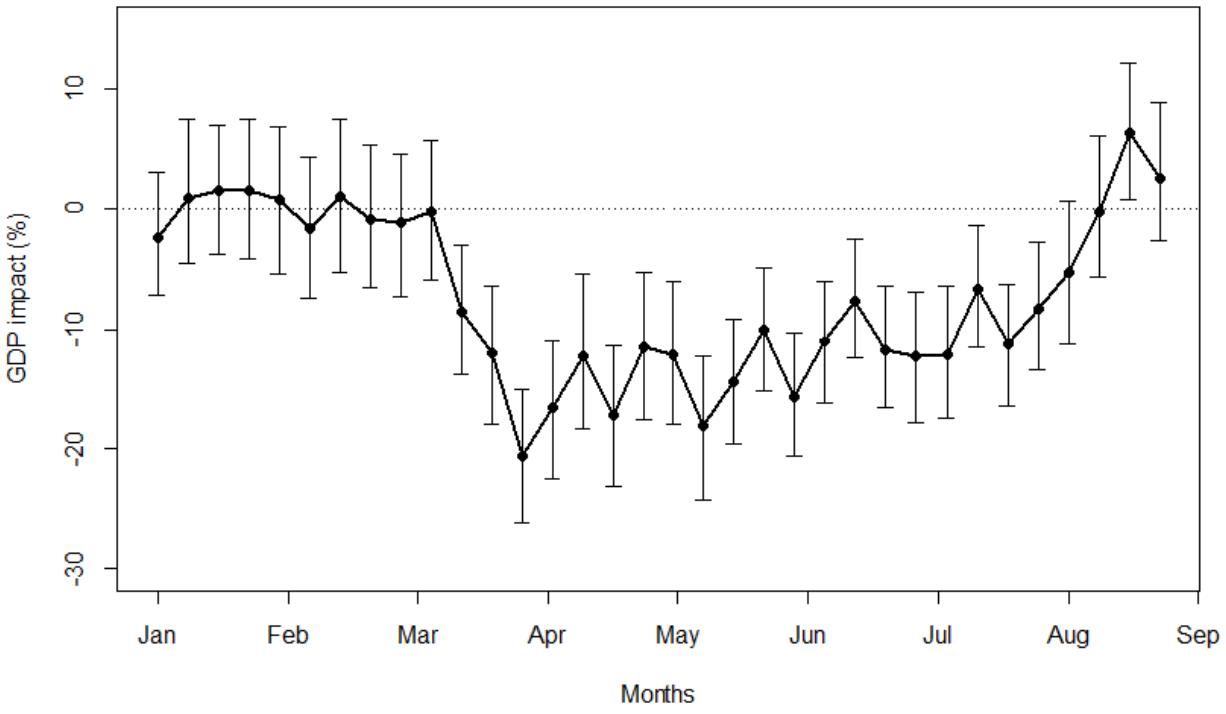
Netherlands

Monthly GDP impacts

Month	GDP impact	Lower bound	Upper bound	Significance
March	-9.29	-13.04	-5.56	***
April	-14.23	-17.98	-10.4	***
May	-13.98	-17.65	-10.38	***
June	-11.15	-14.27	-7.91	***
July	-9.03	-11.7	-5.92	***
August	1.98	-2.06	6.26	

Notes: lower and upper bounds indicate 95% confidence intervals obtained with 5000 Monte Carlo repetitions. Stars indicate significance as follows: *** = 1%, ** = 5%, * = 10%.

Weekly GDP impacts plot



Notes: vertical lines indicate 95% confidence intervals.

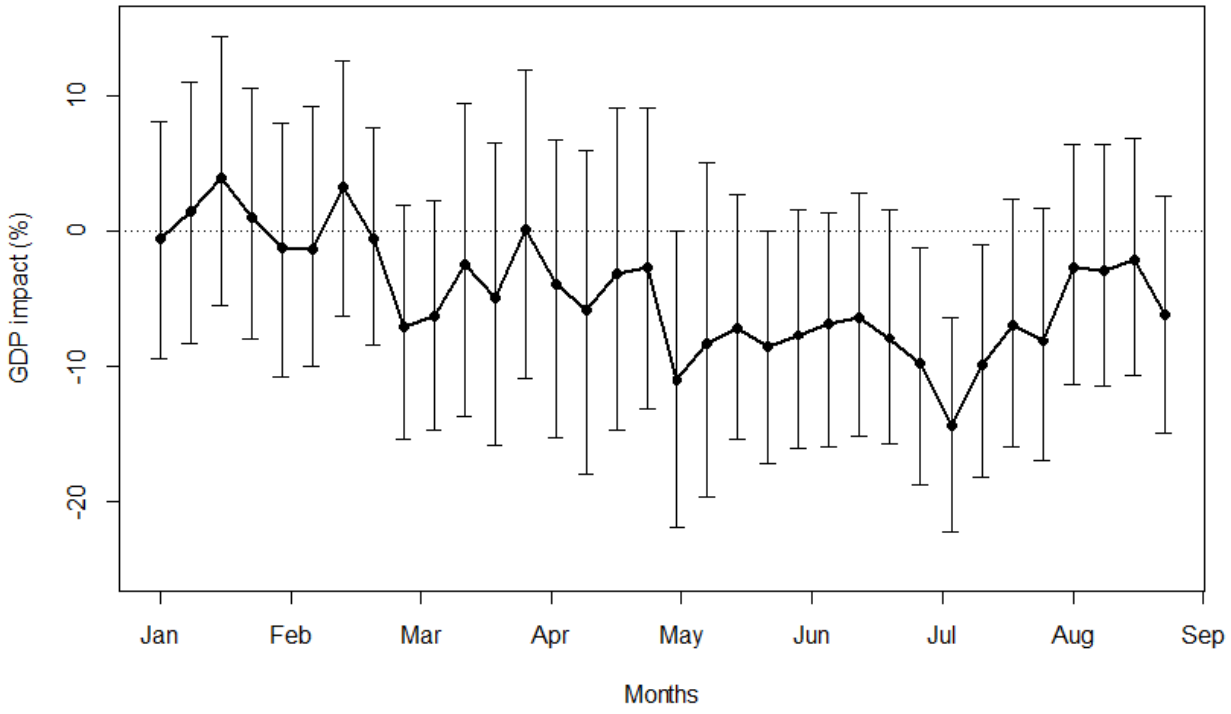
Norway

Monthly GDP impacts

Month	GDP impact	Lower bound	Upper bound	Significance
March	-3.94	-10.33	2.54	
April	-4.5	-11.54	1.21	
May	-8.33	-13.79	-2.51	**
June	-7.74	-12.74	-2.70	***
July	-8.9	-13.68	-4.02	***
August	-3.58	-8.77	2.05	

Notes: lower and upper bounds indicate 95% confidence intervals obtained with 5000 Monte Carlo repetitions. Stars indicate significance as follows: *** = 1%, ** = 5%, * = 10%.

Weekly GDP impacts plot



Notes: vertical lines indicate 95% confidence intervals.

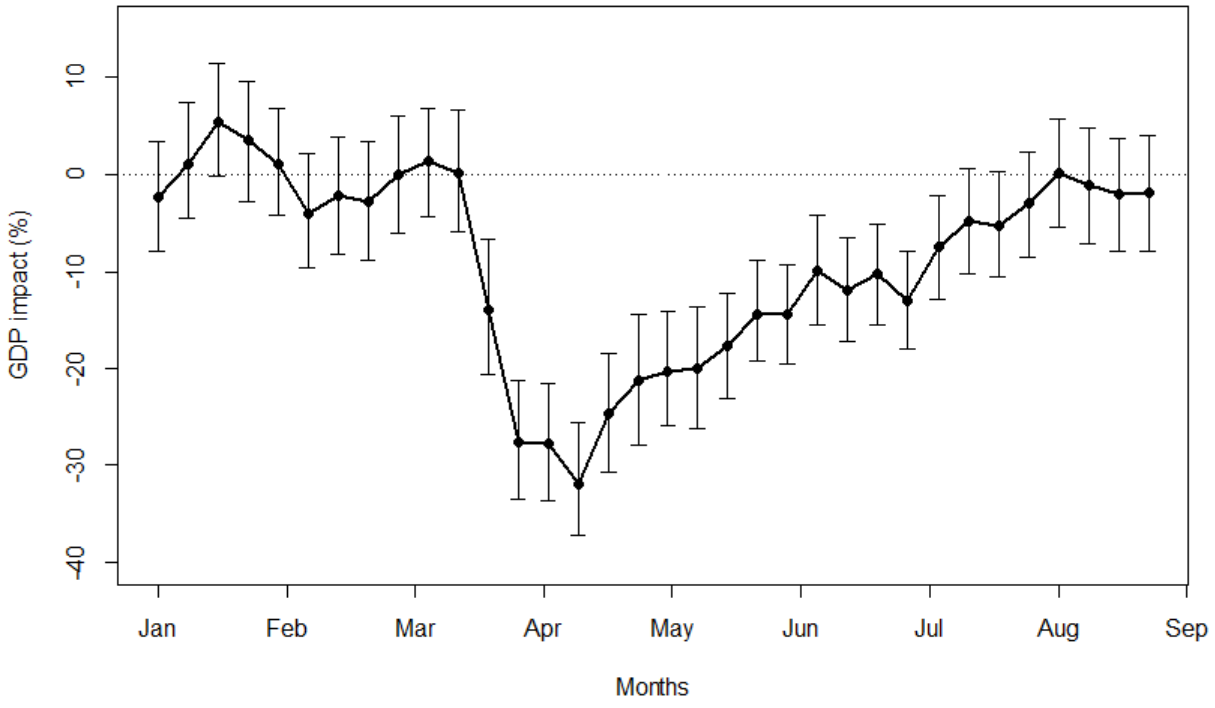
Spain

Monthly GDP impacts

Month	GDP impact	Lower bound	Upper bound	Significance
March	-8.39	-12.11	-4.54	***
April	-25.89	-29.14	-22.15	***
May	-17.16	-20.61	-13.68	***
June	-11.53	-14.69	-8.63	***
July	-4.47	-7.54	-1.29	**
August	-1.5	-4.95	2.53	

Notes: lower and upper bounds indicate 95% confidence intervals obtained with 5000 Monte Carlo repetitions. Stars indicate significance as follows: *** = 1%, ** = 5%, * = 10%.

Weekly GDP impacts plot



Notes: vertical lines indicate 95% confidence intervals.

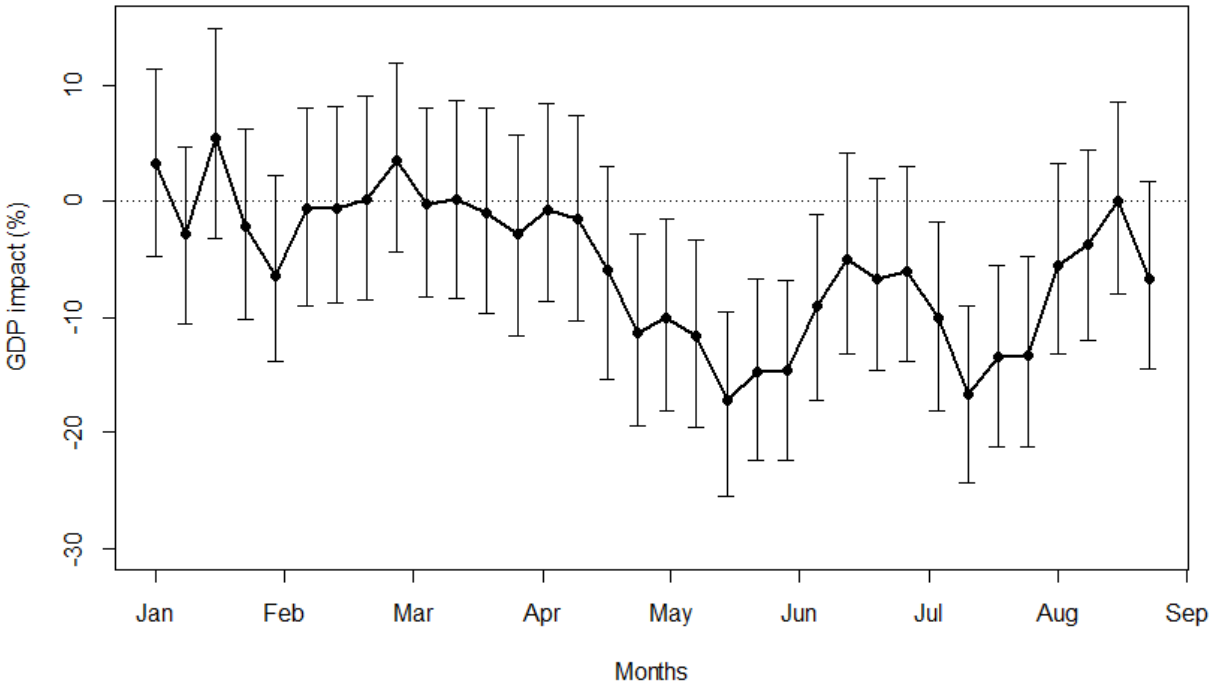
Sweden

Monthly GDP impacts

Month	GDP impact	Lower bound	Upper bound	Significance
March	-0.52	-6.27	5.42	
April	-5.38	-11.11	0.54	*
May	-13.96	-19.36	-8.59	***
June	-7.43	-12.72	-1.92	**
July	-12.41	-17.27	-7.23	***
August	-3.68	-8.66	2.38	

Notes: lower and upper bounds indicate 95% confidence intervals obtained with 5000 Monte Carlo repetitions. Stars indicate significance as follows: *** = 1%, ** = 5%, * = 10%.

Weekly GDP impacts plot



Notes: vertical lines indicate 95% confidence intervals.

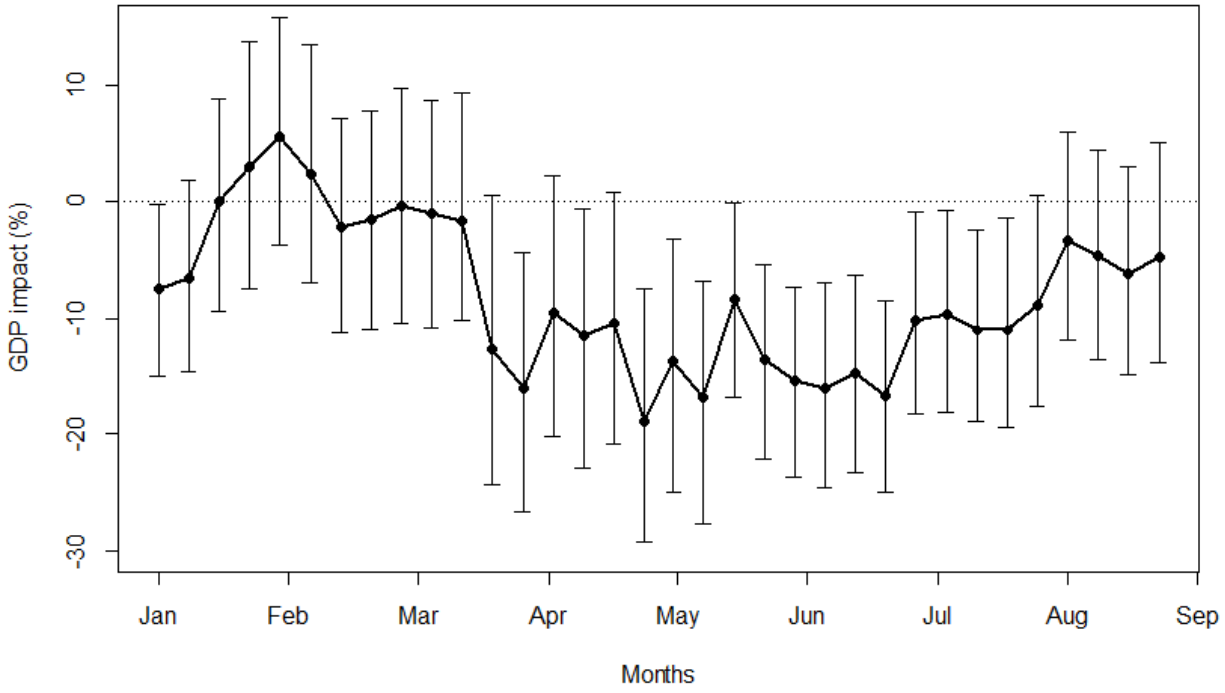
Switzerland

Monthly GDP impacts

Month	GDP impact	Lower bound	Upper bound	Significance
March	-6.59	-13.01	0.82	*
April	-12.91	-20.67	-5.98	***
May	-13.12	-19.2	-6.24	***
June	-14.43	-20.14	-8.58	***
July	-9.51	-15.63	-2.99	**
August	-4.60	-11.68	2.13	

Notes: lower and upper bounds indicate 95% confidence intervals obtained with 5000 Monte Carlo repetitions. Stars indicate significance as follows: *** = 1%, ** = 5%, * = 10%.

Weekly GDP impacts plot



Notes: vertical lines indicate 95% confidence intervals.

A4. Lockdown dates

Lockdown polices varied significantly across countries. Since our focus is the economic impact of the pandemic, in order to provide a comparable analysis between different nations, we define as the date starting the lockdown the one in which it was formally imposed by the country's government, and the date ending the lockdown the one in which all retail shops were allowed to re-open. The dates were taken from various online sources[3] and cross-checked with country level news.

Table A4.1: Lockdown dates used in our analysis

Country	Lockdown	
	starts	**ends**
Austria	16 March 2020	01 May 2020
Belgium	18 March 2020	11 May 2020
Denmark	18 March 2020	11 May 2020
France	17 March 2020	11 May 2020
Germany	17 March 2020	06 May 2020
Great Britain	26 March 2020	15 June 2020
Italy	10 March 2020	04 May 2020
Netherlands	15 March 2020	11 May 2020
Norway	12 March 2020	11 May 2020
Spain	14 March 2020	11 May 2020
Sweden	--	--
Switzerland	17 March 2020	11 May 2020

[3] Example of online sources are https://www.politico.eu/article/europe-coronavirus-post-lockdown-rules-compared-face-mask-travel/ and https://www.dw.com/en/coronavirus-what-are-the-lockdown-measures-across-europe/a-52905137 (last accessed on 20th April 2021).