Early Adoption of Non-Pharmaceutical Interventions and COVID-19 Mortality

Catalina Amuedo-Dorantes
Economics, University of California – Merced, 5200 North Lake Rd., Merced, CA 95343
E-mail: camuedo-dorantes@ucmerced.edu
Tel.: 1-619-300-6362

Cristina Borra*
Economics and Economic History, Universidad de Sevilla, Ramon y Cajal 1, 41018 Sevilla, Spain.
E-mail: cborra@us.es
Tel.: +34 954551699

Noelia Rivera-Garrido
Economics, Universidad Loyola Andalucía, Avda. de las Universidades s/n, Dos Hermanas, 41704 Sevilla, Spain.
E-mail: nriverag@uloyola.es
Tel.: +34 955 641 600

Almudena Sevilla
Social Sciences, University College London, Gower Street, London, WC1E 6BT, U.K.
E-mail: a.sevilla@ucl.ac.uk
Tel.: +44 (0) 20 7679 2000

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Abstract

To contain the spread of the COVID-19 pandemic, many countries around the globe have adopted social distancing measures. Yet, establishing the causal effect of non-pharmaceutical interventions (NPIs) is difficult because they do not occur arbitrarily. We exploit a quasi-random source of variation for identification purposes –namely, regional differences in the placement on the pandemic curve following an unexpected and nationwide lockdown. Our results reveal that regions where the outbreak had just started when the lockdown was implemented had 1.62 fewer daily deaths per 100,000 inhabitants when compared to regions for which the lockdown arrived 10+ days after the pandemic's outbreak. As a result, a total of 4,642 total deaths (232 deaths/daily) could have been avoided by the end of our period of study –a figure representing 23% of registered deaths in Spain at the time. We rule out differential pre-COVID mortality trends and self-distancing behaviors across the compared regions prior to the swift lockdown, which was also uniformly observed nationwide. In addition, we provide supporting evidence for contagion deceleration as the main mechanism behind the effectiveness of the early adoption of NPIs in lowering the death rate, rather than an increased healthcare capacity.

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1. Introduction

In December 2019, the first case of COVID-19 was detected in the province of Wuhan (China). Given its easy and fast transmission, the virus quickly reached other countries, generating a serious health problem worldwide. At the end of January, in response to the first cases of confirmed infections outside China, the WHO decided to declare a "Public Health Emergency of International Importance (ESPII)". Along with Italy, Spain became one of the epicentres of the outbreak in Europe, with 216,582 confirmed cases and 25,100 deaths as of May 2, 2020 (Ministry of Health). These figures represented approximately 15% of all confirmed cases and 18% of deaths in Europe, as well as 7% of confirmed cases and just over 10% of deaths worldwide. In this paper, we use regional variation that stems from the quasi-random placement of Spanish regions on the pandemic curve at the time of the nationwide lockdown to estimate the causal effect of the timing of non-pharmaceutical interventions (NPIs) on mortality outcomes. By evaluating the effectiveness of early public health responses, we contribute to the understanding of how to curb the negative impacts of future similar events.

The rapid growth in the number of confirmed cases, together with the severity of the disease, shocked governments around the globe. In a desperate attempt to control the spread of the virus, countries adopted a variety of non-pharmaceutical interventions (NPIs) ranging from immediate, strict, and either regional or nationwide lockdowns (as in Italy or Spain), to more gradual step-by-step social distancing (as in the U.K. and the U.S.) (Ferguson *et al.*, 2020). In the absence of an effective vaccine, the hope was that NPIs would "flatten the curve" of the pandemic before healthcare systems became overwhelmed. Yet, due to the economic costs associated with the adoption of social distancing measures, the implementation of NPIs is sometimes dangerously delayed.

The epidemiological and economic literatures agree that social distancing is very effective in flattening the pandemic curve by reducing the viral transmission and avoiding the overwhelming of the healthcare system (Adda, 2016; Ferguson *et al.*, 2006; Markowitz *et al.*, 2019; Pichler *et al.*, 2017; Tian *et al.*, 2020). At the present time, the evidence on the effectiveness of early adoption of NPIs in the case of the COVID-19 pandemic originates from mathematical models (Atkeson, 2020), or from studies that exploit the temporal and geographic variation in the adoption of NPIs by counties, states or regions (Dave *et al.*, 2021, 2020). A caveat with the last approach is the non-random adoption of NPIs, which might be logically correlated to incidence and awareness of the disease. In this regard, historical evidence from the 1918 flu pandemic suggests that cities struck by the pandemic at a later time responded more quickly to the spread of the virus because they were made aware of the severity of the pandemic several weeks in advance (Hatchett *et al*., 2007). As noted by Painter and Qiu (2020), early awareness of the severity of the pandemic can lead to the practice of voluntary self-distancing by residents, biasing upwards the estimated effectiveness of a posterior NPI.

Our empirical strategy addresses the abovementioned challenge by exploiting the quasi-random discrepancies in the placement of regions on the pandemic curve at the time of a sudden and unexpected nationwide NPI. To that end, we focus on the Spanish case, which is of interest for various reasons. Spain has been one of the most hard-hit countries by the COVID-19 pandemic. It became one of Europe's epicenters after Italy, ranked second (after Belgium) in the number of deaths per 100,000 (45.5 as of April 21st), and third in total deaths after the U.S. and Italy (21,282 as of April 21st) (Johns Hopkins University, 2020). The Spanish government unexpectedly declared the state of emergency on an extraordinary meeting of the Council of Ministers on Saturday, March 14th, 2020, imposing a strict and nationwide lockdown. The announcement came as a shock, as made evident by massive demonstrations to mark International Women's Day throughout the country and continued sports events taking place during the same week (Tremlett, 2020). The lockdown was also far-reaching, involving school closures, the closure of non-essential businesses, and a stringent shelter in place order. Interestingly, while the lockdown was uniformly applied to the entire country, there was a great degree of regional variation with regards to where each region stood on the pandemic curve at the time of the lockdown. Regions such as La Rioja and Madrid already had between 50 and 100 confirmed COVID-19 cases per 100,000; in contrast, regions like Baleares, Murcia, or the Canary Islands had fewer than 5 confirmed cases per 100,000.

We use daily COVID-19 mortality and infection rates across Spanish regions over the March 4, 2020 through April 17, 2020 period, along with a difference-in-differences approach, to estimate the mortality impact of acting earlier. We account for time-varying regional factors, such as the average daily local temperature and sun exposure, as well as for other regional traits, including population composition and healthcare provision differences that could have influenced mortality. Likewise, we control for time invariant regional idiosyncrasies through regional fixed-effects, as well as for temporal trends to capture changes in testing availability and therapeutic improvements, which could also affect differential changes in mortality. We find that introducing the lockdown one day earlier could have reduced daily COVID-19 mortality rates by 0.16 deaths per 100,000 inhabitants. Simulation exercises show that locking down all regions when infections reached 3 cases per 100,000 inhabitants –the lowest rate when the lockdown was imposed on March 14th, 2020– could have lowered daily deaths by roughly 232 at the peak of the pandemic, between March 30th and April 17th, 2020. This implies that 4,642 deaths could have been avoided by the end of the period being examined, representing 23 percent of the 20,037 cumulative deaths

Spain had experienced at the time. These findings prove robust to the use of alternative definitions of regional outbreaks and infection-to-death time spans, and to the use of alternative units of analysis and datasets.

The validity of our estimates rests on a couple of assumptions. The *first* one relates to the quasi-random spread of the virus, and the fact that the placement of each region on the pandemic curve at the time of the nationwide lockdown was largely orthogonal to mortality rates a year prior. As with other pandemics (Clay *et al.*, 2019; Correia *et al.*, 2020), the spread of the coronavirus appears to have been driven by "international connectivity", rolling from main ports of entry (*e.g.* Madrid, Barcelona, and more touristic regions, like the Canary and Balearic Islands, where the first cases were confirmed) to the rest of the country (De la Fuente *et al.*, 2020). We formally show that the spread of the coronavirus and regions' placement on the pandemic curve on March 14th were unrelated to regional pre-COVID 2019 mortality trends during the previous winter. In other words, regions that had lower infection rates at the time of the lockdown appear to be similarly predisposed to the spread of contagious diseases as regions with higher infection rates.

A second assumption for gauging the importance of the lockdown's implementation timing in curtailing COVID-19 mortality refers to the need for a synchronized and uniformly observed social distancing across all Spanish regions. That is, we need to rule out any prior self-distancing in regions with a later COVID-19 outbreak, which could bias the estimated impact of the lockdown upwards;[1] and second, we need to confirm that the social distancing imposed by the lockdown was uniformly observed across regions. To confirm the validity of these two assumptions, we use Google's high-frequency mobility data (Google LLC, 2020). The data, which inform about

[1] The impact would be biased downwards if self-distancing were practiced by regions with an earlier outbreak.

changes in mobility for various purposes –including work, shopping, school attendance, entertainment and, overall, time away from home– confirm that mobility and the ensuing self-distancing only decreased sharply, as well as simultaneously, across all Spanish regions, after the lockdown, irrespective of urbanization, density levels, or other region-specific traits.[2]

The last part of the paper provides suggestive evidence of how containment of the pandemic spread was the main mechanism responsible for the lockdown's efficacy in curtailing mortality. We show that infection and mortality rates dropped by a similar amount with the lockdown. We also consider other channels, such as the possibility that the earlier adoption of a NPI prevented the health care system from reaching full capacity. After all, there were signals of the Spanish healthcare system being severely affected by the pandemic. For instance, on April 21st, more than 20 percent of confirmed cases were doctors and nurses (Equipo Covid-19, 2020); this, as well as the shortage of masks, gloves and other essential gear, was expected to have seriously hampered the healthcare system's ability to fight the pandemic. However, once we exclude the regions where the healthcare system became clearly overwhelmed, as evidenced by the setup of mobile hospitals, we continue to find similar results. Finally, we also show that non-COVID deaths did not change with the timing of the lockdown. Jointly, the two last results suggest that the main channel for the reduction of COVID-related deaths that trailed the nationwide lockdown was the decrease in infection rates, rather than the avoidance of a congested healthcare system.

The analysis herein makes a couple of important contributions to the scientific literature. First, it contributes to the literature investigating the association between various types of social

[2] In contrast, studies focused on the United States have found that social distance orders were more rigorously followed in densely populated areas (*e.g.* (Dave *et al*., 2020).

distancing measures and the flattening of pandemic curves for diseases other than COVID-19 (*e.g.* Ferguson *et al*., 2006; Markel *et al*., 2006; Hatchett *et al*., 2007; Adda, 2016; Pichler and Ziebert, 2017; Markovitz *et al*., 2019). A second contribution refers to a similar, more recent literature focused on gauging the impact of NPI measures during the present COVID-19 pandemic (Dave *et al*., 2021; Friedson *et al*., 2020; Qiu *et al*., 2020). Instead of relying on the staggered, non-random adoption of policies influenced by the region's awareness of the pandemic, the incidence of the disease, and/or its political partisan ideology (Dave *et al*., 2021; Gupta *et al*., 2020), we rely on the more exogenous regional variation stemming from the regional placement on the pandemic curve at the time of the nationwide lockdown.

The paper is organized as follows. Section 2 details the adoption of the nationwide lockdown in Spain. Section 3 describes the data sets used in the analysis, and Section 4 outlines the empirical methodology. Section 5 presents the main findings, robustness and identification checks. Section 6 discusses the mechanisms at play, and Section 7 concludes.

2. Institutional Setting

With the aim of fighting the spread of COVID-19 and avoid overwhelming the public healthcare system, the Spanish Government declared a state of emergency on March 14th, 2020. Along with the declaration, an immediate nationwide lockdown was mandated, resulting in school and non-essential business closures, along with the requirement that all residents remained indoors other than for essential activities limited to buying food or medicine, working in essential businesses, caring for relatives, or pet walking. Working from home was encouraged, and religious gatherings discouraged, including funerals.

The measure was swiftly adopted. It was approved in an extraordinary session of the Council of Ministers and announced in a broadcasted interview the previous evening. It was unanticipated and was not preceded by changes in social distancing in the regions with a later COVID-19 outbreak, as we shall show in Section 5.3. Finally, the lockdown was strictly enforced. No outings for exercise were allowed. Essential shopping or dog walking had to be performed alone. Curfew violators were subject to fines equivalent to half a month's salary for most Spaniards –fines ranging between €600 and €3,000, and even imprisonment if refusing to obey. As a result, compliance was uniformly high, as we shall also discuss in Section 5.3.

3. Data and Descriptive Evidence

3.1. Mortality and Infection Data

To assess how the lockdown affected COVID-19 mortality, we use official data on daily COVID-19 fatalities and on newly confirmed cases published by the Spanish Ministry of Health.[3] The Spanish Ministry of Health keeps a daily record of all new COVID-19 cases and fatalities reported by the regional epidemiological surveillance services to the National Center for Coordination of Alerts and Emergencies of the Ministry of Health. The dataset contains information on total confirmed cases, hospitalized cases, ICU admissions, as well as on the deceased and individuals who recovered. It allows us to compute the accumulated number of COVID-19 cases by region and date, together with daily regional COVID-19 deaths. Using population figures from the Spanish Statistical Institute, we next compute COVID-related mortality rates.

[3] Our analysis relies on COVID-19 deaths. However, when examining the mechanisms through which social distancing measure might be impacting COVID-19 mortality, we also make use of daily counts of newly COVID-19 confirmed cases.

We also make use of an alternative mortality dataset –the Spanish Daily Mortality Monitoring System (MoMo) in our robustness checks, as well as when assessing the main determinants of the effectiveness of the nationwide lockdown in curtailing COVID-19 deaths. MoMo is a surveillance system shared by European countries aimed at detecting *excess* deaths related to seasonal influenza, pandemics and other public health threats. In Spain, the information is obtained from the computerized entries in the Civil Registers and Notaries of the Ministry of Justice. The entries account for 92% of deaths nationwide, although that percentage ranges from 100% to 54% depending on the region. We use data on total deaths from this alternative dataset as a robustness check. Additionally, we use the information on daily *total* and *COVID-19* mortality figures at the regional level to compute daily *non-COVID* deaths at the regional level, which we use to identify some of the mechanisms responsible for the estimated impact of the lockdown on COVID-19 deaths.

Our dataset spans from March 4, 2020 through April 17, 2020. March 4, 2020 is the date of the first COVID-19 death in Spain, whereas April 17, 2020 represents a break in the series. After that date, the Spanish Ministry of Health changed the definition of COVID-19 confirmed cases. Only those diagnosed through polymerized chain reaction (PCR) and antibody testing were included. See descriptive statistics in Table A.1 in the Appendix.

We construct a measure indicative of the region's placement on the pandemic curve at the time of the nationwide lockdown. Following Correia *et al*. (2020), we define the *speed* of the response to the pandemic as the number of days elapsed between the COVID-19 outbreak in the region (defined as the day when 3/100,000 COVID-19 cases were confirmed in the region) and the nationwide lockdown (that is, March 14, 2020). We use the cutoff of 3 cases per 100,000 inhabitants as the outbreak benchmark because that was the lowest COVID-19 infection rate at the time of the lockdown (in the region of Baleares).[4] We experiment with alternative outbreak definitions –such as having 2, as well as 4, confirmed cases per 100,000 inhabitants, in Section 5.2. As we shall discuss therein, our results prove robust to the use of those alternative definitions.

3.2. Temperature and Mobility Data

We also make use of two additional data sources. One includes data on the average daily temperature and sun exposure, which can affect the transmission of viruses affecting the respiratory system (Adda, 2016; Qiu *et al*., 2020). The data, which are gathered from the Spanish Meteorological Agency, capture the average daily temperature (in ºC) and sun exposure (in hours) 15 days before the death is registered, allowing us to address weather conditions around the time of contagion.

In addition, as part of our identification checks, we make use of daily mobility data for each region obtained from Google (Google LLC, 2020). Google Community Mobility Reports measure changes in mobility related to visits to six different destination categories: grocery stores and pharmacies, parks, transit stations, restaurants and other recreation centres, and workplaces. There is also a residential category that captures changes in the fraction of the day that Google users spend in their residence. The baseline is the median value for the corresponding day of the week, during the 5-week period spanning from January 3 through February 6, 2020. The sample is composed of Google users who have opted-in to location history for their accounts.

Figure 1 displays the daily number of COVID-19 deaths per 100,000 in two sets of regions –regions for which the relative adoption speed of the national lockdown was higher than the

[4] Previous epidemiology literature has used the first death in the locality as the outbreak threshold (Market *et al.*, 2007). We cannot use that same cut-off because some regions only experienced a COVID-related death after the lockdown.

median (*early-on-the-curve*) vs. regions where it was lower than the median (*late-on-the-curve*). In *early-on-the-curve* regions, the lockdown occurred 2 days or less after the pandemic outbreak [*i.e.* Andalucía (1), Baleares (0), Canarias (2), Cantabria (2), Comunidad Valenciana (0), Extremadura (2), Castilla-León (3), Galicia (2), Cataluña (2) and Murcia (1)]. In contrast, in *late-on-the-curve* regions, the lockdown took place 3+ days after the outbreak [*i.e.* Aragón (4), Asturias (4), Madrid (9), País Vasco (7), Castilla La Mancha (4), Navarra (4) and La Rioja (10)].

The contrast in mortality rates between the two sets of regions in Figure 1 is striking. At the top of the pandemic curve (between April 1 and April 5, 2020), the daily mortality rate in *late-on-the-curve* regions averaged 2.72 per 100,000 inhabitants –almost four-fold the mortality rate in the remaining *early-on-the-curve* regions (0.82 per 100,000 inhabitants) (difference=1.90, *t*=25.05). By the end of the analyzed period (*i.e.* April 17, 2020), the COVID-19 fatality rate in the *late-on-the-curve* regions more than doubled the rate in *early-on-the-curve* regions.

4. Empirical Specification

We rely on the natural experiment created by the COVID-19 pandemic, along with the unexpected and nationwide implementation of a stringent lockdown in Spain, to gauge the effectiveness of social distancing measures in containing pandemic deaths using the following differences-in-differences (DD) model specification:

$$Y_{jt} = \alpha + \beta Post_t * S_j + X_{jt}\gamma + \eta_j + \mu_t + \varepsilon_j \quad (1)$$

where Y_{jt} represents COVID-19 deaths in region *j* and date *t*. Our key regressor is an interaction term of two variables: (1) the relative speed of adoption of the nationwide lockdown based on where each region *j* was on the pandemic curve at the time of the lockdown, S_j; and (2) a dummy variable indicative of the post-lockdown period, $Post_t$. The relative speed (S_j) is measured by the number of days elapsed between the regional outbreak, defined as having 3 confirmed cases per 100,000, and the nationwide lockdown. This figure is then multiplied by minus one so that higher values denote a faster response, as in prior studies (Correia *et al*., 2020).[5] The post-lockdown period dummy ($Post_t$) includes a 15-days delay to account for the average number of days between infection and potential death (Lauer *et al*., 2020); hence, it takes the value of 1 from March 29, 2020 onwards.[6] If the lockdown was effective at containing pandemic's deaths, we should expect β to take negative values, signaling that, the faster the response, the lower the mortality rate associated to the pandemic.

The model also accounts for other regional time-varying factors potentially affecting COVID-19 deaths (X_{jt}), such as the average temperature and sun exposure 15 days prior to the recorded deaths –that is, close to infection time. This allows us to better account for atmospheric factors potentially affecting the spread of the virus and contagion. Equation (1) also includes region fixed effects (η_j) to account for time-invariant differences across regions, such as regional differences in mortality rates or traits potentially related to COVID-19 deaths, *e.g.* population aging, density, or tourism (Aparicio Fenoll and Grossbard, 2020). In addition, date fixed effects (μ_t) help us address over time variation affecting mortality rates across regions due, for example, to changes in testing capabilities or treatment improvements (Murray, 2020).[7] Equation (1) is estimated by ordinary least squares, and robust standard errors are clustered at the region level.

As noted earlier, the validity of our estimates rests on a couple of assumptions. First, we assume that each region's position on the pandemic curve at the time of the nationwide lockdown

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[5] For example, Madrid reached 3 cases per 100,000 the 5th of March, that is, 9 days before the lockdown of 14th March. In consequence, the relative speed for Madrid is -9.
[6] In robustness checks, we experiment with using different delays. Results prove to be consistent.
[7] Note that both S_j and $Post_t$ drop with the inclusion of region and date fixed effects.

is randomly determined by the spread of the pandemic and unrelated to pre-existing differences in mortality rates across regions. To this end, in Section 5.3, we present evidence of how regions with an earlier vs. a later outbreak did not exhibit differential pre-COVID mortality rates; rather, the spread of the pandemic has been linked to the extent of "international connectivity" of each region (De la Fuente *et al*., 2020). Second, social distancing must have started simultaneously across regions and observed similarly throughout. If, for example, residents of less affected regions practiced self-distancing prior to the lockdown's announcement, the estimated impact of an early NPI adoption could be biased upwards. The opposite would be the case if self-distancing occurred in more affected regions. Additionally, if the social distancing created by the nationwide lockdown was not uniformly observed across regions, the estimated impact of such NPI in curtailing deaths would be compromised. To assess if any of the abovementioned scenarios occurred in the Spanish case, Section 5.3 examines changes in mobility patterns before and after the nationwide lockdown. As we shall discuss, changes in mobility were highly synchronized across all regions, with mobility dropping similarly throughout the country only after the lockdown was mandated.

5. Quantifying the Importance of Early Intervention when Responding to a Pandemic

5.1. Main Findings

Table 1 shows the results from estimating equation (1) using a sample of daily COVID-19 mortality rates by region. Column (1) shows our estimates without any controls, other than date and region fixed effects. Column (2) further includes the daily average temperature and sun exposure in the region to address for changing weather conditions. According to the estimates in this second specification, imposing the nationwide lockdown one day earlier would have lowered

COVID-19 deaths by 0.162 per 100,000 or by 11%. This means that regions where the outbreak had just started at the time of the lockdown had 1.62 daily deaths per 100,000 inhabitants less than regions for which the lockdown arrived 10+ days after the pandemic's outbreak.

Figure 2 shows average regional COVID-19 mortality rates (in black), together with the results of performing a simulation exercise using the estimated coefficients from the differences-in-differences regression in column (2) of Table 1 (blue line). Our model implies that, if Madrid (speed=-9) had had the lockdown in place immediately after the outbreak –as Baleares (speed=0), 1.45 daily deaths per 100,000 inhabitants could have been avoided. Given Madrid's population of 6.64 million, ninety-seven daily deaths could have been prevented had the lockdown been implemented earlier. If we conduct a similar simulation exercise for other regions (see Appendix Table A.2), we conclude that 232 daily deaths could have been avoided nationwide if the lockdown had been adopted, in each region, when infections reached 3 cases per 100,000 inhabitants –that is, with a speed of intervention of 0. In turn, a total of 4,642 deaths could have been prevented by the end of the period under analysis (April 17, 2020) –approximately 23 percent of the 20,037 deaths Spain had experienced at the time.

It is difficult to compare these results to those in previous studies. Most of them have focused on gauging the impact of lockdowns and social distancing measures on COVID-19 infections, as opposed to deaths (Dave *et al*., 2020; Di Porto *et al*., 2020; Weber, 2020). Other studies have examined the impact of school closures, virus testing, or even municipal elections, as opposed to lockdown policies, on mortality (Bertoli *et al.*, 2020; Neidhöfer and Neidhöfer, 2020; Terriau *et al.*, 2020). The one paper assessing the role of mobility restrictions on COVID-19 mortality focuses on the role of the March, 19th shelter in place order (SIPO) in California (Friedson *et al*., 2020). The authors estimate an 81.6 to 91.6 percent reduction in mortality over a

20-day period –a reduction in daily mortality rates of approximately 5 percent. This impact is approximately half of our estimated impact (11 percent), which is not surprising given the much more stringent nature of the Spanish lockdown compared to the Californian SIPO.

5.2. Robustness Checks

We conduct several robustness checks to assess the sensitivity of our findings to: (1) alternative definitions of what is considered an outbreak (using 2 and 4 cases per 100,000 inhabitants, as opposed to 3); (2) assuming different infection-to-death time spans (14 and 16 days vs. 15); (3) performing the analysis at the province vs. regional level; and (4) using an alternative database to calculate mortality rates (*i.e.* MoMo data). In what follows, we briefly refer to each robustness check.

As we pointed out earlier, the analysis in Table 1 considers that an outbreak occurred when there were, at least, 3 confirmed COVID-19 cases per 100,000 inhabitants in the region, as that was the lowest COVID-19 infection rate at the time of the lockdown (in the region of Baleares). In columns (1) and (2) of Table 2, we experiment with alternative definitions of an outbreak – namely, having 2 and, later on, 4 confirmed cases per 100,000 inhabitants.[8] Our results prove robust to the use of these alternative outbreak thresholds. Accelerating the adoption of the nationwide lockdown by one day lowers the COVID-19 fatality rate by 8.5% when a lower threshold is used as the outbreak, and by 10% when the threshold is slightly higher.

Next, we experiment with using alternative infection-to-death spans. Using information from official COVID-19 reports, together with research from China, we estimated the time span

[8] When the outbreak is defined as reaching 4 in 100,000 confirmed cases, the one region -Baleares- with a prevalence lower than 4 in 100,000 at the time of the lockdown (March 14th) is set to have a relative speed of zero, together with Andalucía, Comunidad Valenciana, and Murcia that reached the 4 in 100,000 infection rate precisely on March 14th.

from infection to death to average 15 days –5 days for incubation and 10 days from the onset of symptoms to death (Equipo Covid-19, 2020; Lauer *et al.*, 2020). In columns (3) and (4), we experiment with using alternative infection-to-death time spans of one-day shorter and one-day longer. As a result, the post-lockdown period dummy ($Post_t$) now takes the value of 1 from March 28, 2020 onward when the time span is shortened by one day, and from March 30, 2020 onward when it is lengthened by one more day. As can be seen in Table 2, the estimates in columns (3) and (4) continue to support our prior findings, as speeding up the adoption of the nationwide lockdown would have lowered mortality from COVID-19 by 11% and 10%, respectively.

Subsequently, we test the sensitivity of our findings to using alternative units of observations and data sources. To that end, we collect data from the regional Ministries of Health to perform the analysis at a higher level of disaggregation, *i.e.* province vs. region.[9] The data on cumulative deaths and cases by province are compiled through data scraping techniques from different data sources –mainly regional press releases– that vary in their recording of COVID-19 cases. Therefore, the data are less reliable. Notwithstanding this caveat, the estimate in column (5) of Table 2 confirms our prior findings. Speeding up the implementation of the nationwide lockdown by one day would have lowered COVID-19 deaths by 6%. This estimate results from using 2 deaths per 100,000 inhabitants as the outbreak definition, since many provinces had not yet reached the 3 in 100,000 threshold used in the main analysis. Overall, the impact is not significantly different from the 8.5% impact reported in column (1) of Table 2, when using the same fatality threshold.

[9] There are 52 provinces and 17 regions in Spain.

Finally, we experiment with using total daily mortality rates by region computed using data from the Spanish Daily Mortality Monitoring System (MoMo). As noted earlier, the information contained in this alternative dataset is gathered from the General Registry of Civil Registers and Notaries of the Ministry of Justice. Column (6) in Table 2 shows that our results are robust to using mortality rates computed using the MoMo data. Declaring the lockdown one day earlier would have reduced total deaths by 3%. Because COVID-19 deaths account for approximately 34% of the Momo deaths, this estimate implies a 9% reduction in COVID-19 deaths had the lockdown started one day earlier –an impact similar to the one documented in Table 1.

In sum, the analyses in Table 2 confirm the robustness of the estimate in Table 1 to alternative definitions of outbreaks, infection-to-death time spans, units of analysis and data sources. In addition, in Figure A.1 in the Appendix, we assess the sensitivity of the estimate to excluding any one region from the analysis by removing one region at a time. As can be seen therein, no single region appears to be driving our key findings.

5.3. Identification Checks

As explained in Section 4, the validity of our findings depends on: (1) the exogenous placement of each region on the pandemic curve at the time of the nationwide lockdown based on the quasi-random spread of the virus, not on pre-existing regional differences in mortality rates, and (2) the synchronized observance of social distancing starting March 14^{th}, and the uniform compliance with the lockdown's orders, across all regions. In this section, we explore whether these assumptions seem to be fulfilled in our case.

5.3.1. Exogenous Placement of Each Region's on the Pandemic Curve on March 14th

An identifying assumption is that each region's position on the pandemic curve at the time of the nationwide lockdown is randomly determined by the spread of the pandemic and, in particular, unrelated to pre-existing differences in mortality rates across regions. In a similar vein to what has been found for other respiratory pandemics (*e.g.* Brainerd and Siegler, 2004), the spread of the coronavirus has been largely influenced by "international connectivity" (De la Fuente *et al*., 2020). The initial spread is likely correlated to both the region's population size and composition, the region's touristic appeal, and the number of overseas students; but not to the region's predisposition to a higher incidence of COVID-19 as captured by its pre-COVID mortality rate. Nevertheless, to formally assess if that is an appropriate assumption, we collect 2019 data on each region's total daily mortality rates from March 4 through April 17 in 2019 –that is, one year earlier. Using those data, we examine the extent to which each region's placement on the pandemic curve is related to pre-COVID regional mortality rates. As shown in column (1) of Table 3, unlike the COVID-19 mortality rates, those corresponding to 2019 are not spuriously correlated to the relative speed of intervention. In addition, Figure A.2 in the Appendix provides graphical evidence of the arbitrary spread of the disease across regions, with *early-in-the-curve* and *late-in-the-curve* displaying very similar mortality rates from March 4 through April 17, 2019.

5.3.2. Synchronized and Uniformly Observed Social Distancing

Another concern refers to the synchronous start of social distancing across regions, as well as its uniformed observance after the lockdown. As noted earlier on, if residents in regions with a later outbreak practiced self-distancing prior to the adoption of the nationwide lockdown, its estimated effectiveness in curtailing deaths would be biased upwards. (The opposite would be the case if, instead, that was the predominantly the case among residents with earlier outbreaks, resulting in a downward biased estimate of the lockdown's effectiveness.) In addition, if after the lockdown, social distancing was observed differentially in regions with an earlier vs. a later outbreak, the estimated impact of the NPI could also be biased. In this regard, Dave *et al*. (2020) show that more densely populated areas in the United States followed social distancing orders more rigorously. If regions with later outbreaks in Spain behaved similarly because they were more densely populated, our estimates could be biased upwards.

To gauge if any of these scenarios took place, we rely on Google mobility measures (Google LLC, 2020). Figure 3 (along with Figures A.3 through A.8 in the Appendix) show how mobility dropped sharply and similarly across all Spanish regions only after the lockdown. In other words, there is no evidence of significant differences in mobility and its ensuing social distancing across regions, neither before nor after the lockdown.[10] In addition, we conduct two checks to gauge regional differences in mobility patterns across regions, as well as their role in explaining our findings. To that end, we first estimate an equation similar to equation (1), where the dependent variable is now Google's residential mobility. As can be seen in column (2) of Table 3, there is no statistically significant link between mobility and the lockdown's relative adoption speed. Mobility patterns did not significantly differ across regions that were *early* vs. *late* in the pandemic curve at the time of the lockdown. We also re-estimate the model in Table 1 accounting for regional daily mobility patterns obtained from Google (Google LLC, 2020). As can be seen in column (3) of Table 3, our findings remain virtually the same as those reported in

[10] If anything, regions with earlier outbreaks, such as Madrid, seem to have curtailed mobility slightly earlier. As noted above, the early start of social distancing in these regions would result in a lower bound estimate of the lockdown's effectiveness in curtailing deaths.

Table 1, which is not surprising since compliance with the mandated lockdown and, thereby, social distancing patterns did not significantly differ across regions.

6. Preventing Contagion as the Main Mechanism behind the Lockdown's Effectiveness

According to the World Health Organization (2020), the COVID-19 virus is primarily transmitted between people through respiratory droplets emitted during coughing or sneezing and through fomites in the close environment around the infected person (*e.g.*, stethoscope or thermometer). By reducing close contact between individuals, lockdowns may slow down the COVID-19 virus transmission and, therefore, deaths. In the absence of effective vaccines and reliable tracking systems, NPIs have also been invoked to flatten the pandemic curve by lowering the demands on public healthcare services, allowing for COVID-19 patients to be properly treated (Ferguson *et al*., 2020). As such, the lockdown could help lower COVID-19 mortality through both a direct channel consisting in reducing contagion, as well as an indirect channel that prevents the congestion of the healthcare system.

We attempt to sort out these two channels by first examining infection rates –known to provide a lower bound of the spread of the disease. If the effectiveness of the lockdown did not primarily stem from reducing contagion but, rather, avoiding an overwhelmed healthcare system, we should not necessarily observe a reduction in the infection rate. Yet, as displayed in column (1) of Table 4, adopting the nationwide lockdown one day earlier would have curtailed infections by 13.5%.

Next, we experiment with excluding from the analysis two regions where the healthcare system became clearly overwhelmed, as captured by the establishment of mobile hospitals to be able to attend the growing number of hospitalizations, *e.g.* Madrid and Cataluña.[11] If the effectiveness of the nationwide lockdown in curtailing COVID-19 deaths primarily stemmed from avoiding an overwhelmed healthcare system, we should not continue to find a significant impact in reducing mortality after removing those two regions. However, as can be seen in column (2) of Table 3, we continue to find evidence of how adopting the lockdown one day earlier would have helped lower the mortality rate by approximately 16%.

Finally, we look at how the earlier vs. later adoption of the lockdown for any given region, based on its placement on the pandemic curve, might have affected non-COVID mortality. If the lockdown primarily helped curtail pandemic deaths by preventing the healthcare system from becoming overwhelmed, non-COVID mortality rates should also be lower in those regions where the lockdown took place earlier in the pandemic curve, as non-COVID patients could still be treated. Based on the results in column (3) of Table 4, which estimates equation (1) for non-COVID death rates, we observe no significant relationship between the speed of response to the pandemic –as captured by the number of days after the first region's outbreak and the nationwide lockdown– and non-COVID deaths. That is, the response speed does not significantly alter non-COVID deaths, as we would expect if avoiding an overwhelmed healthcare system was the primary reason for the reduction in COVID-19 deaths after the lockdown.

In sum, the estimates in Table 4 overall point to preventing contagion as the main mechanism through which the nationwide lockdown might have effectively helped contain pandemic deaths in Spain.

[11] The national press and health authorities reported how ICU units in Madrid and Cataluña were working at double their normal capacity (Grasso and Güell, 2020).

7. Summary and Conclusions

As the pandemic accelerates in developing countries and NPIs are relaxed in developed nations, infection rates might still likely pick up (Prem *et al.*, 2020). That was, in fact, the case in Spain, where the number of infections rose causing a second and third waves accompanied by 34,197 COVID-19 deaths between May 10, 2020 and February 10, 2021 (Spanish Ministry of Health).

The COVID-19 pandemic will only be over once *effective* vaccines or therapeutic drugs are developed and distributed (Ferretti *et al.*, 2020). As of today, several vaccines have been developed and are being distributed around the world. In Spain, the first vaccinations occurred in late December 2020. Between then and February 14, 2021, about 1 million individuals accounting for 2% of the Spanish population have been fully vaccinated –a share still small to understand its contribution in curtailing contagion and mortality nationwide.[12]

In the absence of effective vaccines, given the limitations of testing and tracking systems, social distancing measures remain the only proven tools to curtail pandemic deaths, especially if these second and third waves of infections are followed by subsequent waves of current or new strains of the virus. Non-pharmaceutical interventions of the sort studied here remain the only feasible tools when fighting the uncontrolled spread of a new disease.

Our findings reveal the importance of implementing social-distancing measures early on. The adoption of a nationwide lockdown proved more effective in curtailing COVID-19 deaths in regions that were at an earlier stage of the pandemic spread at the time of the lockdown, than in regions that were at a more advanced stage, even during this short period. Specifically, declaring

[12] Vaccination strategy details in Spain can be found at https://www.mscbs.gob.es/profesionales/saludPublica/ccayes/alertasActual/nCov/vacunaCovid19.htm

a nationwide lockdown one day earlier would have reduced COVID-19 deaths by 0.162 per 100,000 inhabitants. Moreover, locking down all regions when infections reached 3 cases per 100,000 inhabitants –the lowest regional rate when the lockdown was declared– could have avoided 4,642 deaths –roughly 23% of the cumulative number of deaths in Spain by the end of the period under analysis. Additional evidence suggests that the reduction in fatalities caused by the early implementation of NPIs was mainly due to the deceleration of the contagion rate, rather than to the indirect benefit of freeing up health resources to better attend patients.

Overall, our findings underscore the important benefits of responding early to the pandemic –a benefit policymakers will have to balance against any potential socio-economic costs associated to the adoption of social distancing measures.

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Table 1: The Impact of Accelerating the Lockdown's Implementation on Daily COVID-19 Mortality

Model Specification	**(1)**	**(2)**
$Post_t * S_j$	-0.155***	-0.162***
	(0.050)	(0.049)
Observations	782	782
R-squared	0.645	0.650
D. V. Mean in the Post Period	1.501	1.501
Date FE	Y	Y
Regional FE	Y	Y
Control for Daily Weather Conditions	N	Y

Notes: *** p<0.01, ** p<0.05, * p<0.1. Table 1 reports the results from estimating equation (1) on a sample of daily COVID-19 regional deaths spanning from March 4th through April 17, 2020. The specification in column (1) only includes date and regional fixed-effects. We then experiment with adding controls for average daily temperature and sun exposure 15 days before the death is registered in the model specification displayed in column (2). All regressions include a constant term, as well as controls for daily weather, which include average daily temperature and sun exposure. Robust standard errors are in parentheses and clustered at the regional level.

Table 2: Robustness Checks
The Impact of Accelerating the Lockdown's Implementation on Daily COVID-19 Mortality

	(1)	(2)	(3)	(4)	(5)	(6)
	Alternative S_j		**Alternative $Post_t$**		**Alternative Samples**	
Model Specification:	**Cut-off 2/100,000**	**Cut-off 4/100,000**	**$Post_t = 1$ from March 28th**	**$Post_t = 1$ from March 30th**	**Province Level w/ Cut-off 2/100,000**	**Total Deaths (MoMo Data)**
$Post_t * S_j$	-0.127***	-0.157***	-0.165***	-0.154***	-0.080***	-0.132**
	(0.049)	(0.049)	(0.041)	(0.043)	(0.029)	(0.049)
Observations	782	782	782	782	2,240	782
R-squared	0.641	0.651	0.652	0.647	0.530	0.697
D. V. Mean in the Post Period	1.501	1.501	1.501	1.501	1.467	4.414
Date FE	Y	Y	Y	Y	Y	Y
Regional FE	Y	Y	Y	Y	Y	Y
Control for Daily Weather Conditions	Y	Y	Y	Y	Y	Y

Notes: *** p<0.01, ** p<0.05, * p<0.1. Table 2 reports the results from estimating equation (1) using a sample of daily COVID-19 deaths spanning from March 4th to April 17, 2020. In columns (1) and (2), we alter the definition of an outbreak (used to codify S_j) from 3 cases in 100,000 inhabitants, to 2 and 4 cases in 100,000 inhabitants, respectively. In columns (3) and (4), we modify the timespan of infection to death (used to codify the $Post_t$ period) from 15 days, to 14 days (March 28th) and 16 days (March 30th), respectively. Finally, in columns (5) and (6), we experiment with using alternative data samples. In column (5), we estimate equation (1) using province-level data, along with a cutoff of 2 cases per 100,000 inhabitants as the outbreak. In column (6), we estimate equation (1) using daily total regional deaths from MoMo. All regressions include a constant term, as well as controls for daily weather, which include average daily temperature and sun exposure. Robust standard errors are in parentheses and clustered at the regional level.

Table 3: Identification Checks
The Impact of Accelerating the Lockdown's Implementation on 2019 Mortality, Residential Mobility, and COVID-19 Mortality

Column:	**(1)**	**(2)**	**(3)**
Outcome:	**2019 Mortality Rates**	**Google Residential Mobility Index**	**COVID-19 Mortality**
$Post_t * S_j$	-0.004	-0.016	-0.143**
	(0.008)	(0.178)	(0.061)
Observations	782	782	782
R-squared	0.530	0.979	0.660
D. V. Mean	2.445	21.272	1.501
Date FE	Y	Y	Y
Regional FE	Y	Y	Y

Notes: *** p<0.01, ** p<0.05, * p<0.1. Table 3 reports the results from estimating equation (1) on a sample of daily regional deaths spanning from March 4th through April 17, 2019 in column (1), and daily regional residential mobility patters spanning from March 4th through April 17, 2020 in column (2). Column (3) reports estimation results from estimating equation (1) using a sample of daily COVID-19 deaths spanning from March 4th to April 17, 2020, and controlling for changes in mobility patterns across regions. All regressions include a constant term, as well as controls for date and region fixed effects. Robust standard errors are in parentheses and clustered at the regional level.

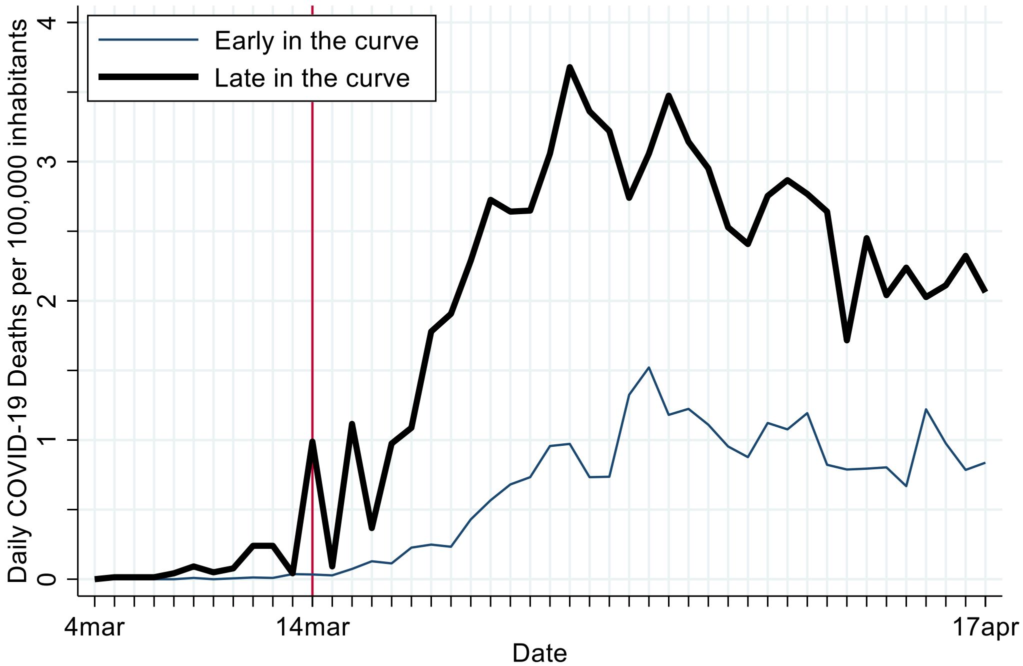
Table 4: Assessing the Main Mechanism
Preventing Contagion vs. an Overwhelmed Healthcare System

Model Specification:	**(1)** Using COVID-19 Cases	**(2)** Excluding Cataluña and Madrid	**(3)** Using Non-COVID Deaths
$Post_t * S_j$	-1.864**	-0.218***	0.011
	(0.681)	(0.034)	(0.061)
Observations	782	690	782
R-squared	0.703	0.642	0.539
D. V. Mean in the Post Period	13.781	1.369	2.958
Date FE	Y	Y	Y
Regional FE	Y	Y	Y
Control for Daily Weather Conditions	Y	Y	Y

Notes: *** p<0.01, ** p<0.05, * p<0.1. Table 3 reports the results from estimating equation (1) using different outcomes and samples. In column (1), we use the daily number of confirmed COVID-19 cases per 100,000 inhabitants in the region as the dependent variable. In column (2), we continue to look at COVID-19 deaths, but exclude the two worst affected regions, *i.e.* Cataluña and Madrid. Finally, in column (3), we use daily non-COVID regional deaths per 100,000 inhabitants as the dependent variable. All regressions include a constant term, as well as controls for daily weather, which include average daily temperature and sun exposure. Robust standard errors are in parentheses and clustered at the regional level.

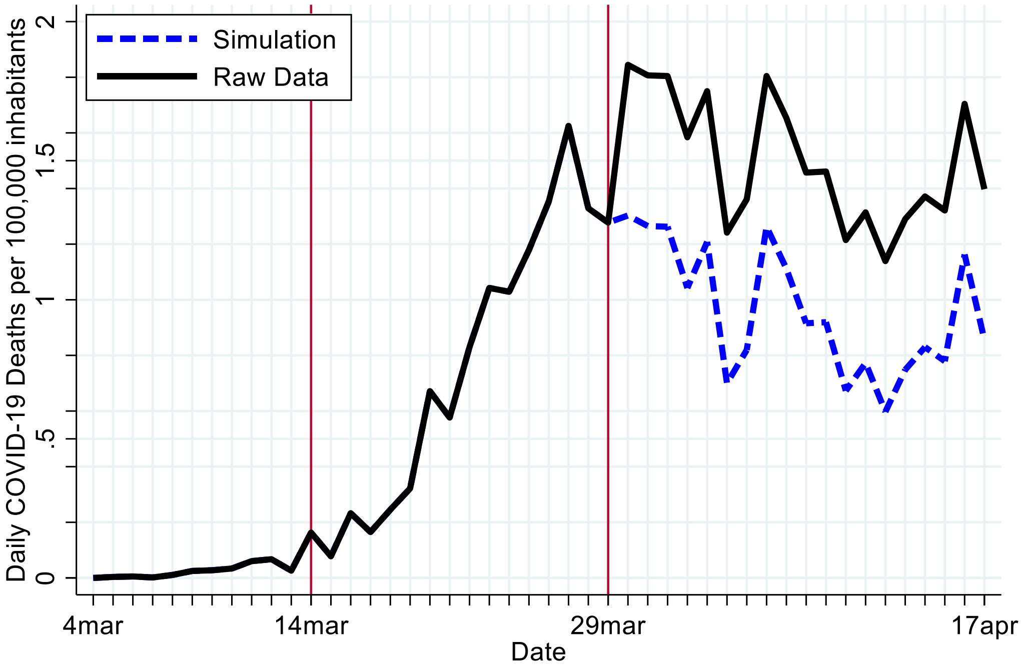
FIGURES

Figure 1
Daily COVID-19 Deaths per 100,000 Inhabitants



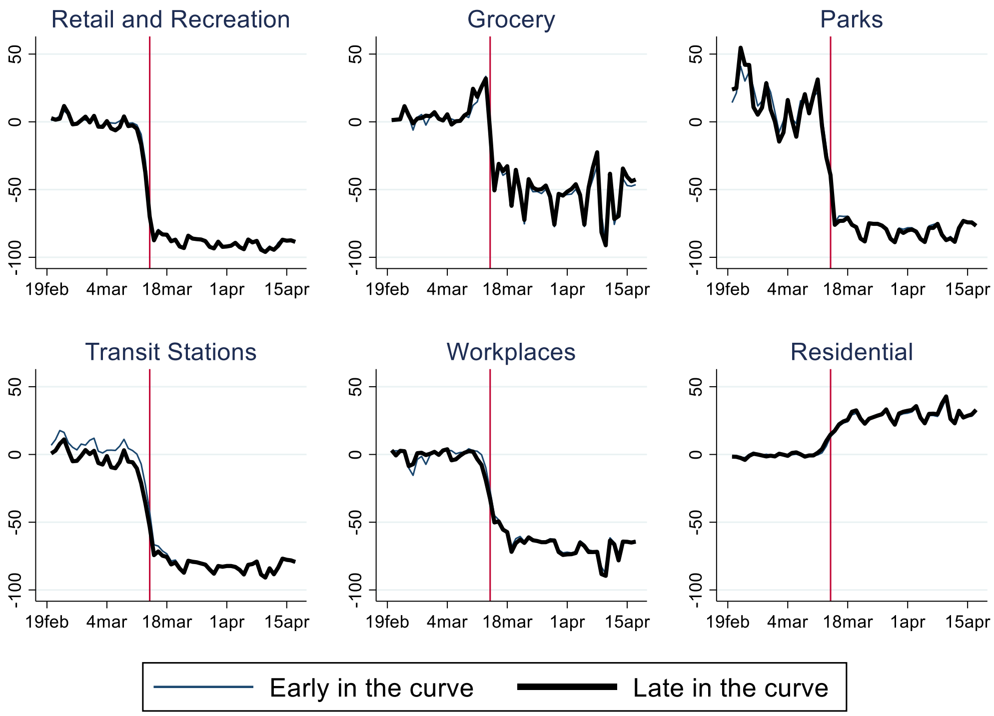
Notes: *Early-on-the-curve* refers to regions for which the lockdown occurred 2 days or less after the pandemic outbreak [*i.e.* Andalucía (1), Baleares (0), Canarias (2), Cantabria (2), Comunidad Valenciana (0), Extremadura (2), Castilla-León (3), Cataluña (2), Galicia (2) and Murcia (1)]. *Late-on-the-curve* refers to regions for which the lockdown took place 3+ days after the outbreak [*i.e.* Aragón (4), Asturias (4), Madrid (9), País Vasco (7), Castilla La Mancha (4), Navarra (4) and La Rioja (10)].

Figure 2
Predicted Daily COVID-19 Deaths per 100,000 Inhabitants
by Days Elapsed from Outbreak to Lockdown



Notes: Raw data are average regional daily death rates. Simulation shows predictions from the model in equation (1) when the variable S_j is set equal to 0.

Figure 3: Changes in Mobility Patterns



Notes: *Early-on-the-curve* refers to regions for which the lockdown occurred 2 days or less after the pandemic outbreak [*i.e.* Andalucía (1), Baleares (0), Canarias (2), Cantabria (2), Comunidad Valenciana (0), Extremadura (2), Castilla-León (2), Cataluña (2), Galicia (2) and Murcia (2)]. *Late-on-the-curve* refers to regions for which the lockdown took place 3+ days after the outbreak [*i.e.* Aragón (4), Asturias (4), Madrid (6), País Vasco (7), Castilla La Mancha (4), Navarra (4) and La Rioja (10)].

Source: Google Mobility Data February 15th to April 17th

Table A.1
Descriptive Statistics

Variables	Obs.	Mean	Std. Dev	Min	Max
Panel A: Used in the Main Analysis					
Regional daily COVID-19 Mortality (per 100,000)	782	0.89	1.21	0	11.85
Regional daily COVID-19 Cases (per 100,000)	782	9.81	11.66	0	133.94
Regional daily Temperature (in ºC)	782	11.97	3.37	2.54	24.80
Regional daily Sun exposure (hours)	782	6.41	3.47	0	11.80
Regional Speed 2 (outbreak defined as 2 cases per 100,000)	782	-4.59	3.07	-11	-1
Regional Speed 3 (outbreak defined as 3 cases per 100,000)	782	-3.35	2.81	-10	0
Regional Speed 4 (outbreak defined as 4 cases per 100,000)	782	-2.76	2.92	-10	0
Panel B: Used in Additional Analyses					
Regional daily Non-COVID-Mortality (per 100,000)	782	2.89	1.22	0	10.27
Regional daily Total Deaths (MoMo Data) (per 100,000)	782	3.77	1.87	0.96	12.78
Retail and recreation mobility (% change)	782	-68.49	36.17	-97	13
Grocery and pharmacy mobility (% change)	782	-36.72	30.86	-94	46
Parks mobility (% change)	782	-57.78	38.16	-93	58
Transit stations mobility (% change)	782	-62.01	34.22	-93	25
Workplaces mobility (% change)	782	-49.66	29.57	-92	12
Residential mobility (% change)	782	21.27	12.71	-6	46
Province daily COVID-19 Mortality (per 100,000)	2,240	0.94	1.45	0	12.51
Province Speed (outbreak defined as 2 cases per 100,000)	2,240	-3.41	3.41	-13	0
Province daily Temperature (in ºC)	2,240	11.98	3.65	0	27
Province daily Sun exposure (hours)	2,240	6.57	3.63	0	12

Notes: The sample is March 4th to April 17th. Speed is measured by the number of days elapsed between the outbreak and the nationwide lockdown, multiplied by (-1) to ensure that higher values denote a faster response.

Sources: COVID-19 data are gathered from the Spanish Ministry of Health, whereas data on 'Total Deaths' are obtained from the Spanish System of Monitoring Mortality. Temperature and sun exposure data originate from the Spanish Meteorological Agency, and mobility data derive from Google Mobility Reports.

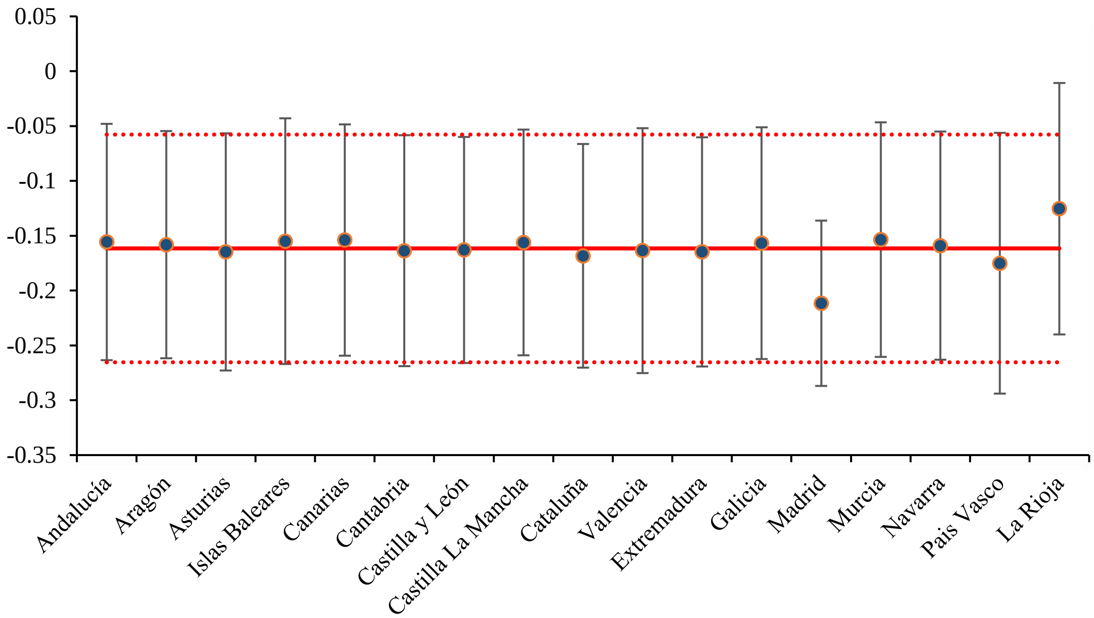
Table A.2
Preventable Deaths – Simulation Exercise

	(1)	(2)	(3)	(4)	(5)
Region	**Speed of Intervention (days)**	**Estimated Drop in Daily Mortality Rate (per 100,000 inhabitants)**	**Regional Population (inhabitants)**	**Preventable Daily Deaths**	**Preventable Cumulative Deaths**
Andalucía	-1	0.162	8,427,404	13.62	272
Aragón	-4	0.646	1,320,586	8.53	171
Asturias	-4	0.646	1,022,205	6.61	132
Balears	0	Ref.	1,188,220	0.00	0
Canarias	-2	0.323	2,206,901	7.13	143
Cantabria	-2	0.323	581,641	1.88	38
Castilla y León	-3	0.485	2,407,733	11.67	233
Castilla - La Mancha	-4	0.646	2,034,877	13.15	263
Cataluña	-2	0.323	7,566,430	24.45	489
Comunidad Valenciana	0	Ref.	4,974,969	0.00	0
Extremadura	-2	0.323	1,065,424	3.44	69
Galicia	-2	0.323	2,700,441	8.73	175
Madrid	-9	1.454	6,641,648	96.58	1,932
Murcia	-1	0.162	1,487,663	2.40	48
Navarra	-4	0.646	649,946	4.20	84
País Vasco	-7	1.131	2,177,880	24.63	493
Rioja	-10	1.616	313,571	5.07	101
Total in Spain			46,767,539	232.09	4,642

Notes: Speed of intervention in column (1) is the number of days elapsed between the outbreak (defined as the day when 3/100,000 COVID-19 cases were confirmed in the region) and the nationwide lockdown (that is, March 14, 2020), multiplied by (-1) to ensure that higher values denote a faster response. Column (2) reports predictions from the difference in differences model of the regression of daily regional mortality rates as shown in Column 2 of Table 1. Baleares and Comunidad Valenciana with the fastest speed of intervention of 0 days have a zero estimated reduction in the daily mortality rate. Column (3) shows regional population numbers. Preventable daily deaths in column (4) are calculated as the product of columns (2) and (3). Column (5) provides the cumulative number of deaths that could have been prevented up until April 17 by multiplying the daily deaths in column (4) times 20 days.

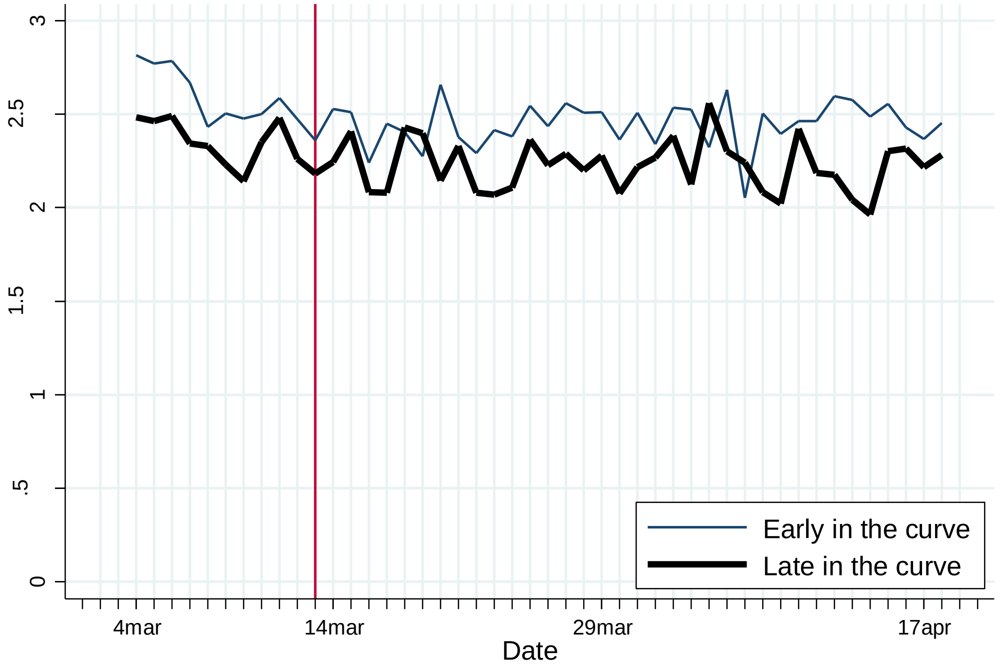
Sources: COVID-19 data are gathered from the Spanish Ministry of Health, Temperature and sun exposure data originate from the Spanish Meteorological Agency, and population data come from Spanish Statistical Institute site.

Figure A.1
The Impact of Accelerating the Lockdown Implementation on Daily COVID-19 Mortality
Removing One Region at a Time



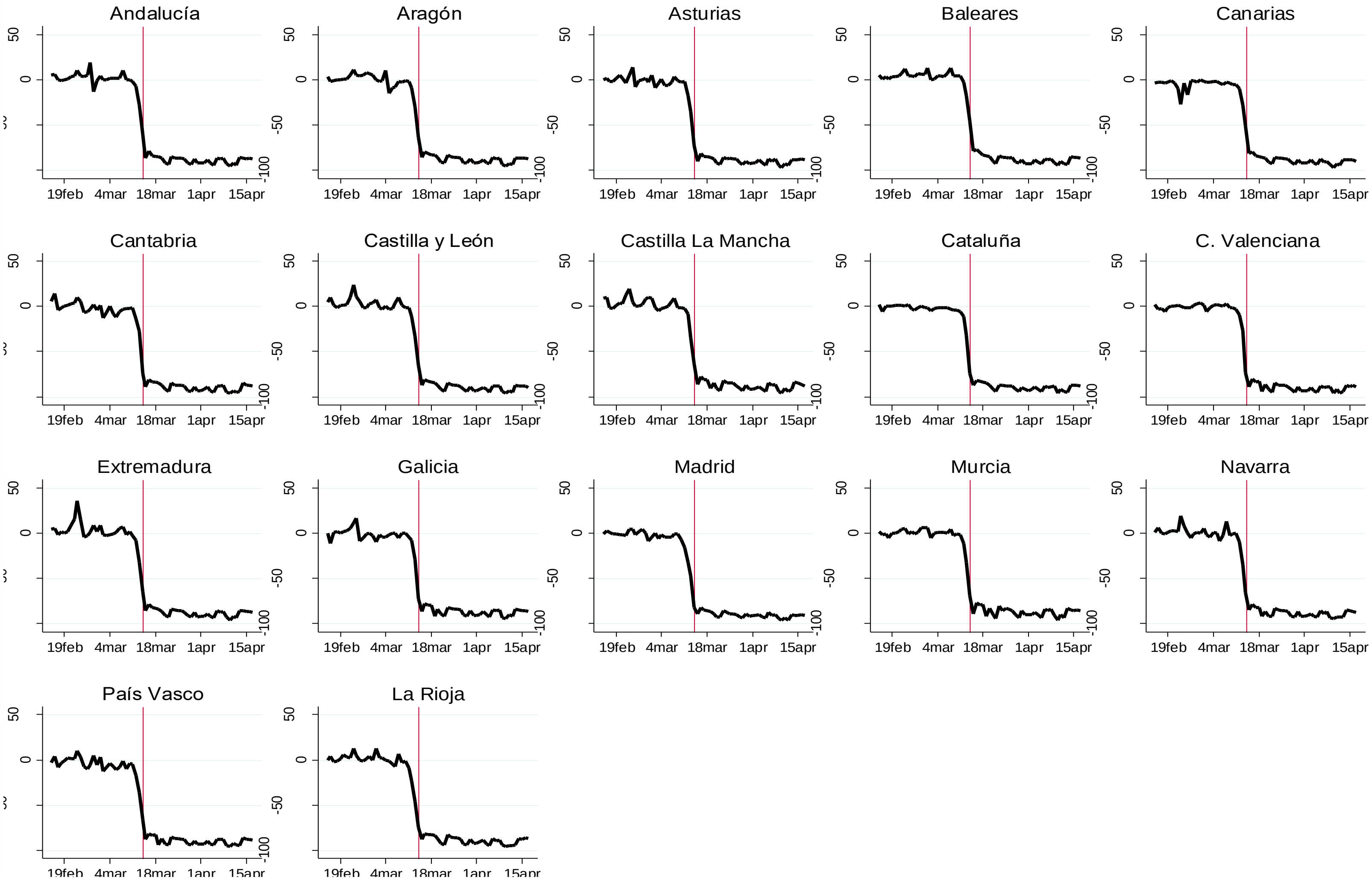
Note: The horizontal red line represents the impact of accelerating the lockdown implementation on daily COVID-19 mortality when using all regions, and the dotted lines the corresponding confidence intervals. Each one of the thicker dots represents the effect of accelerating the implementation of the lockdown on daily COVID-19 mortality when we exclude one region at a time.

Figure A.2
Daily 2019 Deaths per 100,000 Inhabitants



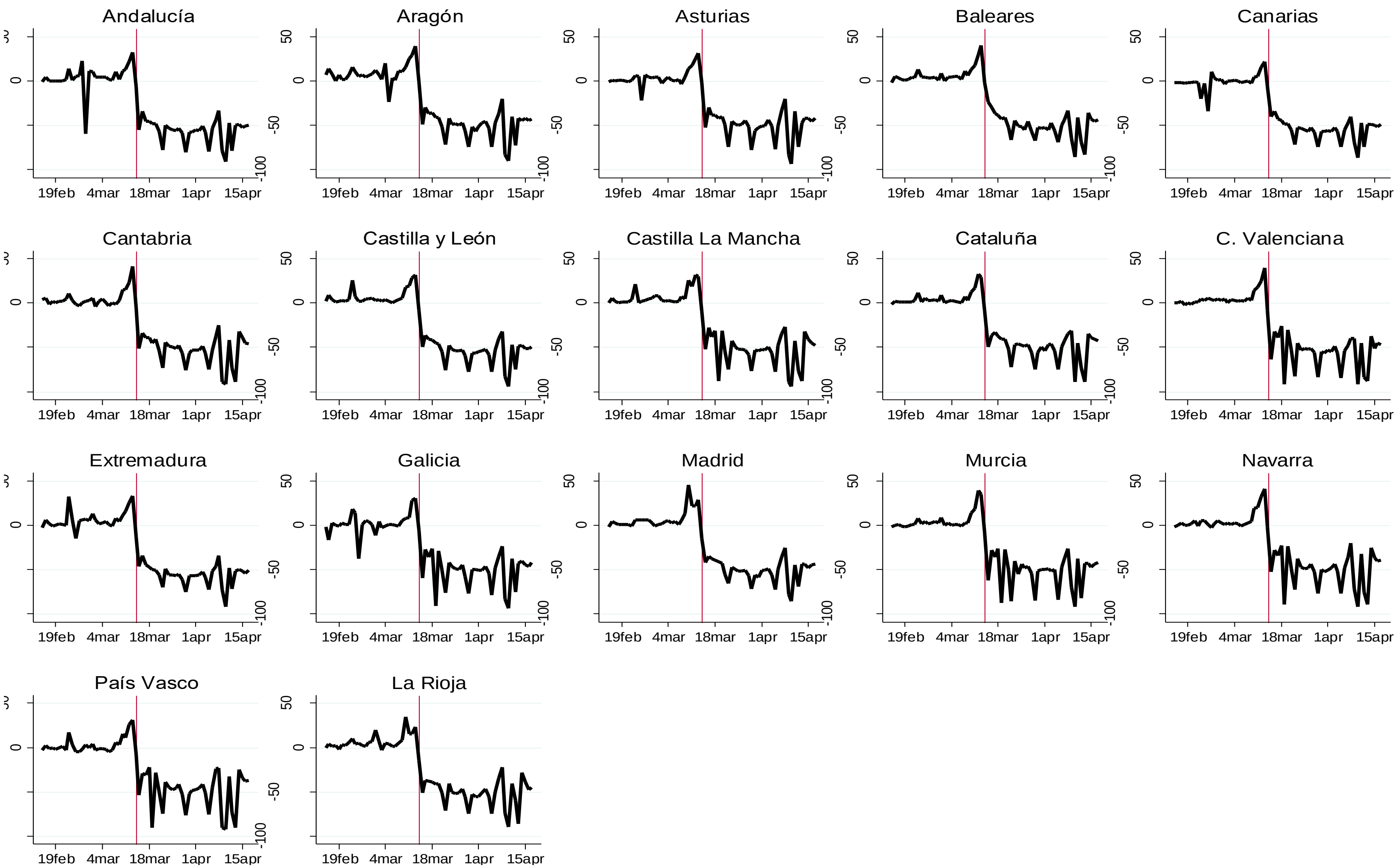
Notes: *Early-on-the-curve* refers to regions for which the lockdown occurred 2 days or less after the pandemic outbreak [*i.e.* Andalucía (1), Baleares (0), Canarias (2), Cantabria (2), Comunidad Valenciana (0), Extremadura (2), Castilla-León (3), Cataluña (2), Galicia (2) and Murcia (1)]. *Late-on-the-curve* refers to regions for which the lockdown took place 3+ days after the outbreak [*i.e.* Aragón (4), Asturias (4), Madrid (9), País Vasco (7), Castilla La Mancha (4), Navarra (4) and La Rioja (10)].
Source: MoMo data from March 4th, 2019 to April 17th, 2019.

Figure A.3: Retail and Recreation Mobility



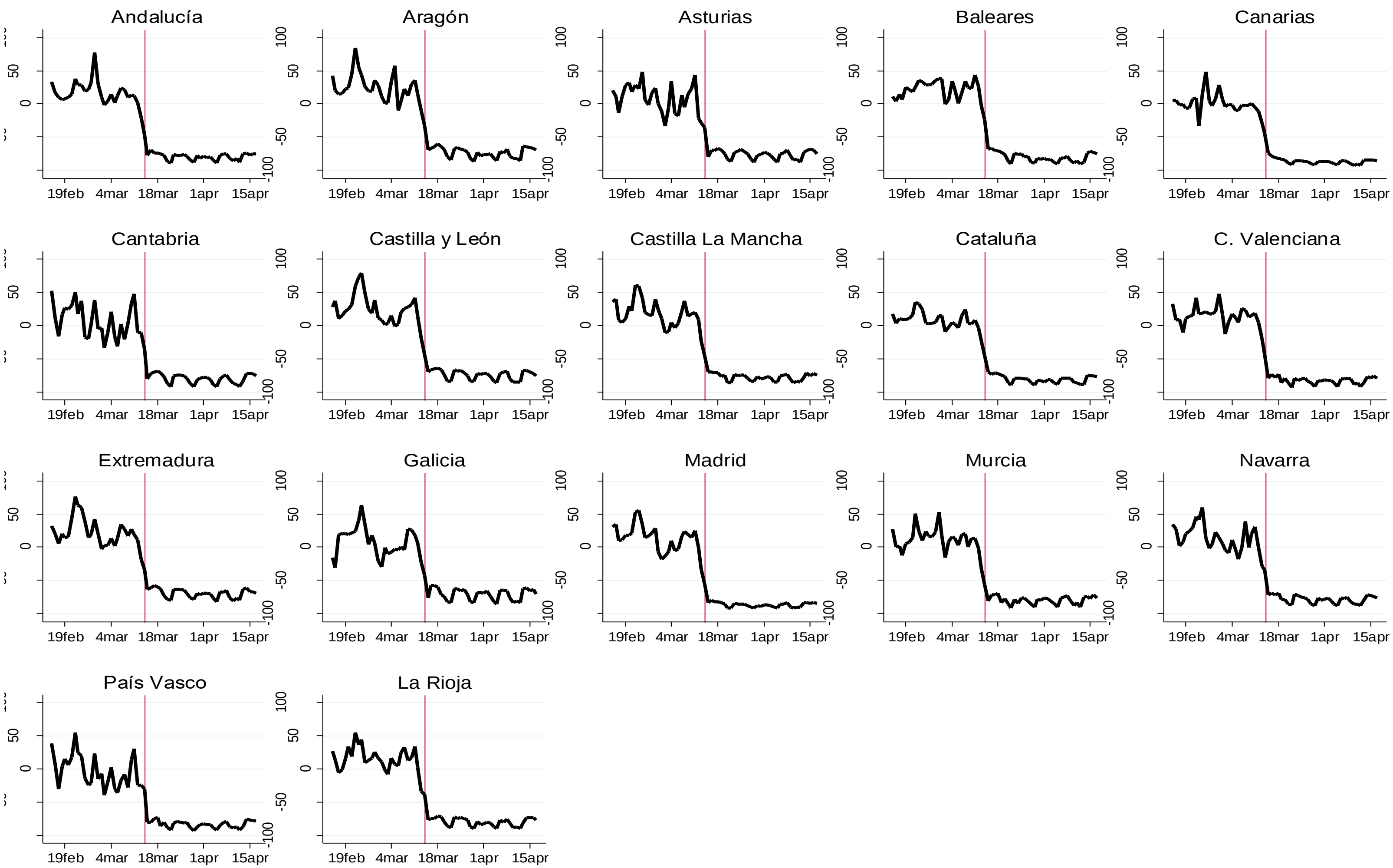
Source: Google Mobility Data February 15th to April 17th.

Figure A.4: Grocery and Pharmacy Mobility



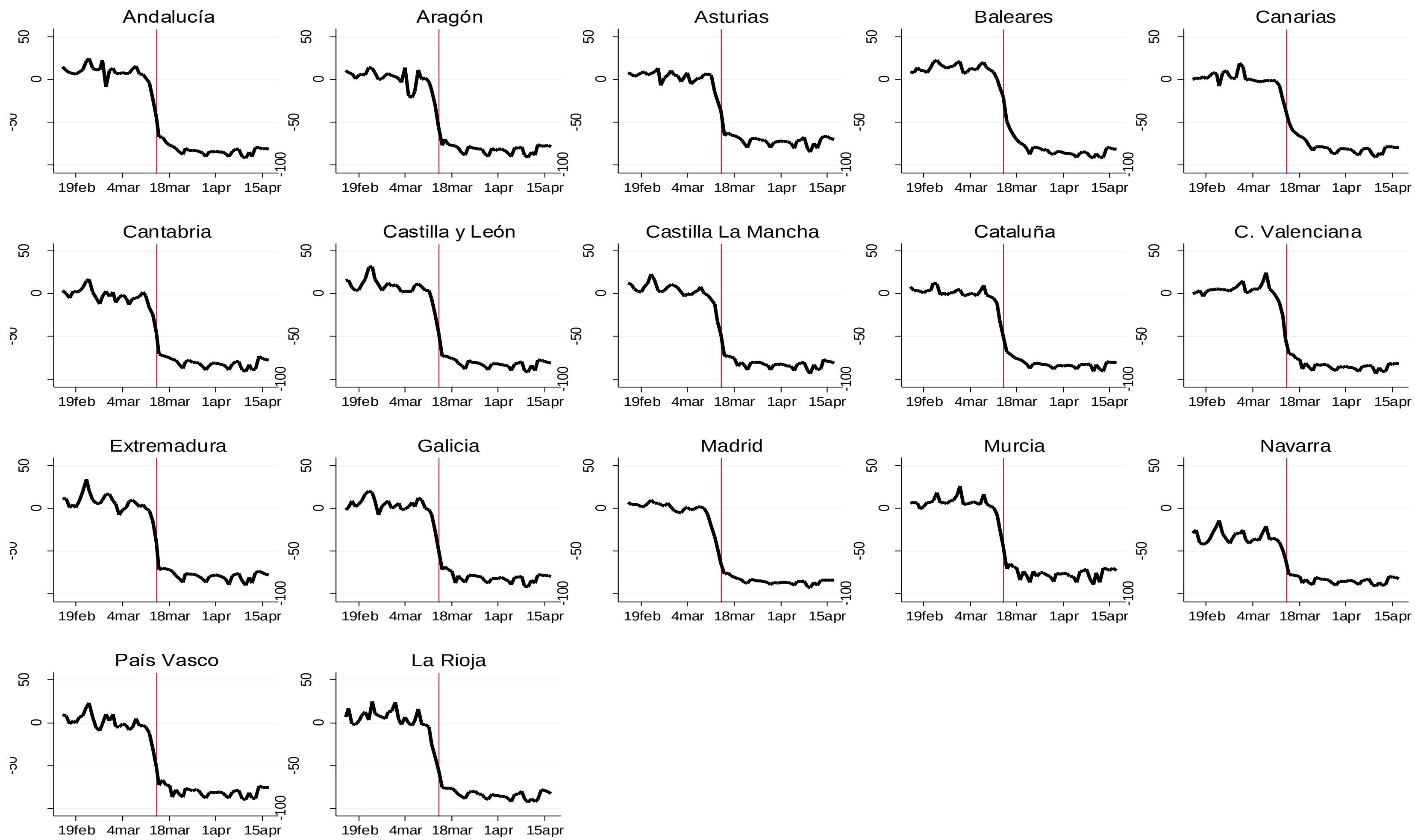
Source: Google Mobility Data February 15th to April 17th

Figure A.5: Parks Mobility



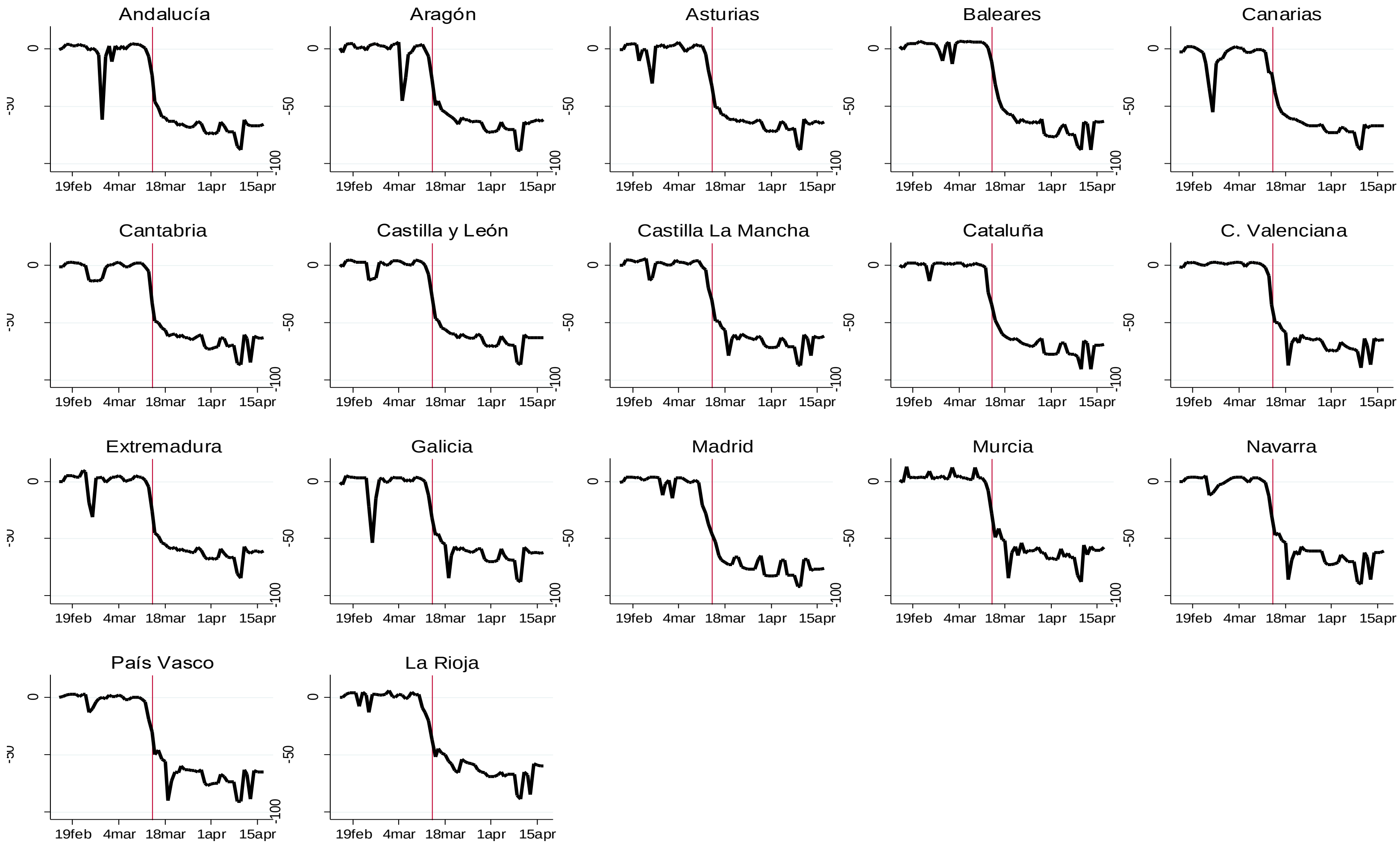
Source: Google Mobility Data February 15th to April 17th

Figure A.6: Transit Stations Mobility



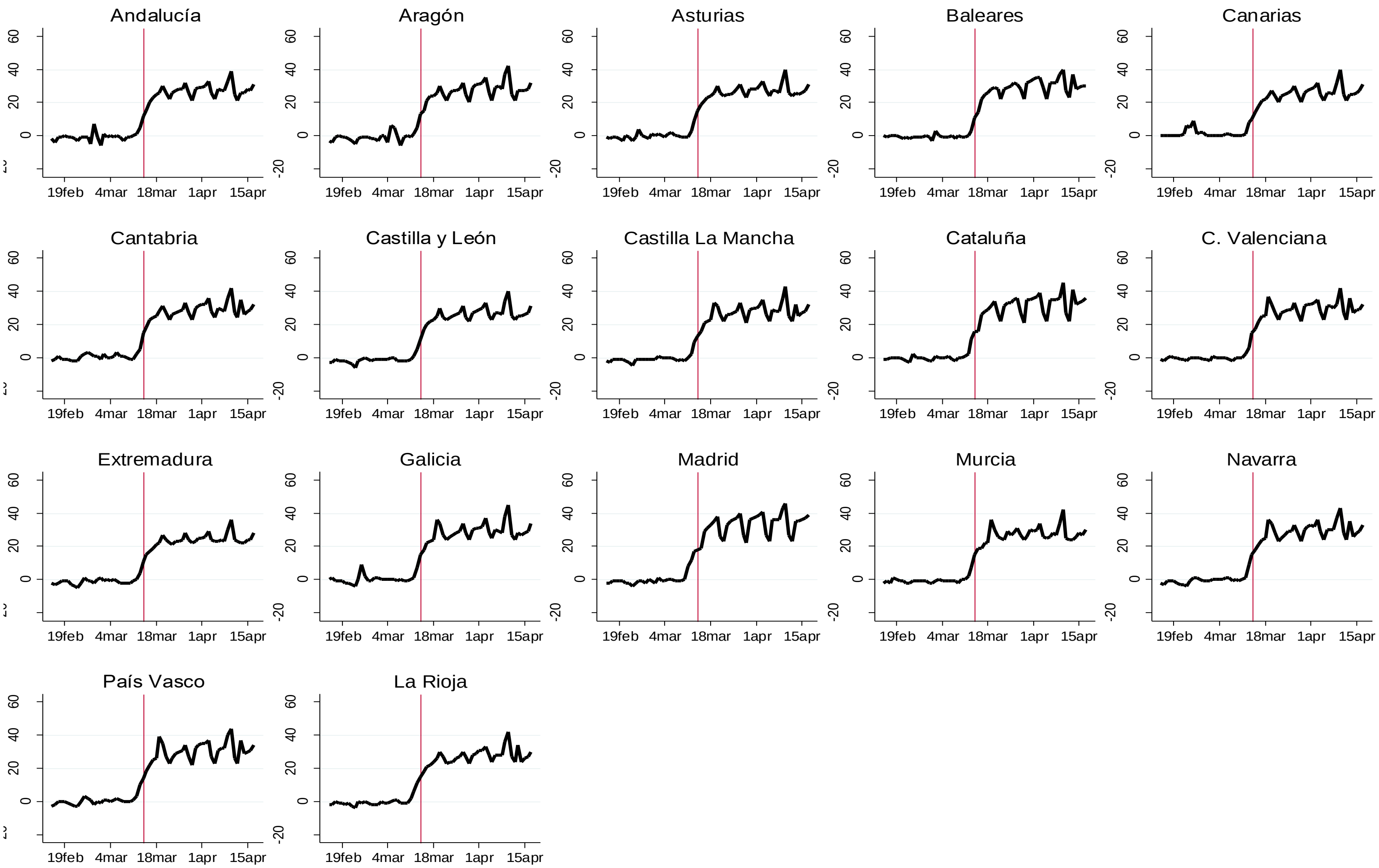
Source: Google Mobility Data February 15th to April 17th

Figure A.7: Workplaces Mobility



Source: Google Mobility Data February 15th to April 17th

Figure A.8: Residential Mobility



Source: Google Mobility Data February 15th to April 17th