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The effect of COVID-19 confinement policies on community mobility trends in the EU

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Contents

Foreword

The views expressed in this report are solely of the author and do not preclude a policy position of the European Commission of any kind. The brief was prepared to inform policy-making and its empirical analysis can not be considered as definitive. As more data on daily changes in mobility trends become available and better estimates arise, we will update this report.

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The author would like to thank Ian VOLLBRACHT for his critical assessment of the report. His comments and suggestions significantly improved the report.

Author

Athanasios Lapatinas

Abstract

All EU Member States were affected by the coronavirus outbreak. In response, national governments implemented containment measures such as closure of schools, cancelation of public events, limit to the number of people that can meet in public and private spaces, closure of public services and facilities, change in policies around prisons to mitigate the spread of the disease, limitations to the populations living in camps and/or camp like conditions, partial and full lockdowns.

These non-pharmaceutical interventions focus on reducing peoples' mobility and social interactions.

However, the causal impact of different COVID-19 confinement policies on how mobility trends have changed after the spread of the epidemic has not been studied for the EU Member States. This is crucial also for answering the question when and how the confinement measures can be relaxed, besides avoiding unpreparedness to possible new wave of cases and introduction of new measures if needed.

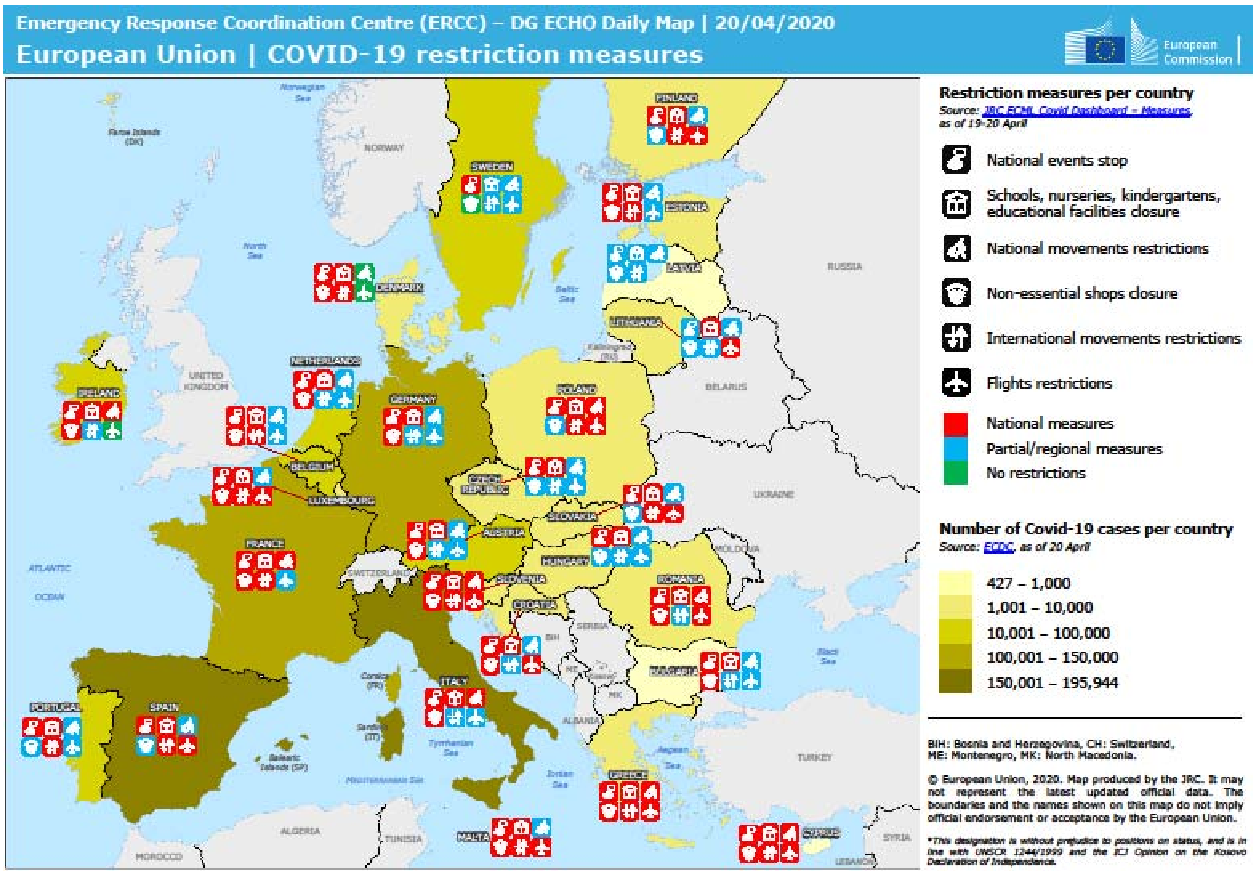
In this report, we adopt a quasi-experimental approach to measure the impact of COVID-19 confinement policies on peoples' presence at home and their mobility in different types of public and private places.

Our empirical findings indicate that reductions in out-of-home social interactions and visits to public and private places are driven by a combination of restrictive measures introduced by Member States. Not surprisingly, the analysis suggests that partial and full lockdowns have the strongest causal impact on increasing presence at home and reducing visits to workplaces, public transport hubs, grocery, pharmacies, open public spaces, restaurants, cafes, shopping centres, theme parks, museums, libraries, and movie theatres. The impact of public services closure and schools closure is significant but of a smaller magnitude. At the COVID-19 outbreak in EU, policy measures such as large gathering bans and changes in prison policies seem to have had no significant causal impact on communities' overall mobility trends, but may have had some impact upon social distancing behaviour. We cannot measure the "pairwise" distance between individuals via this data set and so cannot use it to measure social distancing trends in a direct sense. Interestingly, our results also show that the lockdown of people living in camps and/or camp like conditions, such as refugees and other minorities, had a statistically significant negative effect on visits to places like national parks, public beaches, marinas, dog parks, plazas, and public gardens. However, it should be noted here that this result is attributed to two countries: Greece and Malta are the only Member States that implemented this confinement policy.

This is a preparatory study and when more data will become available (we utilize daily changes in mobility trends), we will update this report with better estimates. In the future, we also intend to estimate the causal effect of social interactions and presence at home on the reported cases and deaths in the EU.

1 Introduction

COVID-19 has led to exceptional challenges for EU health care systems and economies. Following the evidence from China that quarantine, social distancing and isolation of infected populations can contain the epidemic ([1])([2]), all Member States have prohibited public gatherings, closed (totally or partially) schools and introduced border/travel restrictions. Most recently, they introduced wide-scale social distancing including local and national lockdowns.



Understanding whether these policies are having the desired impact of deteriorating peoples' mobility and their presence at homes is critical given that reduced out-of-home social interactions achieve lower transmission and mortality rates ([3]). Furthermore, these policy measures come at a high social and economic cost, hence it is clear that they cannot last indefinitely and there is a need for a continuous assessment on which interventions are necessary to maintain control of social distancing.

In this report, we adopt a quasi-experimental approach to measure the impact of COVID-19 confinement policies on peoples' presence at home and their mobility in different types of

([1]) WHO, Coronavirus disease 2019 (COVID-19) situation report—44. https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200304-sitrep-44-covid-19.pdf?sfvrsn=783b4c9d_2

([2]) See Anderson et al. (2020).

([3]) European Center for Disease Prevention and Control (ECDC), "Coronavirus disease 2019 (COVID-19) in the EU/EEA and the UK – eighth update", 8 April 2020.

places such as national parks, public beaches, marinas, dog parks, plazas, public gardens, grocery markets, food warehouses, farmers markets, food shops, drug stores, pharmacies, restaurants, cafes, shopping centres, theme parks, museums, libraries, movie theatres, workplaces, subway, bus, and train stations ([4]).

Our empirical findings indicate that reductions in out-of-home social interactions and visits to public and private places are driven by a combination of restrictive measures introduced by Member States. Not surprisingly, the analysis suggests that partial and full lockdowns have the strongest causal impact on increasing presence at home and reducing visits to workplaces, public transport hubs, grocery, pharmacies, open public spaces, restaurants, cafes, shopping centres, theme parks, museums, libraries, and movie theatres. The impact of public services closure and schools closure is significant but of a smaller magnitude. At the COVID-19 outbreak in EU, policy measures such as large gathering bans and changes in prison policies seem to have had no significant causal impact on communities' overall mobility trends, but may have had some impact upon social distancing behaviour. We cannot measure the distance between "pairwise" individuals via this data set and so cannot use it to measure social distancing trends in a direct sense. Interestingly, our results also show that the lockdown of people living in camps and/or camp like conditions, such as refugees and other minorities, had a statistically significant negative effect on visits to places like national parks, public beaches, marinas, dog parks, plazas, and public gardens. However, it should be noted here that this result is attributed to two countries: Greece and Malta are the only Member States that implemented this confinement policy.

Understanding what works, when and how, is also critical for answering the question when and how the confinement measures can be relaxed. This report adds on the scientific knowledge available to date and aims to support the EU steps towards managing successfully the gradual lifting of the existing confinement measures by using data on mobility from Google's COVID-19 Community Mobility Reports in order to evaluate the causal impact of the various containment measures put in place by the Member States.

As more data become available (our empirical specification utilizes daily changes in mobility trends), we intend to update this report with better estimates because it is evident that societies will have to live with COVID-19 until a treatment is found. This requires constant and detailed monitoring and evaluation of COVID-19 policies in order to ensure preparedness for possible new waves of cases and the (re)introduction of new measures if needed.

([4]) For a similar analysis for the US see Abouk and Heydari (2020).

2 Data and descriptive analysis

COVID-19 Community Mobility Reports [5]

Google's COVID-19 Community Mobility Reports show how visits and length of stay at different places change compared to a baseline. Google calculates these changes using the same kind of aggregated and anonymized data used to show popular times for places in Google Maps ([6]). Changes for each day are compared to a baseline value for that day of the week:

- The baseline is the median value, for the corresponding day of the week, during the 5-week period Jan 3–Feb 6, 2020.
- The reports show trends over several weeks with the most recent data representing approximately 2-3 days ago; this is how long it takes for Google to produce the reports.

Google collects data from users who have opted-in to Location History for their Google Account, so the data represents a sample of Google's users. We assessed the database on 17-03-2020. The dataset includes mobility trends also at regional level; however, we base our analysis at the country level because most intervention policy measures in Member States are implemented country-wide.

Overall, we have data on mobility trends (percentage changes from baseline) for:

- Retail and recreation (*retail*): restaurants, cafes, shopping centres, theme parks, museums, libraries, and movie theatres.
- Grocery and pharmacy (*grocery*): grocery markets, food warehouses, farmers markets, specialty food shops, drug stores, and pharmacies.
- Parks (*parks*): national parks, public beaches, marinas, dog parks, plazas, and public gardens.
- Transit stations (*transit*): public transport hubs such as subway, bus, and train stations.
- Workplaces (*workplaces*): places of work.
- Residential (*residential*): places of residence.

Table 1 shows the summary statistics for these six categories of data. The dataset covers the 26 EU countries (data on mobility trends for Cyprus are not available) and the period from 02/15/2020 to 04/11/20 (daily observations).

The dataset has a number of limitations. First, people without smartphones and/or people not carrying their device when visiting the places mentioned above, are not included in Google's database. Second, the database only includes people with Google accounts and with the location history setting activated ([7]).Finally, we note here that most of the variables included in the database regard changes to peoples' visits to the above mentioned places and can be considered as indirect proxies of social distancing at the aggregate level. However, we argue that the presence at home variable (*residential*) most directly captures the primary goal of the social distancing and lockdown policies, namely the reduction of the time people spend outside of their homes. This is why the (sensitivity) analysis and the discussion of the results focus primarily on this outcome variable.

([5]) See https://www.google.com/covid19/mobility/
([6]) See https://support.google.com/business/answer/6263531
([7]) See https://support.google.com/accounts/answer/3118687?hl=en

Table 1. Summary statistics for the mobility trend variables

Variable	Mean	Std. Dev.	Min	Max	Obs.
retail	-30.771	34.133	-96	29	1482
grocery	-10.372	21.075	-92	59	1482
parks	-2.785	37.428	-91	188	1482
transit	-30.113	31.650	-92	31	1482
workplaces	-25.535	26.335	-90	25	1482
residential	10.472	11.155	-4	46	1480

Policy measures data

We collected all COVID-19 related policies, their issue and effective dates for the EU-26 countries (except for Cyprus because Google mobile data were not available) from the #COVID19 Government Measures Dataset that puts together all the measures implemented by governments worldwide in response to the Coronavirus pandemic ([8]). We accessed the data on 04/1620. ACAPS consulted government, media, United Nations, and other organisations sources and categorized the data into the following categories:

- Social distancing
- Movement restrictions
- Public health measures
- Social and economic measures
- Lockdowns

This report focuses on the policies that aim at social distancing and lockdowns and more specifically on the measures listed in Table 2. We considered the effective date as the implementation day of the measure. We assumed the implementation date of the policy as the day that the first - non-targeted to a specific population group - policy measure in question has been activated. Figure 1 summarizes the policy adoption timeline for each policy measure by showing the number of EU countries who had each policy in effect on any given day from 02/15/20 to 04/11/20, suggesting a wide heterogeneity in both the type and the adoption date of each policy measure during this period.

The first EU hotbed was recorded in Northern Italy on February 20th. Italy was the first Member State that adopted a schools closure policy on 02/21/20 and on 02/25/20 moved on the cancelation of public events and limitation to the number of people in public and private spaces. On 03/11/20, Italy also closed public services and facilities and on 03/17/20 the country changed its policies around prisons to mitigate the spread of the disease. The partial lockdown policy was implemented on 03/20/20 and the full lockdown was activated three days later, on 03/23/20.

([8]) See https://www.acaps.org/covid19-government-measures-dataset

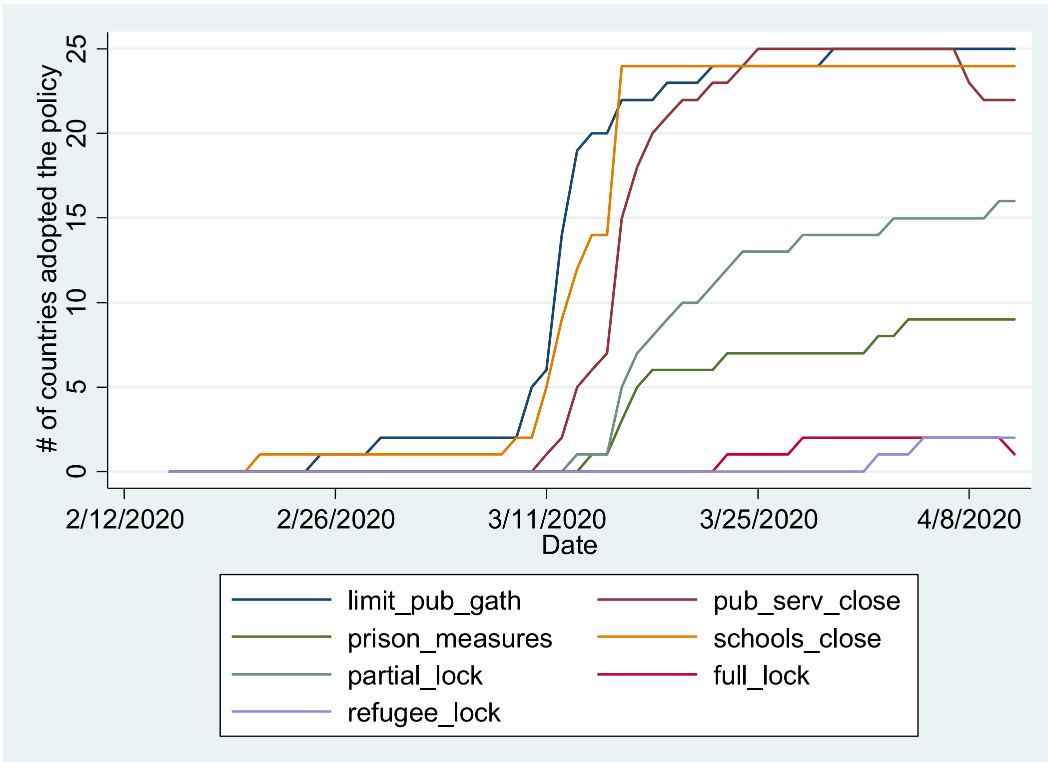
Table 2. Policy measures considered in the analysis.

Category	Measure	Description
Social distancing	Limit public gatherings ($limit\_pub\_gath$)	Cancelation of public events. Limit to the number of people that can meet in public and private spaces.
	Public services closure (pub_serv_close)	Public services and facilities are closing access to the public. In some countries, services are available online.
	Changes in prison policies ($prison\_measures$)	Change in policies around prisons to mitigate the spread of the disease. This may include early release but also suspension of day-release programs, suspension of visits etc.
	Schools closure ($schools\_close$)	Authorities have closed schools.
Lockdown	Partial lockdown ($partial\_lock$)	Partial lockdown includes: 1. The population cannot leave their houses apart for specific reasons that they have to communicate to the authorities. 2. All stores that are not related to alimentation or pharmacies are not open.
	Full lockdown ($full\_lock$)	Full lockdown includes: 1. The population cannot leave their houses apart for specific reasons that they have to communicate to the authorities. 2. All non-essential services closed and production stops.
	Lockdown of refugee/IDP camps or other minorities ($refugee\_lock$)	Limitations to the population living in camps and/or camp like conditions.

The first COVID-19 policy that Spain implemented was the closure of schools (03/09/20). Bulgaria, Denmark and Greece closed their schools two days after, on 03/11/20. The next day, it was Czechia, Estonia, Poland and Slovakia that initiated this policy. On 03/13/20 schools closed also in Belgium, Ireland and Malta. Hungary and Latvia followed this policy the next day. Austria, Croatia, Finland, France, Germany, Lithuania, Luxemburg, Netherlands, Portugal and Slovenia closed their schools on 03/16/20. Romania and Sweden kept their schools open.

After Italy, it was France that adopted the limit public gatherings policy on 02/29/20. Austria, Germany and Slovenia activated this policy on 03/10/20, next day it was Hungary and two days after it was Czechia, Estonia, Ireland, Netherlands, Poland, Portugal, Slovakia, and Sweden. On 03/13/20, the policy of limit public gatherings was not active only in the following Member States: Bulgaria, Croatia, Latvia, Lithuania, Malta, Romania, and Spain. Next day, Latvia implemented the policy and after two days, Lithuania and Spain. Croatia activated the policy on 03/19/20 and Romania on 03/22/20. According to our dataset and the methodology we followed to create our variables, Malta implemented the policy of limit public gatherings on 03.30.20.

Figure 1. EU-26 COVID-19 policy adoption timeline for seven social distancing and lockdown policy measures from 15-02-2020 to 11-04-2020.



Notes: For the description of the policy measures see Table 2.

Following Italy, Slovakia implemented the policy of public services closure on 03/12/20. Bulgaria, Denmark and Luxembourg activated it the next day and Poland on 03/14/20. Netherlands implemented it the next day and Czechia, Estonia, Finland, France, Germany, Ireland, Lithuania and Spain on 03/16/20. Next day, the policy was initiated by Austria, Hungary, and Malta. On 03/18/20, it was Greece and Slovenia that took the baton, Croatia the next day and Portugal after two days. Romania activated the policy on 03/22/20 and Belgium after two days. According to our dataset, Latvia was the last country that implemented this policy on 03/25/20 (Sweden didn't close public's access to public services and facilities).

Figure 2. Mobility trends on 04/11/20: percentage changes from baseline: *retail*.

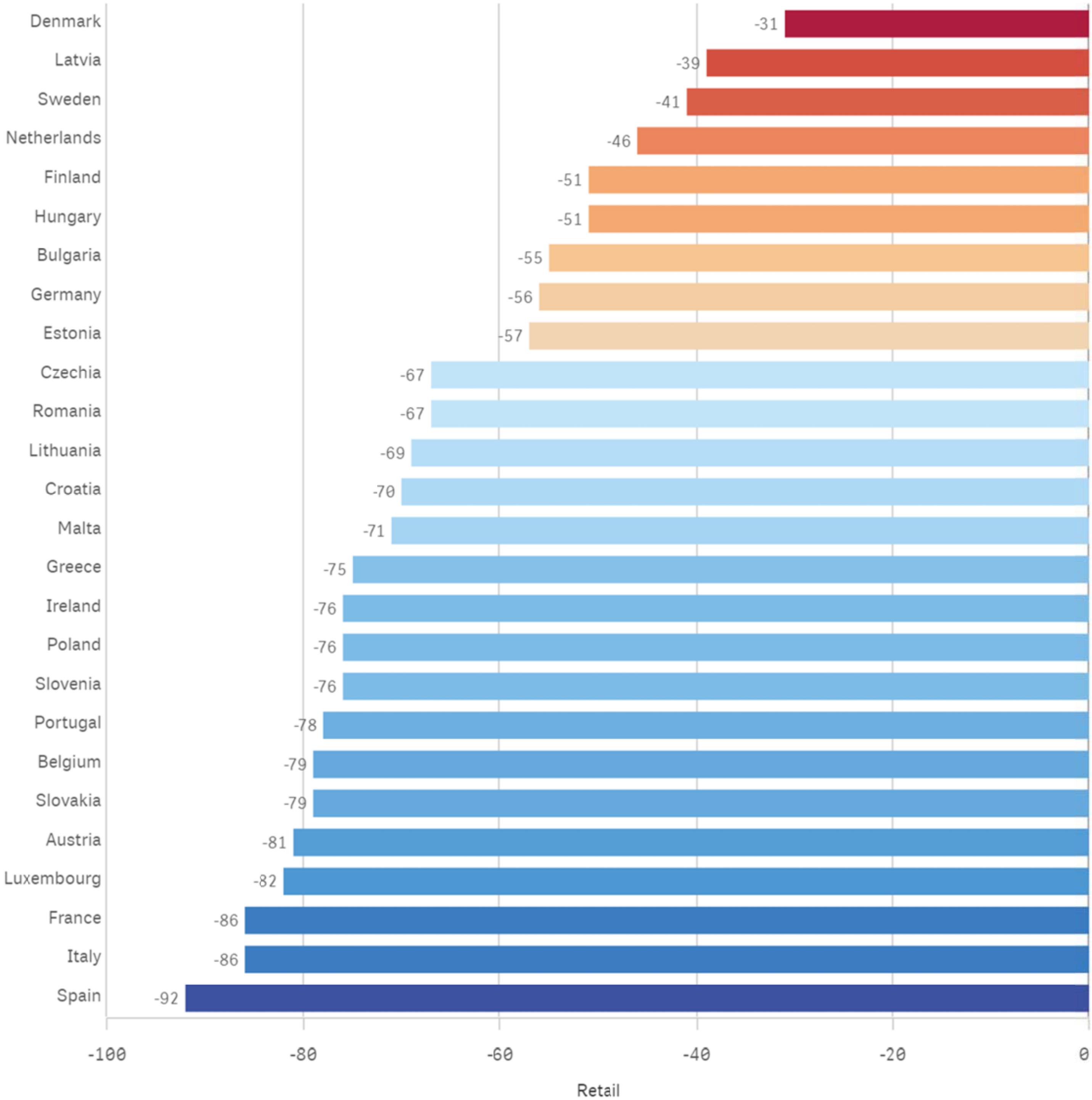


Figure 3. Mobility trends on 04/11/20: percentage changes baseline: *grocery*.

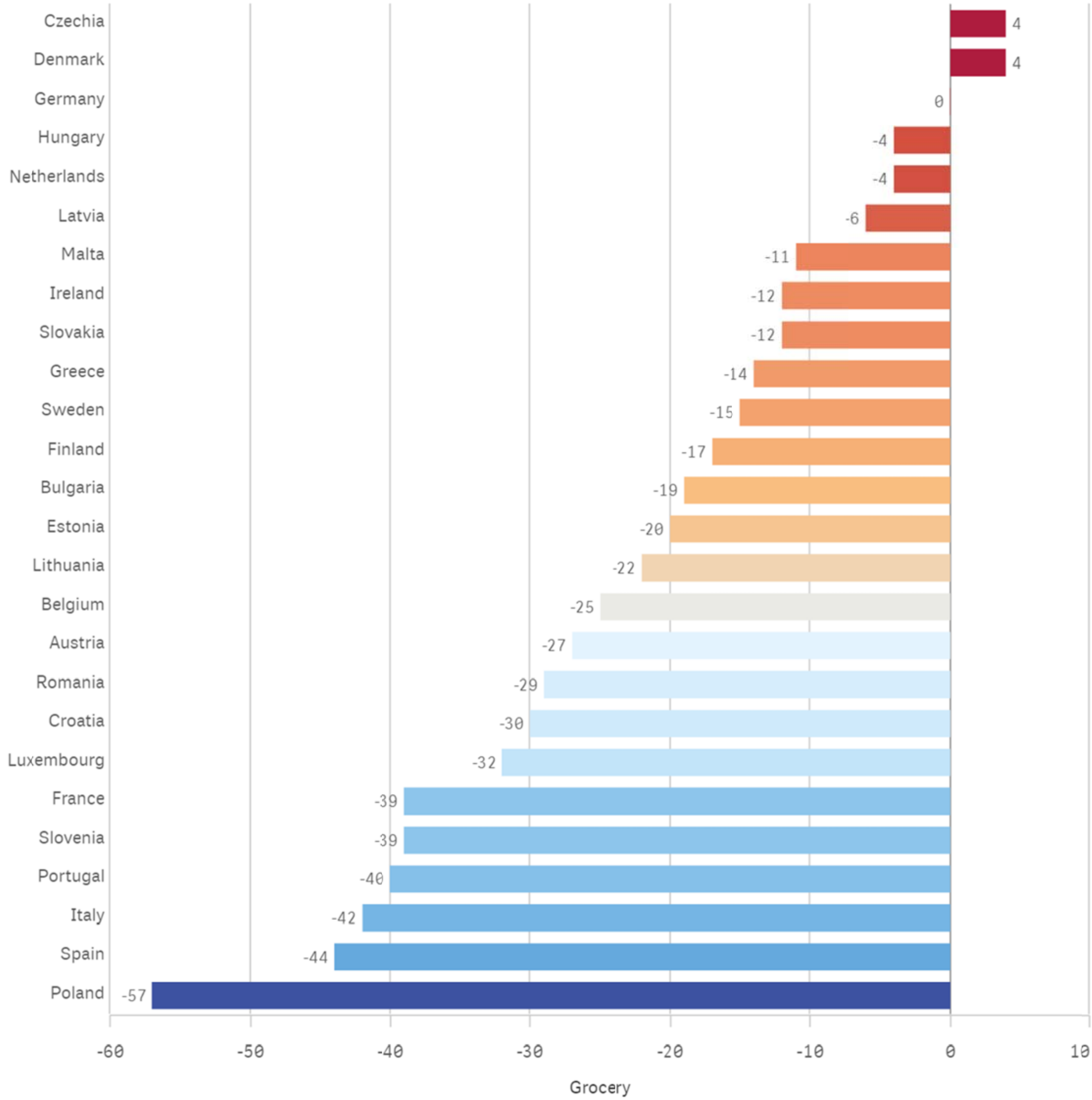


Figure 4. Mobility trends on 04/11/20: percentage changes from baseline: *parks*.

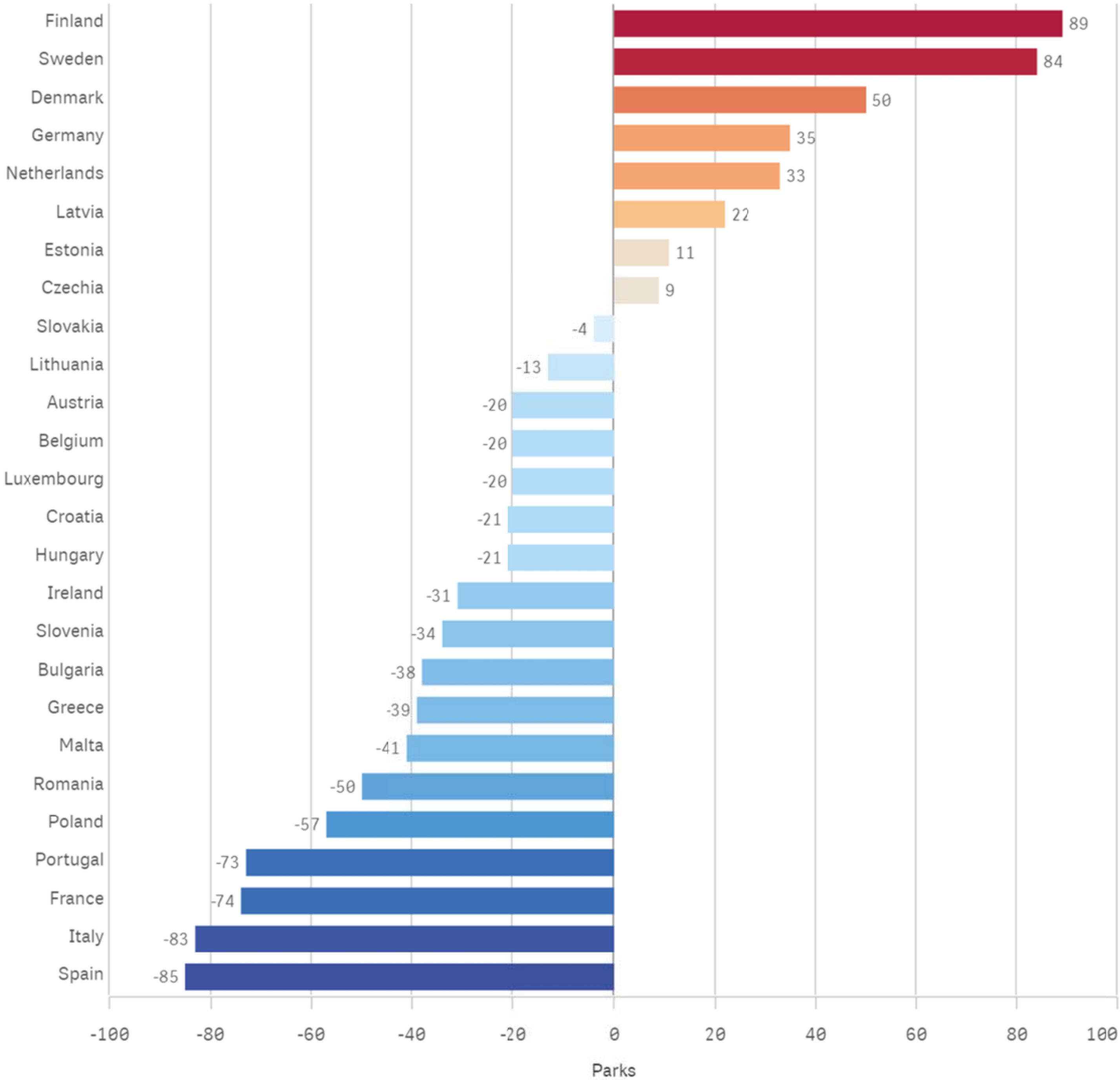


Figure 5. Mobility trends on 04/11/20: percentage changes from baseline: *transit*.

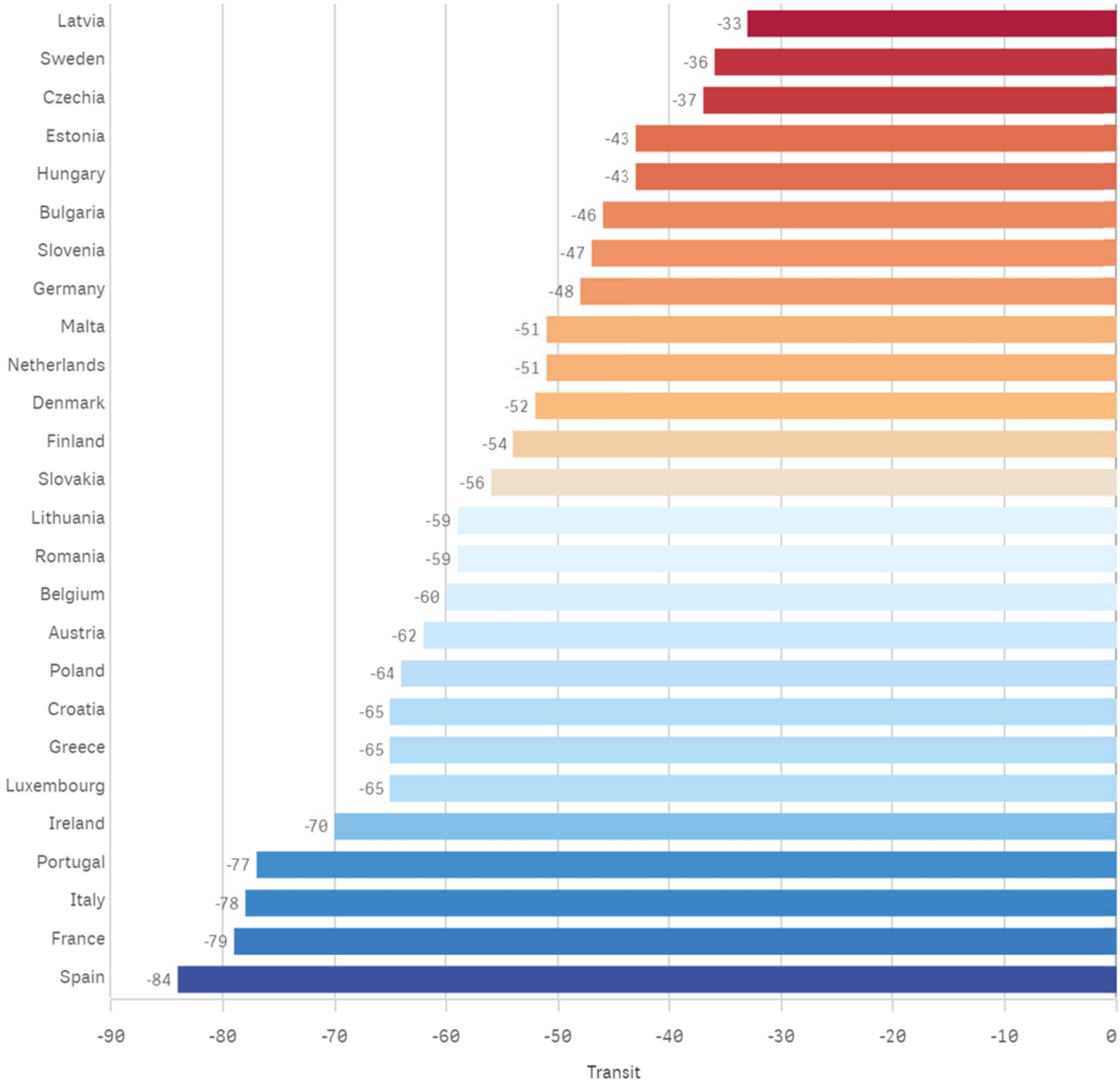


Figure 6. Mobility trends on 04/11/20: percentage changes from baseline: *workplaces*.

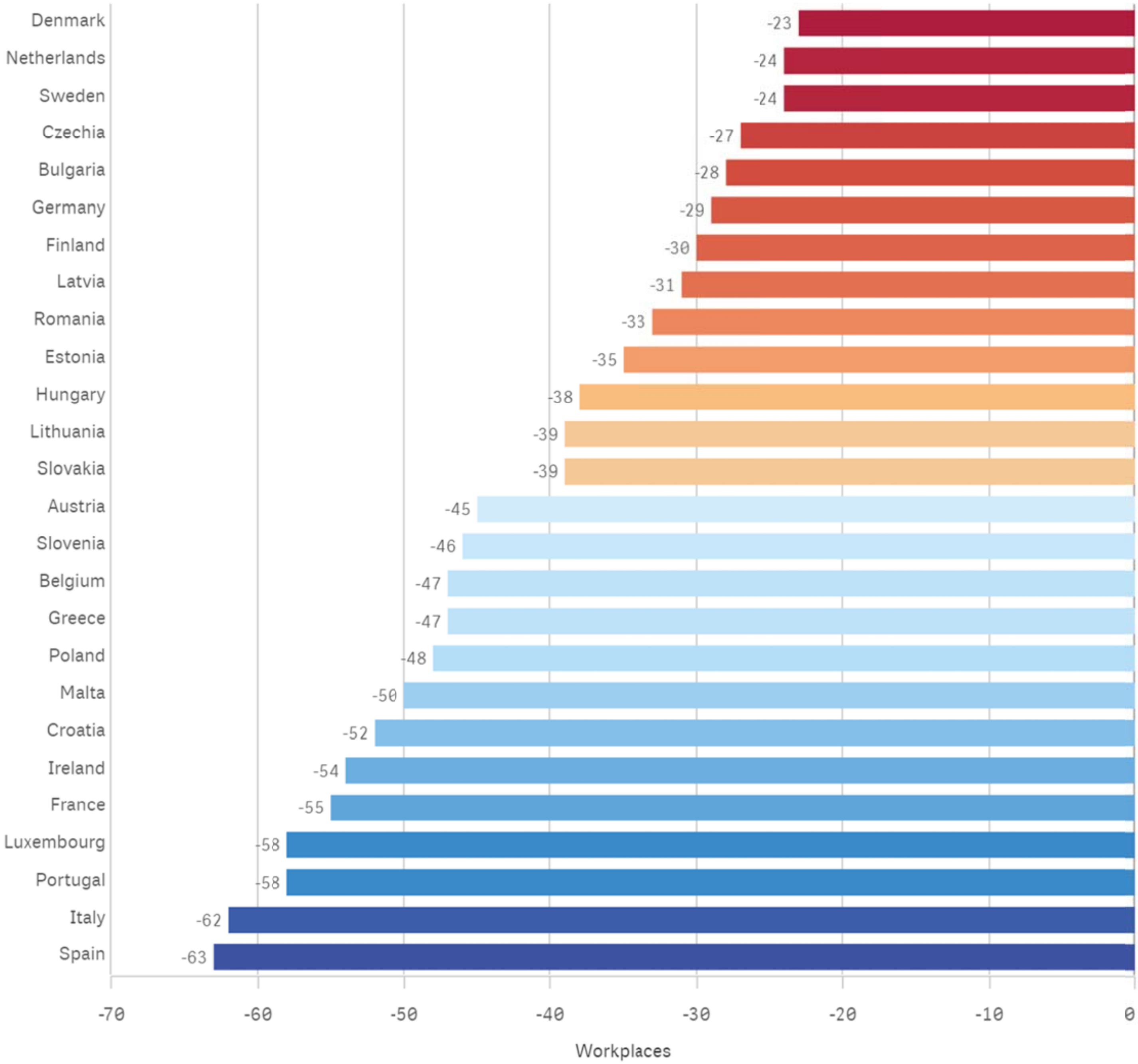
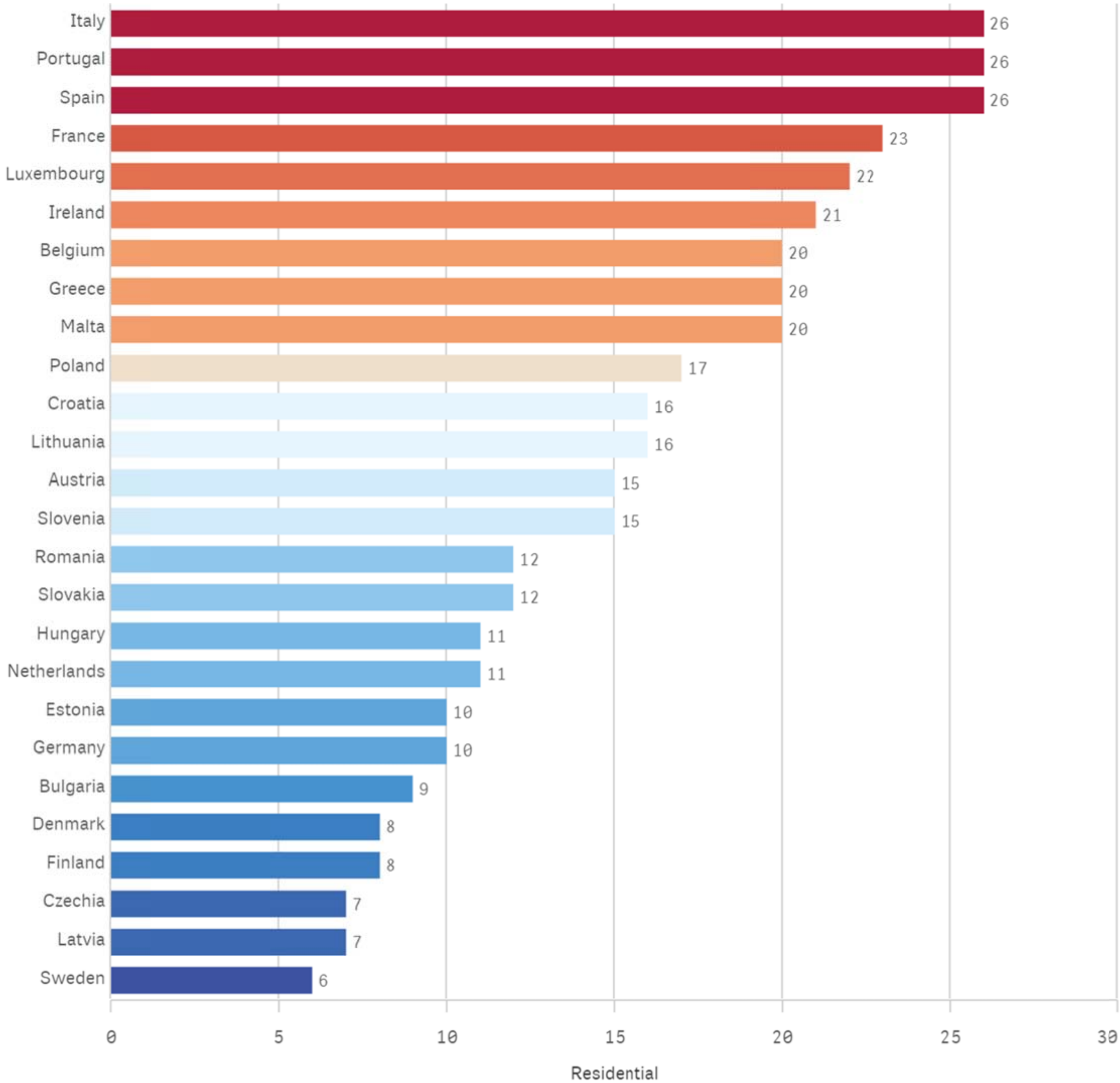


Figure 7. Mobility trends on 04/11/20: percentage changes from baseline: *residential*.



Besides Italy, also the following countries implemented policies related to prisons: Latvia (03/14/20), Lithuania and Spain (03/16/20), Belgium (03/17/20), Denmark (03/18/20), Poland (03/23/20), Portugal (04/02/20), and Estonia (04/04/20).

Regarding lockdown policies, only Italy and Spain decided to fully lockdown their economies (according to our dataset the implementation date for Spain is 03/28/20). Partial lockdown policies were implemented first by Bulgaria (03/13/20) and after three days by Austria, Czechia, Luxembourg and Spain. On 03/17/20 the policy was adopted by France and Hungary and one day after by Belgium. Slovenia activated the policy on 03/19/20, Italy on 03/20/20, Germany on 03/22/20, Greece on 03/23/20, Poland the next day, Ireland on 03/28/20, Portugal on 04/03/20, and Estonia on 04/10/20.

Finally, the COVID-19 policy adoption timeline for the lockdown of the population living in camps and/or camp like conditions is the following: Greece implemented this policy on 04/02/20 and Malta on 04/05/20. Only these two countries have activated this containment measure.

The data for mobility trends on 04/11/20 (last date with available data in our dataset) by Member State are shown in Figures 2-7. We argue that 04/11/20 is 'safely' distant from policies' implementation dates for drawing conclusions about their impact on community mobility trends.

Figure 1 shows percentage changes from the baseline median (see details above) for visits to restaurants, cafes, shopping centres, theme parks, museums, libraries, and movie theatres (*retail*). Spain takes the lead on this mobility category with 92% less visits compared to the pre-COVID period. Italy and France run close with 86%. On 04/11/20, Denmark had the lowest performance on this indicator (-31%).

Denmark didn't implement any lockdown policies and this is reflected in almost all mobility trends categories. However, the 'picture' is not so clear for the other countries that didn't activate lockdown policies e.g. Slovakia, Romania, Croatia and this constitutes our main motivation for considering also an empirical analysis and more specifically, a quasi-experimental approach to measure the impact of COVID-19 containment policies on peoples' presence at home (*residential*) and their mobility in different types of public/private places (Section 3).

Figure 2 shows that Polish reduced their visits to grocery shops and pharmacies by 57% compared to the pre-COVID period. On the other end of the spectrum, Czechia, Denmark and Germany registered non-negative percentage changes.

Figure 3 shows that visits to parks reduced substantially for some Member States: for the EU's worst-hit countries by the COVID-19 pandemic, peoples' visits to parks reduced by 83-85%. However, there were Member States that on 04/11/20, the mobility of their people to parks increased by 84% and 89% relative to the baseline period.

Regarding peoples' visits to public transport hubs, the best performers were again the worst-hit Member States (Figure 4). Spanish, French and Italian reduced their visits to public transport hubs by 80% compared to pre-COVID period. Czechia, Sweden and Latvia lie on the other end of the spectrum with -37, -36 and -33 percentage changes, respectively. Public transportation in Sweden was operating and the borders to most EU countries remained open.

Spain, Italy, Portugal and France are the best performance Member States also for the visits to workplaces (*workplaces*) and presence at home (*residential*) categories. For the *residential* variable, the percentage change relative to the baseline is +26% for Italy, Portugal and Spain. On the other hand, Swedish spent less time home compared to other Europeans during the COVID-19 crisis. In Sweden, most policy measures announced by the authorities were mainly recommendations. Anyone that was displaying the COVID-19 symptoms was asked to stay home, but other members of their family were not restricted from going to school or showing up for work. Latvians and Czechs increased their time spent home only by 7%. Czech Republic initiated a general curfew on 03/16/20 but it included generous exemptions, such as continuation of usual essential shopping and going to/from work among many others. Visiting family members and going to parks was also allowed ([9]).

([9]) See https://apps.odok.cz/attachment/-/down/IHOABMQVW63P

3 Empirical specification and results

In this report, we follow a micro-econometric approach, defining the adoption of a policy measure as a 'treatment' administered to Member States, and estimate the causal effect of the treatment through a difference-in-difference estimation. This methodology allows us to exploit both the time series and the cross sectional variation in the data. The estimation method also exploits "instantaneously" the within-country variation as well as the comparison between countries, taking into account both the problem of unobserved variables that move all countries at the same time, and the omitted variables problem.

The unit of analysis is a policy-country-day observation (there are 7 different areas of reforms for the 26 EU countries from 02/1520 to 04/11/20). The dependent variable, ${mobility^s}_{c,t}$, is the community mobility (percentage changes from baseline) for the category *s* (*retail*, *grocery, parks, transit, workplaces, residential*), for country *c* and day *t*. Since policy measures' implementation does not take place in all countries at the same time, to implement the difference-in-difference approach we estimate the following baseline specification in the whole sample of 'treated' and 'control' countries:

$$\begin{aligned} {mobility^s}_{c,t} = a_0 + \ &\beta_1 limit\_pub\_gath_{c,t} + \ \beta_2 pub\_serv\_close_{c,t} + \beta_3 prison\_measures_{c,t} \\ &+ \beta_4 schools\_close_{c,t} + \beta_5 partial\_lock_{c,t} + \beta_6 full\_lock_{c,t} + \beta_7 refugee\_lock_{c,t} + \ \gamma_c + \ \delta_t \\ &+ \ \varepsilon_{c,t} \end{aligned} \tag{1}$$

where γ_c, δ_t are country, and time fixed effects, respectively. Our variables of interest, with the accompanying coefficients (β_i, $i = 1,..,7$) capture the effect of the policy measures on the dependent variable ${mobility^s}_{c,t}$ for the Member States in our dataset. The policy measure variables are binary variables, set to one if a given Member State adopts that policy measure after a certain day during the sample period, and otherwise zero. We consider robust standard errors in all regressions. Furthermore, we check the assumption of parallel trends in changes in community mobility before each policy measure's implementation in the Annex.

In Table 3 we give the estimation results of our specification (equation 1), including country and time fixed effects. Robust t-statistics are shown in parentheses.

Results indicate that the most effective COVID-19 policies for reducing community mobility are the public services and facilities closures (*pub_serv_close*), the partial lockdown (*partial_lock*) and the full lockdown (*full_lock*). Schools closure (*schools_close*) seems to reduce significantly the visits to workplaces and public transport hubs and increase the presence at home. Limitations to the population living in camps and/or camp like conditions (e.g. refugees, minorities) have a statistical significant effect on the visits to parks and the magnitude of the estimated coefficient (*refugee_lock*) is relatively high. Finally, the analysis indicates that the cancelation of public events (*limit_pub_gath*) and the changes around prisons (*prison_measures*) have no statistical significant effect on community mobility as measured in the Google's COVID-19 Community Mobility Reports.

Table 3. Effect of COVID-19 policies on community mobility

	(1) retail	(2) grocery	(3) parks	(4) transit	(5) workplaces	(6) residential
limit_pub_gath	-3.126	-1.288	7.635	-3.149	-1.39	0.647
	(-0.895)	(-0.589)	(1.025)	(-1.364)	(-0.470)	(0.457)
pub_serv_close	-10.651**	-10.268**	-13.793	-8.384**	-6.881**	3.234**
	(-2.170)	(-2.354)	(-1.403)	(-2.440)	(-2.342)	(2.243)
prison_measures	5.037	2.061	11.326	1.977	-0.569	-0.392
	(1.095)	(0.545)	(0.909)	(0.611)	(-0.220)	(-0.276)
schools_close	-8.113	1.146	3.554	-7.457*	-7.120**	2.454*
	(-1.452)	(0.23)	(0.308)	(-1.735)	(-2.157)	(1.818)
partial_lock	-13.531***	-8.943**	-36.582***	-8.077***	-5.913**	4.046***
	(-3.435)	(-2.628)	(-3.510)	(-2.824)	(-2.180)	(2.845)
full_lock	-11.135**	-12.815**	-36.594***	-7.925	-9.274*	5.510***
	(-2.480)	(-2.073)	(-3.367)	(-1.493)	(-2.056)	(3.069)
refugee_lock	-4.82	-1.271	-30.825**	-0.745	-1.511	2.038
	(-1.413)	(-0.219)	(-2.655)	(-0.319)	(-0.444)	(1.095)
Observations	1482	1482	1482	1482	1482	1480
R-sq	0.931	0.704	0.418	0.943	0.906	0.917

Notes: All the regressions include country and time fixed effects. Robust t-statistics are shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Public services closure reduces significantly the visits to restaurants, cafes, shopping centres, theme parks, museums, libraries, and movie theatres but somewhat less the visits to workplaces and public transport hubs. This policy also increases the presence at home but it is less effective than the lockdowns. As one would expect, full lockdown is also more effective than other policies in reducing visits to workplaces, grocery and pharmacies, parks. However, for reducing the visits to public transport hubs the analysis underlines the partial lockdown and the public services closure as relatively more effective policies compared to the other containment measures under question. Finally, the policies that specifically target inducing more presence at home are the most effective at achieving this: lockdowns, public services closure and schools closure.

Table 4. Effect of COVID-19 policies on community mobility (residential): *Sensitivity analysis*.

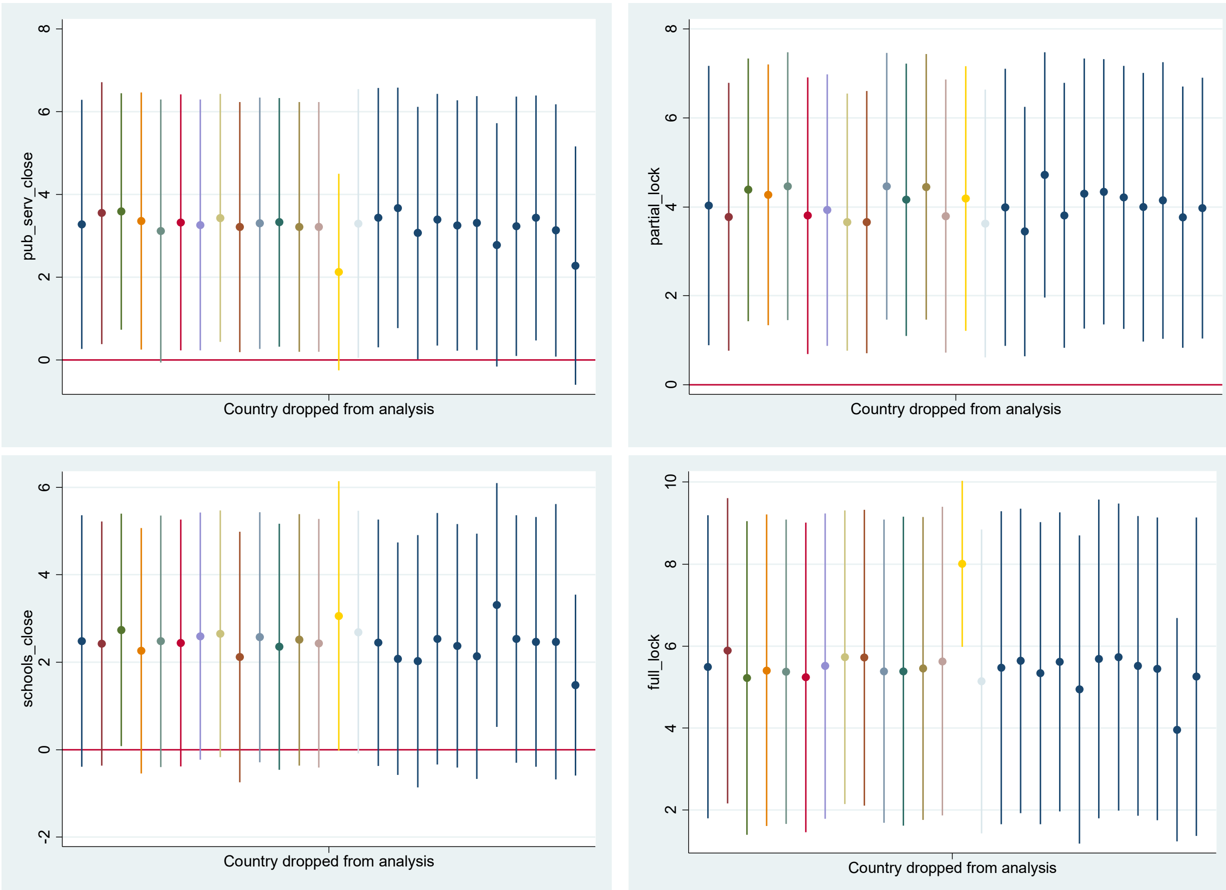
	(1) residential	(2) residential	(3) residential	(4) residential	(5) residential	(6) residential
limit_pub_gath	0.966	0.702	0.974	0.444	0.325	0.59
	(0.655)	(0.442)	(0.59)	(0.296)	(0.216)	(0.378)
pub_serv_close	2.284	2.130*	1.046	3.134**	2.783*	1.938
	(1.637)	(1.849)	(1.145)	(2.123)	(1.953)	(1.37)
prison_measures	-0.685	-0.785	-1.068	-0.878	-0.223	-0.549
	(-0.476)	(-0.535)	(-0.719)	(-0.628)	(-0.157)	(-0.381)
schools_close	1.474	3.060*	1.853*	2.467	3.305**	2.085*
	(1.468)	(2.052)	(1.803)	(1.618)	(2.445)	(2.004)
partial_lock	3.971**	4.192***	4.117***	3.769**	4.127***	4.084***
	(2.794)	(2.907)	(2.862)	(2.65)	(2.943)	(2.836)
full_lock	5.257**	8.004***	7.950***	3.959***	5.732***	5.415***
	(2.794)	(8.171)	(7.961)	(2.999)	(3.16)	(2.817)
refugee_lock	1.933	2.09	1.992	2.06	2.305	2.176
	(1.044)	(1.087)	(1.036)	(1.122)	(1.189)	(1.128)
Observations	1423	1423	1366	1423	1423	1366
R-sq	0.919	0.92	0.923	0.915	0.917	0.918

Notes: All the regressions include country and time fixed effects. Robust t-statistics are shown in parentheses. Column 1 drops Sweden from the sample. Column 2 drops Italy. Column 3 drops both Sweden and Italy. Column 4 drops Spain. Column 5 drops Romania. Column 6 drops both Romania and Sweden. *** p<0.01, ** p<0.05, * p<0.1

Given that the COVID-19 spread in the EU started from Italy and this country experienced a high volume of positive cases and deaths, there is always a concern that the estimated policy effects are driven by Italy (and/or Spain which has been hit hard as well). We provide a sensitivity analysis of the baseline results presented in Table 3: we drop each country from the sample one at a time and estimate the effect of policies (Figure 8). For this analysis we focus on the presence at home variable (*residential*) because the primary goal of the social distancing and lockdown policies is to decrease the time people spend outside of their homes. Figure 8 shows the results for the presence at home community mobility outcome variable (*residential*), for the policies that the corresponding estimated coefficient is statistically significant (*pub_serv_close*, *schools_close*, *partial_lock, full_lock*) in the baseline results ([10]).

([10]) The results for the rest community mobility variables are available upon request.

Figure 8. Effect of COVID-19 policies on community mobility (residential): *Sensitivity analysis*.



Notes: Countries dropped from analysis (from left to right): Austria, Belgium, Bulgaria, Croatia, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden.

It seems that Italy and Sweden inflate the coefficient of public services closure. For Sweden, it is because the country has never adopted this policy. Figure 8 depicts that also Spain has a distorting effect, especially on the coefficient of *full_lock*. According to our policy measures dataset, Romania has never implemented a schools closure policy and this has a deteriorating impact on the magnitude of the relevant estimated coefficient: without Romania in the sample, the estimated coefficient increases to 3.305 and becomes more statistically significant ([11]). In Table 4, column 1, the coefficient of public services closure when Sweden is dropped from the sample is 2.284 and statistically insignificant. Column 2 depicts the results when Italy is dropped: the magnitude of the estimated coefficient of public services closure policy drops to 2.130. On the other hand the effect of the schools closure policy increases to 3.060. Without Italy in the sample, there is also a higher effect of the full lockdown policy on the presence at home variable, compared to the baseline results. When both countries, Sweden and Italy, are excluded from the sample, the coefficient of *schools_close* reduces substantially to 1.853 (column 3). Column 4 shows the estimated coefficients without Spain: lockdown policies have lower effect in the time spent home and the effect of schools closure becomes statistically insignificant. Column 5 excludes Romania

([11]) Sweden has not implemented a schools closure policy as well.

and the effect of schools closure policy is higher and more statistically significant, which is an expected result, given that the country decided not to close its schools. Column 6 excludes both Romania and Sweden from the sample and the main difference with the baseline estimation is that the coefficient of the public services closure measure loses its statistical significance.

4 Conclusions

This report adopts a quasi-experimental approach to measure the impact of COVID-19 social distancing and lockdown policies on people's presence at home and their mobility in different types of places during the COVID-19 outbreak and before lifting containment measures to restart EU's community life and the Member States' economies.

Our empirical findings indicate that reductions in out-of-home social interactions and visits to public and private places are driven by a combination of restrictive measures introduced by Member States. Not surprisingly, the analysis suggests that partial and full lockdowns have the strongest causal impact on increasing presence at home and reducing visits to workplaces, public transport hubs, grocery, pharmacies, open public spaces, restaurants, cafes, shopping centres, theme parks, museums, libraries, and movie theatres. The impact of public services closure and schools closure is significant but of a smaller magnitude. At the COVID-19 outbreak in EU, policy measures such as large gathering bans and changes in prison policies seem to have had no significant causal impact on communities' overall mobility trends, but may have had some impact upon social distancing behaviour. We cannot measure the "pairwise" distance between individuals via this data set and so cannot use it to measure social distancing trends in a direct sense. Interestingly, our results also show that the lockdown of people living in camps and/or camp like conditions, such as refugees and other minorities, had a statistically significant negative effect on visits to places like national parks, public beaches, marinas, dog parks, plazas, and public gardens. However, it should be noted here that this result is attributed to two countries: Greece and Malta are the only Member States that implemented this confinement policy.

We emphasize here that the results of this work should not be generalized to possible future waves of the outbreak as (a) people's behaviour and preferences may be changing in response to the evolution of the virus; (b) we do not claim that measures such as large gathering bans and changes in prison policies do not impact the infection rate and disease mortality. Furthermore, for arguing that specific policies which accomplish a lower level of out-of-home mobility impact negatively the infection rate requires a second stage analysis that sheds light on the causal effect of social interactions and presence at home on the reported cases and deaths. We intend to tackle this question in a future report.

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Annex

Figure A1. Parallel trends assumption check for presence at home (*residential*).

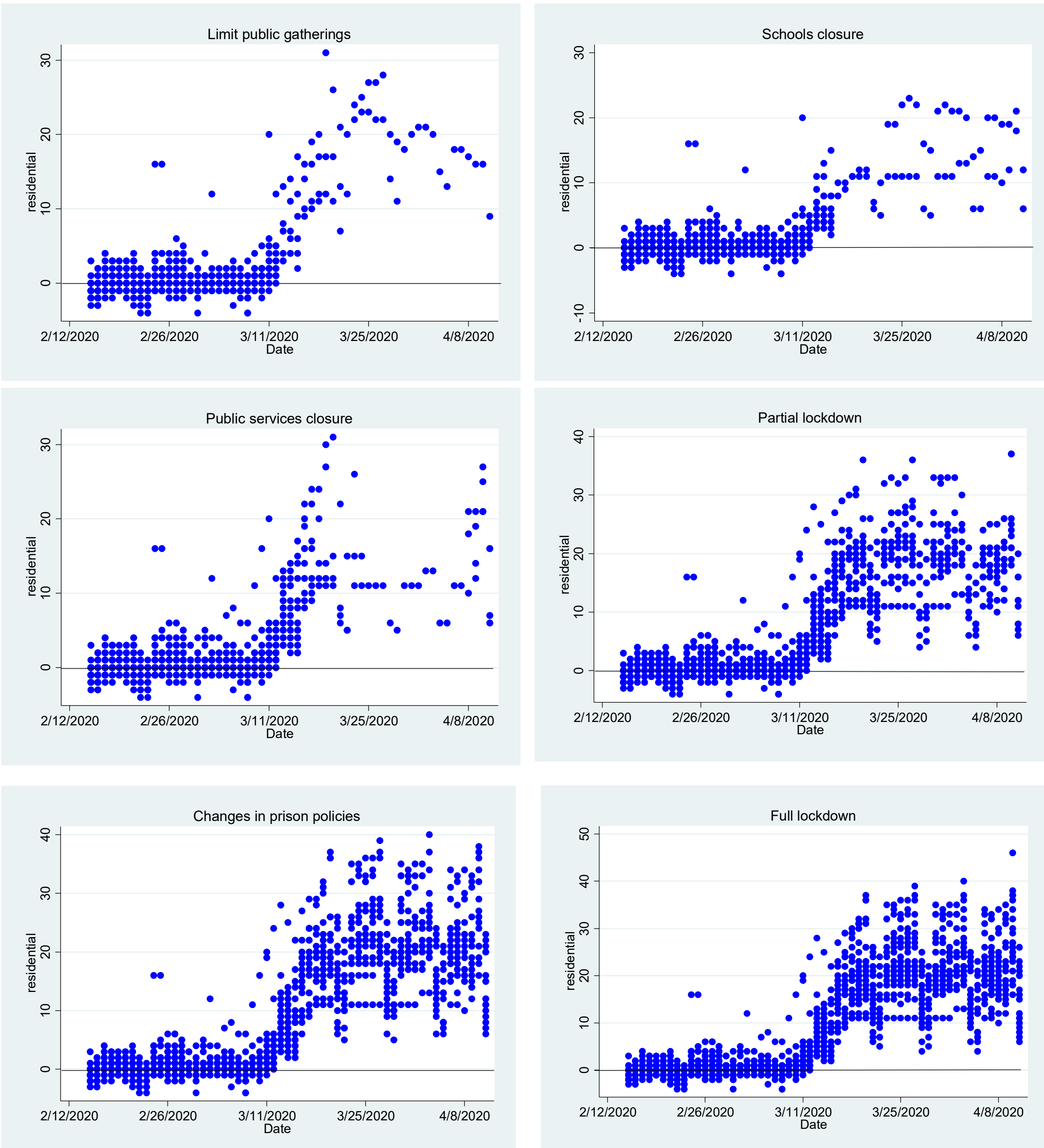
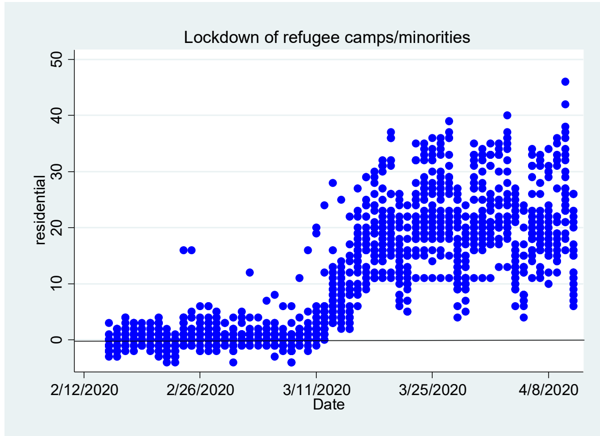


Figure A1 (continued). Parallel trends assumption check for presence at home (*residential*).



Notes: Results for the rest of the mobility trends outcome variables are available upon request. The report focuses on the presence at home variable because the primary goal of the social distancing and lockdown policies is to decrease the time people spend outside of their homes.

Figure A2. Trends in presence at home and the start date of the social distancing and lockdown policies implemented in each country: *limit public gatherings*.

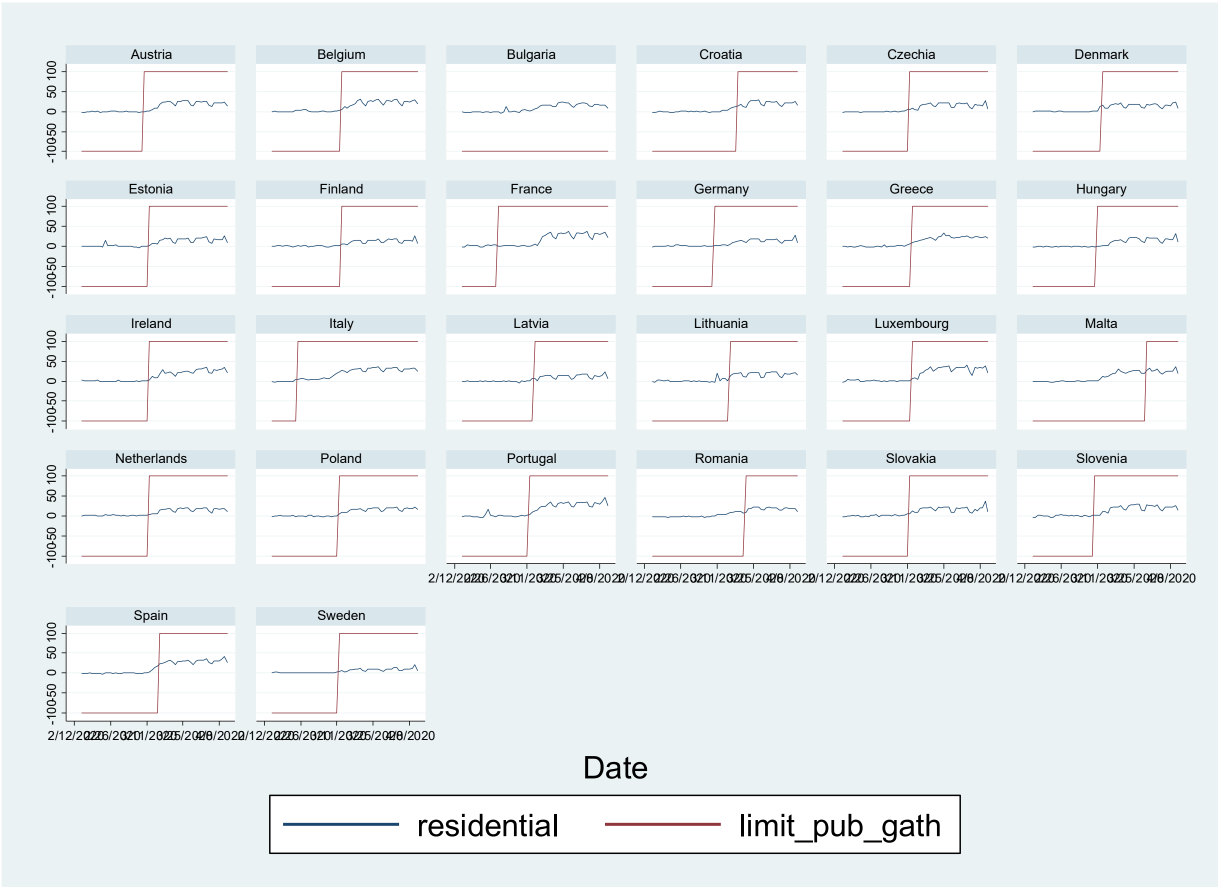


Figure A3. Trends in presence at home and the start date of the social distancing and lockdown policies implemented in each country: *public services closure*.

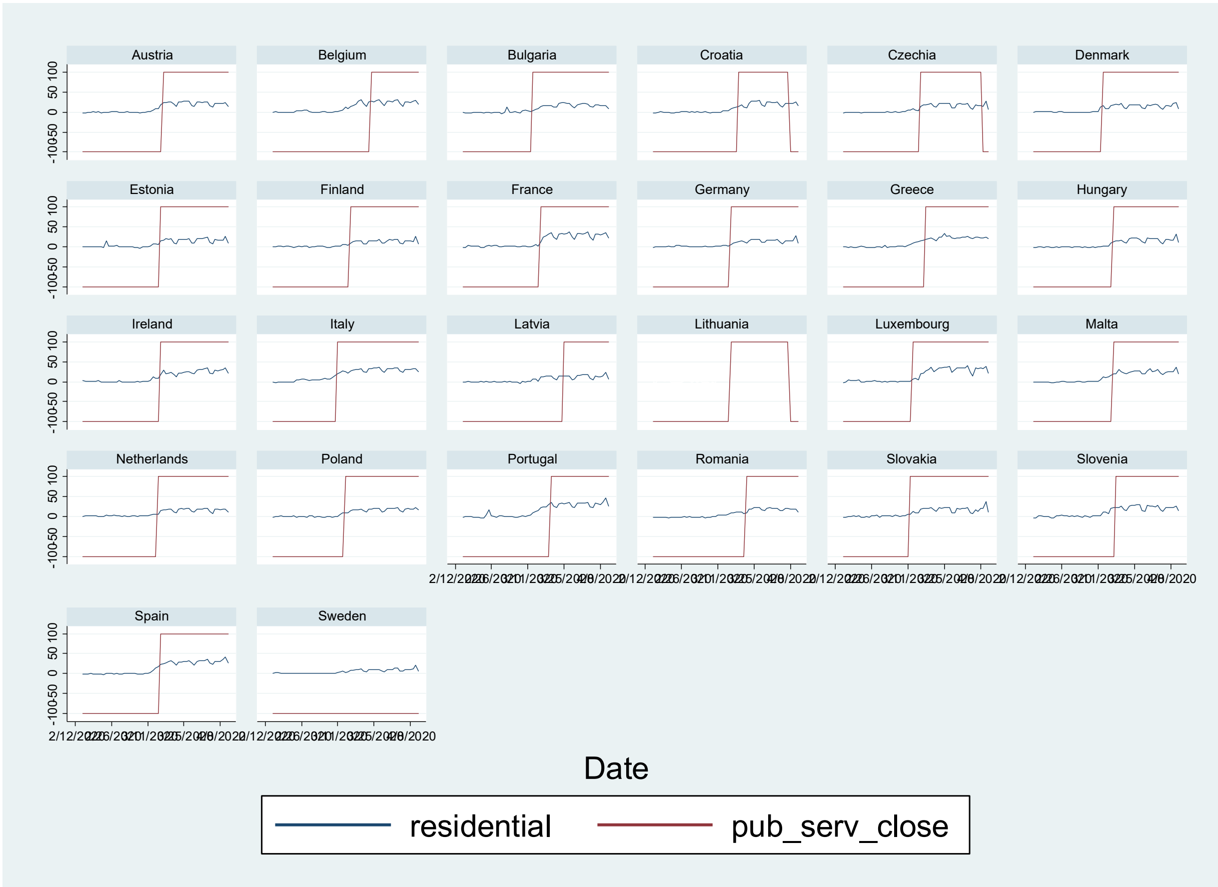


Figure A4. Trends in presence at home and the start date of the social distancing and lockdown policies implemented in each country: *changes in prison policies*.

Figure A5. Trends in presence at home and the start date of the social distancing and lockdown policies implemented in each country: *schools closure*.

Figure A6. Trends in presence at home and the start date of the social distancing and lockdown policies implemented in each country: *partial lockdown*.

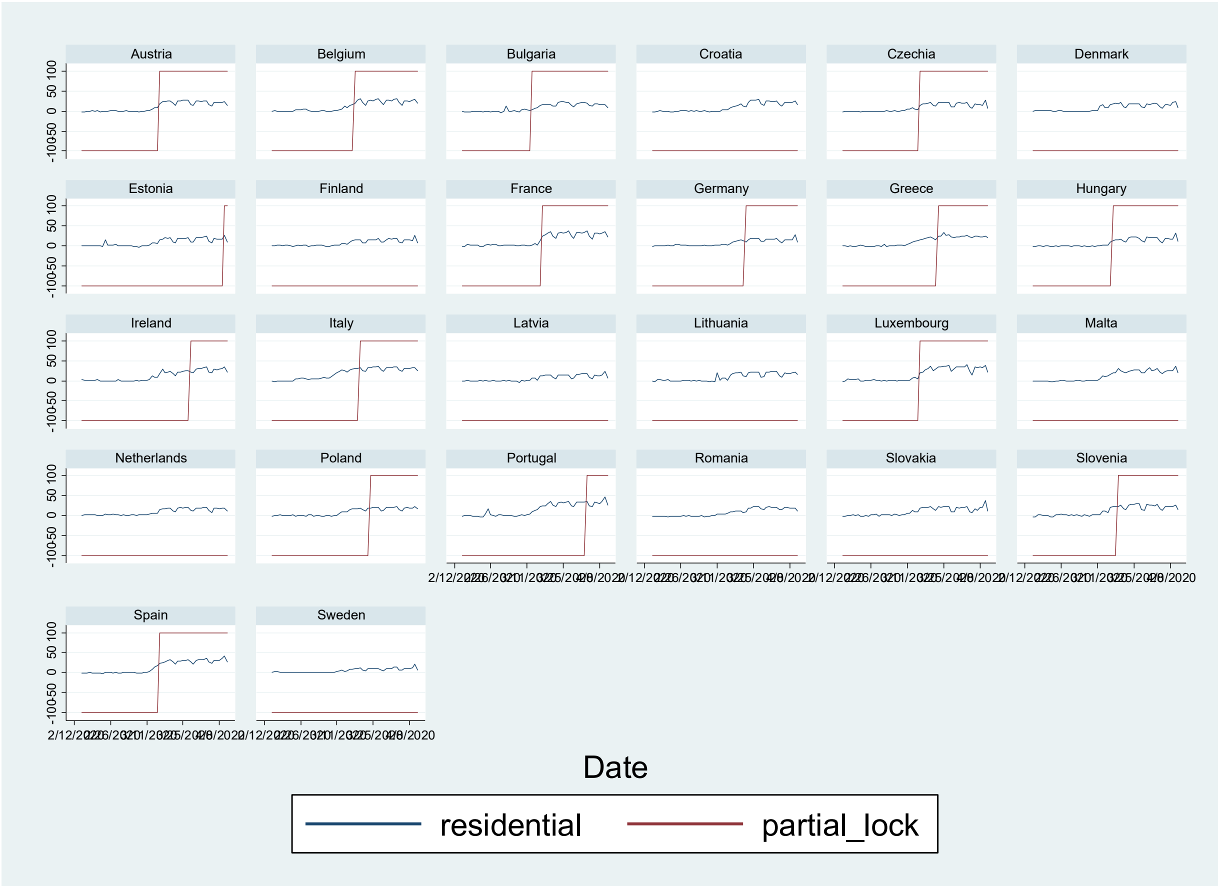


Figure A7. Trends in presence at home and the start date of the social distancing and lockdown policies implemented in each country: *full lockdown*.

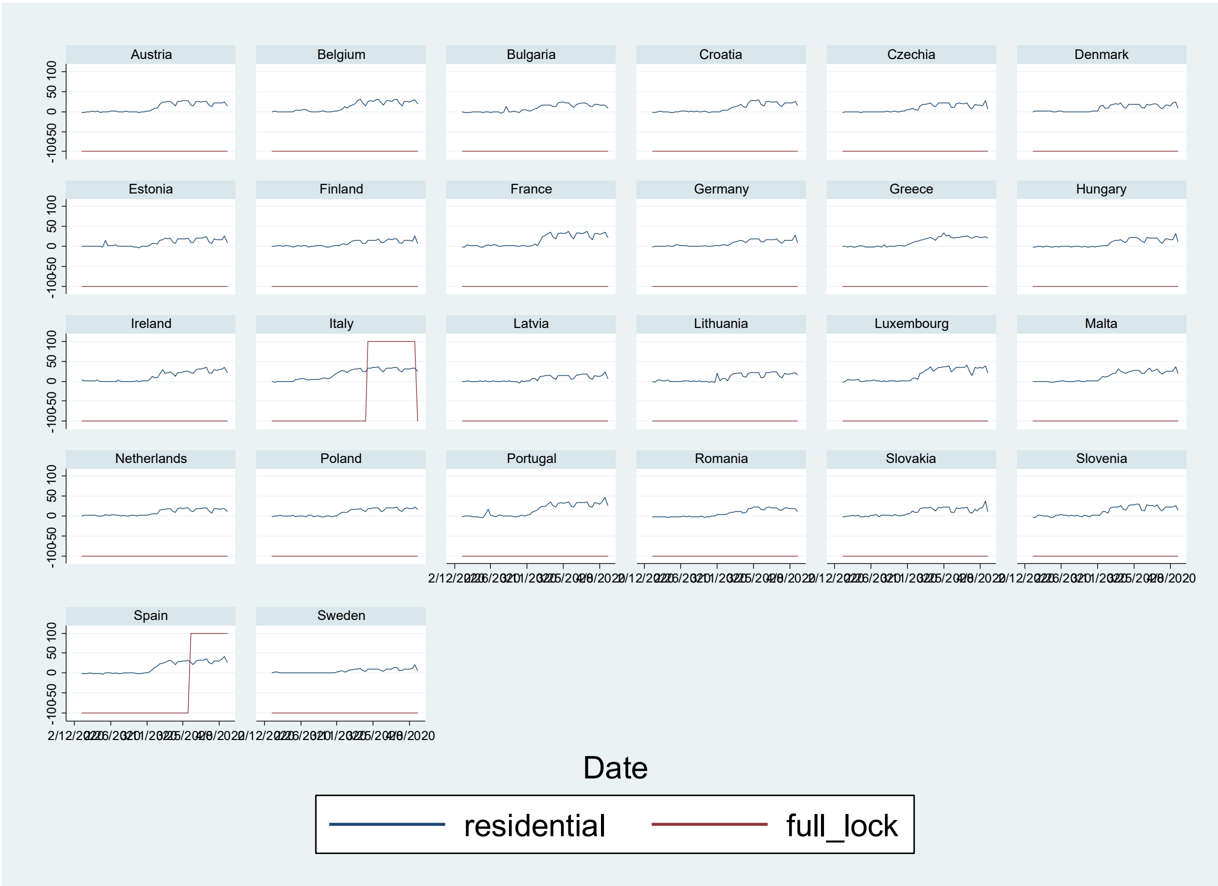


Figure A8. Trends in presence at home and the start date of the social distancing and lockdown policies implemented in each country: *lockdown of refugee, camps, other minorities*.

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