INTERNAL MIGRATION AND THE SPREAD OF COVID-19

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Abstract

How does internal migration affect the spread of a pandemic? Looking at the case of Italy and using data on the province of origin of migrants located in outbreak areas, we document that provinces more exposed to the virus experience higher mortality in post-outbreak weeks, even when comparing provinces within the same region. We calculate that, had all non-outbreak provinces been as exposed as the one at the lowest decile of the exposure distribution, they would have experienced 60% fewer COVID-19 deaths. Additional evidence from phone records data confirms that the effect is mainly driven by increased mobility from outbreak areas.

Keywords: internal migration; mobility; health; epidemic; Covid-19.

JEL classification: J61; R23; H12; I10.

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1 Introduction

Covid-19 has claimed more than 600,000 lives so far[1]. It is also generating massive and unprecedented economic costs in terms of health care (e.g., hospitalization of sick people, testing of sick and healthy, quick expansion of intensive care health capacity), in terms of missed work, both direct (e.g., lost work due to sickness) and indirect (e.g., lost work due to quarantine measures), and in terms of lost human capital (e.g., lost education due to quarantine measures). Some economists expect the worst recession since the 1930s.[2]

In this paper, we ask whether internal migration helps spread viruses. The idea is that, once a virus outbreaks, its diffusion to the rest of the country depends on pre-existing internal migration routes, either because people travel regularly along them, either because the virus and its immediate consequences lead recent migrants to move back to their hometowns. The latter is not really surprising: migration is a natural response in the face of disaster (Boustan et al 2012, Hornbeck 2020). This is especially true if the government's main responses (self-isolation, social distancing and the shut-down of major economic activities) is expected to last for a long time, or if the effect of these measures on the economy is so disruptive as to leave people jobless (Topel 1986). The people most likely to migrate away from the outbreak areas will be those with weak ties locally and strong ties elsewhere,[3] like recent internal migrants.[4] Unless potential return migrants realize they could be asymptomatic carriers (or interpret their symptoms correctly as signs of Covid) and internalize the effect of their actions on others, they will migrate and thus spread the virus further.

To test for the existence and the quantitative importance of this mechanism, we use

[1] 612,054 lives at the 22^{nd} July 2020, according to the World Health Organization Situation Report - 184.

[2] According to the OECD, relative to the previous quarter, GDP decreased by 3.6 percent in the Euro area (1.3 percent in the US) in 2020Q1 and by 12.1 percent (9.5 percent in the US) in 2020Q2.

[3] Reasons for weak ties where they reside could be social (e.g., family somewhere else) or economic (e.g., not owning the house they live in, having informal employment or a short-term contract).

[4] These could be temporary migrants (who would have gone back anyway) anticipating their return, or permanent migrants changing their plans. Dustmann and Görlach (2016) provide a review of theory and evidence on return migration. Yang (2006) provides evidence of a negative economic shock increasing return migration, even though that was in the context of international migration at the time of the Asian financial crisis.

subnational data for Italy. Covid, in Italy alone, has claimed more than 35,000 lives:[5] until recently, it was the worst hit European country by absolute number of deaths and by deaths per capita. Sadly, this provides us with substantial statistical power to test our hypothesis. We use panel data at the provincial and regional level and exploit detailed data on individuals' changes of residence between Italian provinces before Covid to measure the share of people who moved to outbreak areas in recent years.

Our identification strategy relies on the use of total mortality as outcome and the control for region fixed effects. Relying on total mortality protects us from possible measurement issues associated with the detection of Covid cases and, to a lesser extent, with the detection of Covid deaths. In addition, it provides us with pre-Covid placebo tests that would not have been available otherwise. Relying on region fixed effects protects us from arbitrary choices in the selection of controls. Indeed, we find that, after controlling for region fixed effects, including or not a wide range of controls affects neither the direction nor the statistical significance of the coefficients of interest.

The results suggest that a 50 percent increase in exposure to outbreak relative to the mean (*i.e.*, about one standard deviation in exposure) is associated with 117 additional Covid deaths and 147 additional total deaths per province. A back-of-the-envelope calculation suggests that, had all provinces had the same exposure to outbreak areas as the one at the tenth percentile, non-outbreak regions would have experienced 7,348 fewer total deaths and 5,895 (60 percent) fewer Covid deaths. The country as a whole would have experienced 18 percent fewer Covid deaths.

We then use mobile phone based mobility data to test whether more exposed provinces do indeed receive a greater inflow of people from outbreak areas and whether this explains the reduced form effects. The evidence confirms that greater exposure leads to greater inflow, which improves our confidence that the effects we identify are driven by cross-provincial mobility from outbreak areas rather than some other factor, and suggests that such greater inflow explains between 41 and 100 percent of the reduced form effect (depending on the month and the mortality measure one looks at).

[5] 35,092 at the 23^{rd} July 2020, according to the Italian Health Ministry daily report available at `http://www.salute.gov.it/`.

This paper makes four contributions. First, it contributes to the literature on the aggregate effects of internal mobility, which recently found that removing barriers to internal migration can substantially increase aggregate productivity (Bryan and Morten 2019).[6] Internal migration can be particularly valuable in case of local negative economic shocks, as it helps to *dissipate* them (Monras 2020). Our work shows instead that internal migration can be detrimental in case of local negative health shocks (as in the case of the outbreak of an infectious disease), as it helps to *propagate* them.

Second, it contributes to the literature on the effect of migration on countries and locations of origin. Such literature may be grouped into two strands. The first one focuses on the overall effects of migration on countries[7] and areas[8] of origin. The channel of transmission in this literature is typically information, network effect, return migration or a combination of the three. The second strand of this literature focuses instead specifically on return migration.[9] None of these papers considers the role of migration in spreading diseases back home. This is surprising, because the threat that migration poses in terms of health risk is well known not just from the time of Ellis Island and the age of mass migration to the US, but also by Diamond's description of how colonizers spread diseases during the colonization of the Americas (Diamond 1997).

The third contribution has to do with the Black Death (1347-1351). At that time, cities were death traps: both in absence of the virus (Woods 2003, Clark and Cummins 2009, Voigtländer and Voth 2013) and especially when the virus started to spread. To

[6]Examples of barriers to internal mobility identified in this literature are housing regulations (Hsieh and Moretti 2019) and commuting technology (Monte et al 2018).

[7]This literature suggests that international migration may have the following effects on countries of origin: greater bilateral trade (Parsons and Vezina 2014), FDI (Burchardi et al 2018), economic development (Burchardi and Hassan 2013), innovation (Kerr 2008), greater membership to labor unions, voting and public expenditure (Karadja and Prawitz 2019) and democratic capital at large (Pfutze 2012, Docquier et al 2016), greater collectivism (Knudsen 2019) and a change in fertility norms (Beine et al 2013). See also Anelli and Peri (2017) for evidence democratic capital that stands in contrast with some of the other papers.

[8]This literature suggests that internal migration may have the following effects on areas of origin: greater risk spreading (Gröger and Zylberberg 2016 and references therein), which might also be a determinant of migration itself, greater support for right wing parties (Mantovani 2019) and different fertility norms (Daudin et al 2016).

[9]This literature suggests that the return migration may foster democratic capital among the population at large (Chauvet and Mercier 2014, Barsbai et al 2017) and among leaders (Spilimbergo 2009, Mercier 2016, Grewal 2020); may foster local development (Chauvet et al 2015); may be profitable (Abramitzy et al 2019); may lead to greater entrepreneurship (Yang 2008); and may be associated with newer attitudes and beliefs (Clingsmith et al 2009).

escape the virus (and secure some food), many escaped to the countryside (Boccaccio 1352, Carmichael 2014). It is not hard to imagine that some of those people brought the virus with them, and that such escape might have been more likely for people born in the countryside to start with (since they might have had a hometown to go back to). However, to the best of my knowledge, no paper in the literature on the Black Death has investigated this possibility. Jedwab et al (2019) is the only attempt to analyze the spatial dimension of the Black Death, albeit only for cities. Future research could try to gather similar data for rural areas and estimate the dynamics of the spreading of the disease.[10]

The fourth contribution is to the growing literature on the diffusion of Covid-19 and viruses in general. Such literature may be grouped into three strands. The first one focuses on estimating the effect of restrictions.[11] The second one focuses on the determinants of compliance to self-isolation measures.[12] The third one focuses on the determinants of the spreading of viruses other than government imposed restrictions, like railways (Adda 2016), trade (Oster 2012), paid sick leave (Barmby and Larguen 2009; Pichler and Ziebarth 2019) and Facebook connections (Kuchler et al 2020).

Hence, this study contributes to this literature by suggesting a novel diffusion mechanism (internal migration from outbreak areas) and finding that it is not only statistically but also economically relevant for the diffusion of the virus.[13] The basic idea of this paper could easily replicate to other viruses and to other countries whenever outbreak areas are

[10]Another historical episode lending credit to this mechanism may be the Spanish flu (1918-1919) and the role of soldiers' coming back from the front at the end of WWI (1914-1918), since the two overlapped for nine months. See Beach et al (2018) and references therein for recent work on the Spanish flu using micro-data. See Barro et al (2020) for a recent cross-country analysis.

[11]Here the most important contribution is probably Adda (2016), who analyzes the effect of school and public transportation closure for many (pre-Covid19) viruses using French data. Litvinova et al (2019) instead look at school closure using Russian data. For Covid-19, Bayham and Fenichel (2020) look at school closure using US data, while Fang et al (2020), Chinazzi et al (2020) and Kraemer et al (2020) look at city lock down using Chinese data. Gatto et al (2020) instead use an epidemiological model to estimate the combined effect of all restrictions on the spread of infections using Italian data.

[12]Briscese et al (2020) estimate the effect of expected duration of restrictions on intention to comply, while Durante et al (2020) estimate the effect of social capital on compliance. Chudik et al (2020) look at voluntary and mandatory social distancing in Chinese provinces.

[13]In Section 4.5, we show that it is crucial to focus on exposure to migration from outbreak areas. Had we focussed on exposure to migration from any area, we would have obtained completely different (null) results. The zero effect associated with exposure to generic domestic migration is consistent with the mixed results for India, Pakistan and Bangladesh found by Lee et al (2020).

relatively few and clearly identifiable.[14]

Finally, we hope to contribute to the policy debate on how to deal with future waves of Covid-19 as well as future viruses. The exposure index provided in this paper could help central governments in allocating scarce resources in times of emergency. Most importantly, the results of this paper suggest that central governments might want to build a continuously updated database on both people who moved recently to other provinces and people who move routinely across provinces. We come back to this point towards the end of the paper.

2 Context

The first confirmed cases in Italy date back to the 30^{th} January 2020. By the end of February, the confirmed cases were in the hundreds. On the 21^{st} February, Italy had the first Covid death. The country recorded around 77,000 cases (and 12,000 deaths) by the end of March, around 101,000 cases (28,000 deaths) by the end of April, 42,000 cases (33,000 deaths) by the end of May and 18,000 cases (34,000 deaths) by the end of June.[15] During the health crisis, the Government took unprecedented measures, which started with an initial lock-down in the province of Lodi (21^{st} February)[16] and school closure in Lombardia, Veneto, Emilia-Romagna and Friuli-Venezia Giulia (24 February), continued with the expansion of the lock-down to most of northern areas (08^{th} March) for a total coverage of 16 million people, and finally reached the national level (9^{th} March).[17]
As the news of the expansion of the lock-down leaked (Saturday 7^{th} March),[18] people rushed to take night trains from Milan to the rest of the country to escape the quarantine measures. It was common wisdom in the media at that time that such mass departure

[14] One such example is Russia, where Moscow constitutes the outbreak area. Research on social distancing for this country builds up on the findings of our paper to predict the arrival of the virus in other regions. It then interacts the timing of such arrival with local ethnic diversity and estimate its effect on social distancing (Egorov et al 2020).

[15] Data from the Italian Ministry of Health elaborated by the Department of Civil Protection and described in the next section.

[16] Decreto del presidente del consiglio dei ministri 22 febbraio 2020

[17] Decreto del presidente del consiglio dei ministri 09 marzo 2020

[18] Severgnini (8 March 2020). Corriere della Sera

would have helped to spread the disease.[19]

People leaving Milan are presumably internal migrants who had come to Milan for studies or work. Hence, the higher the number of out-migrants (to Lombardy) a region has, the higher should be the number of return migrants the same region experienced on the 8^{th} March (or later), and the higher should be the number of infected cases and deaths by Covid-19 later on.

3 Data and research design

3.1 Data on Covid deaths and identification of outbreak areas

To measure the number of Covid-19 deaths,[20] We use daily data from the Italian Ministry of Health elaborated by the Department of Civil Protection.[21]
These data are available in two forms: regional-daily level and provincial-"monthly" level (20 20^{th} Feb.-31^{st} Mar., April, May).[22]
To identify outbreak areas, we take the following steps. First, we use regional daily data on Covid deaths to identify which regions experienced Covid deaths first. These are Veneto (21^{st}),[23] Lombardia (22^{nd} February)[24] and Emilia-Romagna (26^{th} February).[25] Figure 1 shows the evolution of Covid deaths over time: Covid deaths peaked around the 30^{th} of March and slowly decreased thereafter.

Second, we compute the proportion of 20^{th} Feb. - 31^{th} March Covid deaths in a province relative to all deaths within the region for the same period. We use these shares to disaggregate the 20^{th} Feb. - 31^{th} March regional daily data into provincial daily data.

[19] Giuffrida and Tondo (8 March 2020). The Guardian.

[20] Throughout the entire paper, we focus on Covid deaths, rather than Covid infections, because the Italian government, along many other central governments around the world, tested primarily people showing symptoms of infection, rather than pursuing quasi-random testing (as in Iceland and South Korea).

[21] Data and description are available at https://github.com/pcm-dpc/COVID-19

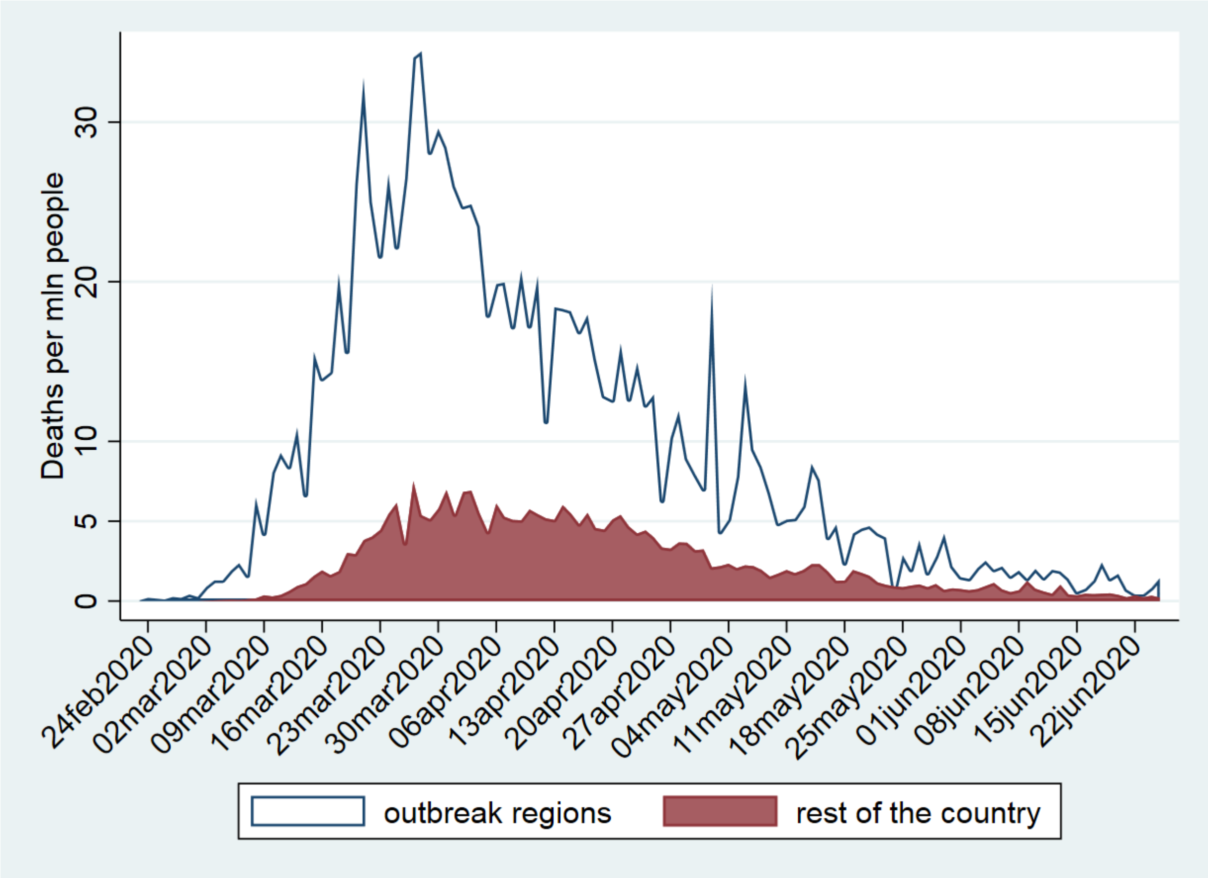
[22] Provincial-monthly level data also include data on total deaths, both in levels and in growth rates. We will discuss these additional data carefully in the section on descriptive statistics.

[23] See Custodero (Repubblica, 22^{nd} February 2020)

[24] See TgCom24 (22^{nd} February 2020).

[25] Data from Department of Civil Protection described at the beginning of the section. All other Italian regions experienced their first Covid deaths several days or weeks later: Marche on the 2^{nd} of March, followed by Liguria on 3^{rd}, Puglia on 4^{th}, Piemonte on the 5^{th}, Lazio on 6^{th}, Friuli V.G. on the 8^{th}, Toscana on the 9^{th} and Abruzzo on the 10^{th}.

Figure 1: Covid-19 deaths in outbreak regions and in the rest of the country



Notes: outbreak regions are Lombardy, Veneto and Emilia-Romagna.

Third, we pick the latest date before the appearance of Covid deaths outside the three outbreak regions, *i.e.*, the 1st of March.[26] Figure A.1 shows the distribution of Covid deaths per capita across the 28 provinces in these regions. Fourth, we pick one Covid death per million people as the cut-off defining the outbreak provinces. This leaves us with 15 provinces: 10 in Lombardy and 5 in Emilia-Romagna.

[26]Covid deaths are the most reliable proxy for Covid presence, but they are a lagged proxy, because it takes time for an infection to degenerate and bring someone to death. Detailed reports from the Italian Istituto Superiore della Sanitá on the characteristics of deceased Covid patients ("Caratteristiche dei pazienti deceduti positivi allinfezione da SARS-CoV-2 in Italia") indicate that Covid patients experienced their first symptoms 11 days before their deaths. Hence, the stock of Covid deaths on the 1st of March proxies Covid diffusion on the 19th February.

3.2 Data on mobility

To measure trips from outbreak provinces to the rest of the country, we use data on mobility based on mobile phone tracking data provided by Teralytics. The data are available at the province of origin - province of destination - day level. For one of the robustness checks, we will also use trips within a given province.

3.3 Data on internal migration and exposure to outbreak areas

To measure the exposure of Italian provinces to outbreak areas, we use yearly data on changes of residence between Italian provinces.[27] The data are available up until 2018 and are structured as a matrix, *i.e*, for a given year, they provide the number of people who de-registered themselves from, say, Catania province (Sicily), and registered themselves in the province of Milan (Lombardy) during the previous 12 months.[28] We focus on changes of residence that took place between 2015 and 2018 and divide them by the 2018 population of the province (or region) of origin. This is our *ExposureToOutbreak* indicator.

To control for general propensity to emigrate from a province (region), we also compute the total number of changes of residence to any other province in the country during the same period.

3.4 Descriptive statistics

Figure 1 shows the evolution of Covid deaths in non-outbreak regions. Covid arrived later and had a much lower intensity throughout the entire period, even though there is a convergence over time between outbreak and non-outbreak regions.

Table A.1 and Table A.2 show detailed descriptive statistics at the regional and provincial level for 16 non-outbreak regions and 76 non-outbreak provinces.[29] At the regional

[27] Data provided by the Italian National Institute of Statistics (ISTAT).

[28] People have an incentive to register themselves in their new residence to get access to some basic services like, among others, the family doctor.

[29] We drop: Sud Sardegna province, which was aggregated and disaggregated repeatedly during the past years and therefore has inconsistent migration data; Gorizia province, which is not well covered by the mobility data; and Valle D'Aosta region, which has only one province and therefore gets dropped out in the specifications with region fixed effects.

level, the number of Covid deaths per million inhabitants is 2.51 per day. At the provincial level, it is 87 between the 20^{th} of February and the 31^{st} of March, 155 in April and 45 in May. This rise-and-decline mirrors the pattern shown in Figure 1.

Important complements to the Covid deaths are the data on total deaths, which have the key advantage of being available even before the appearance of Covid. Data on total deaths are available in two forms. First, they are available in levels for the 20^{th}Feb-31^{st}Mar. period, averaged over 2015-2019 and, separately, for 2020. When looking at 2020, the total number of deaths is of course much higher than the number of Covid deaths: 1,292 instead of 87. This is not surprising, but it highlights how demanding could be to detect an effect on Covid deaths when looking at total deaths. Second, total mortality data are available as growth rates for January-February, March, April and May. Averages suggest that total deaths declined during January and February (-7 percent), then increased in March (+20 percent) and April (+17 percent) and declined again in May (-5 percent). This is consistent with the rise-and-decline of Covid deaths shown in Figure 1.

The number of daily trips from outbreak areas is similar across the two datasets and averages 3-4 trips per 1000 inhabitants. Provincial data suggest that trips were relatively high during the pre-Covid period (6.09), declined partially during the post-outbreak & pre-lockdown period (4.5) and finally fell drastically during the lockdown (1.15).

Non-outbreak provinces have an average of 4.48 migrants (per 1000 inhabitants) to outbreak provinces. Two features of such migration are important for our identification strategy. First, migration to outbreak areas shows substantial variation, as it ranges from 1.59 to 11.46 with a standard deviation of 2.04. Figure A.2 shows the distribution of exposure across provinces outside the outbreak regions. Second, migration to outbreak provinces constitutes only a small fraction of overall migration (28.08). This will allow us to estimate the effect of exposure to outbreak areas keeping general propensity to emigrate constant.

3.5 Econometric specification

Given the type of available data, we will run two types of analysis: one that uses the region as unit of analysis; and another that uses the province.

The analysis at the regional level takes the following form:

$$CovidDeaths_{r,date} = \alpha + d_{date} + \sum_{week} \beta_{week} \left[ln(ExposureToOutbreak_r) \times d_{week} \right] + X'_{r,week}\Gamma + \epsilon_{r,date} \quad (1)$$

where $CovidDeaths_{r,date}$ is the number of Covid deaths in region r in a given day, $ExposureToOutbreak_r$ is our exposure indicator, and $X_{r,week}$ is a set of interactions between (pre-determined) controls and week indicators, and $\epsilon_{r,date}$ is the error term. Observations are weighted by population.

The analysis at the regional level has one key limitation. There are only 16 regions in Italy outside the outbreak regions.[30] Hence, we can only control for a limited number of covariates without saturating our specification.

The list of pre-determined controls includes log distance to outbreak areas, social capital, state and health capacity, share of population at risk and general propensity to migrate. Social capital is proxied by the first principal component of the share of people with high school (or higher), the share of people with university education, newspaper readership (at least once and at least five times a week) and the share of people trusting others. State and health capacity is proxied by the first principal component of regional GDP per capita, unemployment and the number of intensive care beds per 100,000 inhabitants. Population at risk is the share of people above 70 years old. General propensity to migrate is the log number of people who changed their residence from region r to any other region in the country during 2015-2018 (per 1000 inhabitants). Standard errors are clustered at the regional level and adjusted for few clusters using Cameron, Gelbach and Miller (2008).

The analysis at the provincial level complements the regional analysis. The time

[30] Besides the outbreak regions (Lombardia, Veneto and Emilia-Romagna), we drop also Valle D'Aosta to ensure consistency between the regional and the provincial level analysis. The reason for dropping Valle D'Aosta from the provincial level analysis will become obvious later in the section.

dimension is coarser than the daily level. However, there are many more units (76), which allow us to control for a much wider set of covariates *and* for region fixed effects:

$$Deaths_{r,p} = \alpha_r + \beta ln(ExposureToOutbreak_{r,p}) + X'_{r,p}\Gamma + \epsilon_{r,p} \tag{2}$$

where $Deaths_{r,p}$ is a measure of deaths in region r and province p, $ExposureToOutbreak_{r,p}$ is our exposure indicator, α_r is a set of region fixed effects, $X_{r,p}$ is a set of (pre-determined) controls, and $\epsilon_{r,p}$ is the error term. Observations are weighted by population.

The inclusion of region fixed effects is very important, because it controls for any cross-regional difference between more and less exposed provinces, thus restricting the comparison to provinces that have different exposure but are situated in the same region. The inclusion of provincial controls ensures that such within-region comparison is not biased by potential confounders such as the level of economic development, the local health capacity or risk factors that might be correlated also with Covid deaths.

The list of pre-determined controls is rich and includes: log distance to outbreak areas, share of people with high school education or higher, share of people with university education, number of firms per capita, value added per capita, median financial wealth, median income, number of intensive care beds per 100,000 inhabitants, share of people above 70 years old, size of the province, altitude, share of seaside cities, population density, share of males, whether there is an airport, share of urban areas, whether the province includes the regional capital, and general propensity to migrate.

The deaths measure at the province level is the number of Covid deaths (per million people) for, separately, 20^{th}Feb-31^{st}Mar., April and May. Besides that, the mortality analysis at the provincial level offers an additional key advantage: the possibility of estimating the effect on total number of deaths, which are available both before and after the appearance of Covid. First, we focus on the diffusion period (20^{th}Feb-31^{st}Mar.). We estimate the effect on total deaths for 2015-2019, which constitutes our first placebo estimation. Second, we estimate the effect on total deaths for 2020. Third, we focus on the growth of total deaths in 2020 (relative to the 2015-2019 average) at the province level for, separately, January-February, March, April and May. While we keep the right-hand side of the specification the same as eq. 2, its interpretation is now akin to that of a first difference model with the log number of deaths as dependent variable: time-invariant differences in deaths between more and less exposed provinces are now controlled for; region FEs capture time-varying differences in deaths across regions, and province controls capture differences in trends across provinces in observables.

Hence, the identification assumption is that, after controlling for all province time-invariant characteristics, for all regional time-varying characteristics, and for a whole range of provincial time-varying characteristics, there is no residual time-varying unobserved factor that is related to both exposure to outbreak areas and death rates.

Indirect tests for this identification assumption will be the estimation for growth of total deaths in January-February (which is our second and most important placebo) and the observation of whether and to what extent our estimates vary with and without provincial controls.

Any potential remaining omitted factor would have to be consistent with the results of these estimations as well as with the results of complementary estimations for mobility. For mobility, we will use a FE model that controls for province FEs, region-week FEs and province controls interacted by week dummies, with standard errors clustered at the province level. We will discuss remaining endogeneity threats after presenting the main results.

4 Results

We will now present the reduced form relationship between exposure to outbreak and deaths; the relationship between exposure to outbreak and mobility from outbreak areas; and whether / to what extent the mobility results explain the reduced form estimates. Finally, we will discuss alternative channels, provide some additional robustness and placebo tests and a back of the envelope calculation to assess the magnitude of the effects.

Table 1: Exposure to outbreak and Covid-19 deaths by province-month

	(1)	(2)	(3)	(4)	(5)	(6)
			PANEL A: COVID DEATHS			
Dep var.	Number of deaths 20Feb-31Mar	Number of deaths 20Feb-31Mar	Number of deaths April	Number of deaths April	Number of deaths May	Number of deaths May
ln(Exposure To Outbreak)	153.289***	169.347***	137.222*	241.456*	17.693	28.844
	(41.972)	(47.021)	(72.272)	(137.225)	(20.840)	(46.648)
Mean	86.968	86.968	155.054	155.054	45.430	45.430
R-squared	0.849	0.915	0.727	0.812	0.727	0.782
Region FEs	Yes	Yes	Yes	Yes	Yes	Yes
Province controls		Yes		Yes		Yes
			PANEL B: TOTAL DEATHS			
Dep var.	Number of deaths 20Feb-31Mar 2015-2019	Number of deaths 20Feb-31Mar 2020	Growth of deaths Jan-Feb 2020 vs 2015-2019	Growth of deaths March 2020 vs 2015-2019	Growth of deaths April 2020 vs 2015-2019	Growth of deaths May 2020 vs 2015-2019
ln(Exposure To Outbreak)	59.315	509.973**	0.009	0.382**	0.203*	0.080
	(125.079)	(213.585)	(0.031)	(0.166)	(0.103)	(0.048)
Mean	1107	1292	-0.065	0.203	0.167	-0.048
R-squared	0.685	0.844	0.631	0.885	0.921	0.658
Region FEs	Yes	Yes	Yes	Yes	Yes	Yes
Province controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	76	76	76	76	76	76

Notes: number of Covid deaths (Panel A) and total deaths (Panel B, Columns 1-2) is per million inhabitants. Growth of total deaths (Panel B, Columns 3-6) is per province. "Exposure To Outbreak" is the number of people who moved from the province to one of the outbreak areas between 2015 and 2018 (per 1000 inhabitants). Geographic controls include: log distance to outbreak provinces, number of square kilometres, altitude, share of seaside cities. Socio-demographic controls include: population density, share of males, number of intensive care hospital beds per 100,000 inhabitants, whether there is an airport, share of urban areas, population share above 70 years, population share with high school education or higher, population share with university education. Economic controls include: number of firms per capita, value added per capita, median financial wealth, median income. Total migration is the log of the number of people who moved from the province to any other area in the country between 2015 and 2018 (per 1000 inhabitants). Robust standard errors in brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

4.1 Effect on mortality

Table 1, Panel A, shows that a one percent increase in exposure is associated with 1.69 additional Covid deaths per million people during March (Column 2), 2.41 during April (Column 4) and 0.29 during May (Column 6). This implies that a variation in exposure of 50 percent relative to the mean (i.e., about one standard deviation in exposure), joint with an average population of 0.53 million people, would be associated with 45 (March), 64

(April), 8 (May) and 117 (total) additional Covid deaths per province. Notably, estimates are robust to the inclusion of a wide range of controls.

Panel B shows the results for total deaths. Column 1 shows the estimates for 20^{th}Feb.-31^{st}Mar. averaged over 2015 to 2019, *i.e.*, *before* the start of the pandemic. A one percent increase in exposure is associated with a positive but statistically insignificant effect on total deaths equal to 0.59. This effect is tiny (12%) compared to the effect we find for its 2020 counterpart (Column 2: 5.10). Interestingly, the effect for total deaths (in 2020) is also larger than the effect on Covid deaths for the same time window (Panel A, Column 2). We come back to this point after discussing the growth effects.

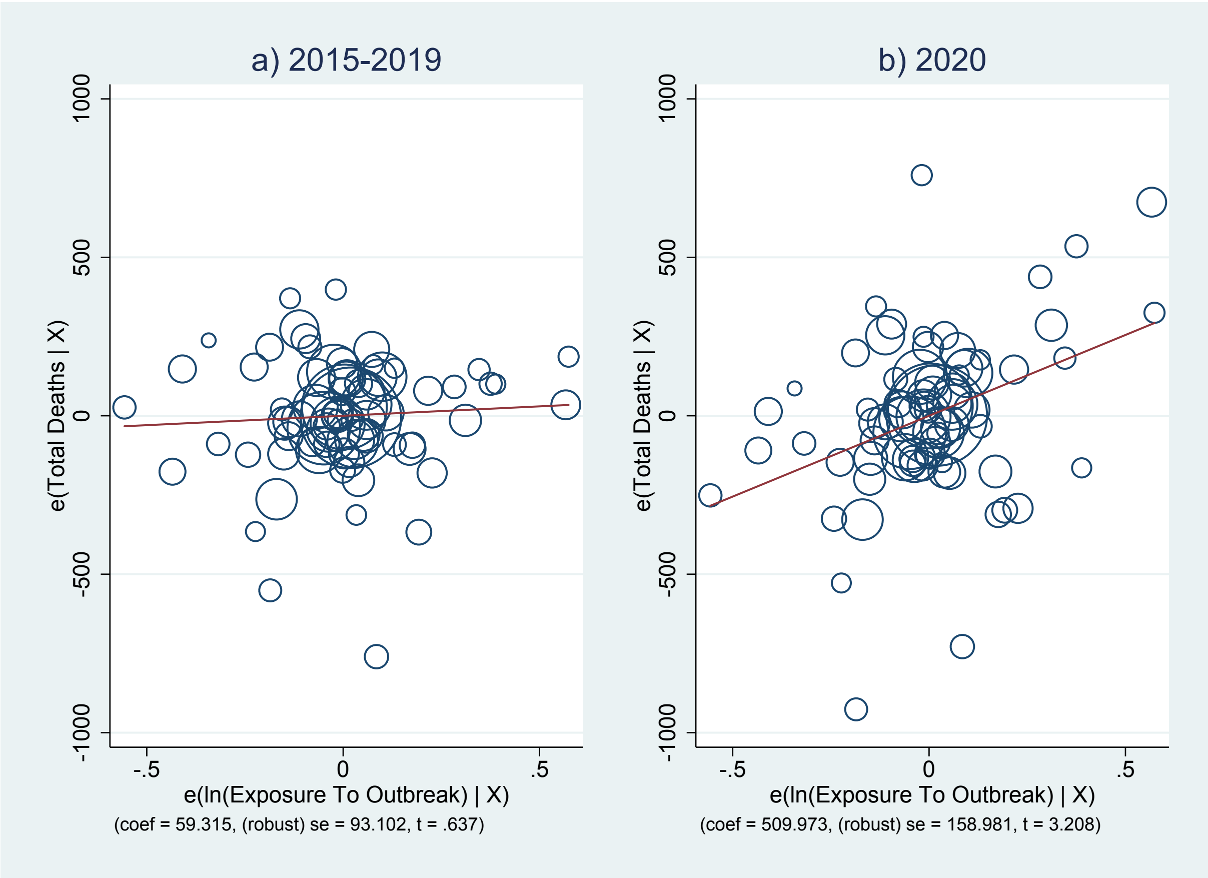
Columns 3-6 show the results of the growth estimations. Column 3 shows that exposure has no effect on the Jab.-Feb. growth rate, which confirms the validity of the research design. On the other hand, a one percent increase in exposure is associated with a 0.382 percentage point increase in total deaths per province in March (Column 4), a 0.203 percentage point increase in April (Column 5) and a 0.080 percentage point increase in May (Column 6). Based on the 2015-2019 average total deaths for these months,[31] these effects corresponds to, respectively, 1.62, 0.93 and 0.39 additional deaths. This implies that a variation in exposure of 50 percent would be associated with 81 (March), 46 (April), 20 (May) and 147 (total) additional total deaths per province.

Figure 2 and 3 show that the results are not driven by outliers. Table A.4 shows that they are also not driven by the wide, but potentially arbitrary, choice of province controls. If anything, estimates without province controls are just more accurate, which is consistent with the fact that the 17 province controls (for 76 provinces in total) are mostly just consuming degrees of freedom.

Overall, estimates for Covid deaths suggest a strong effect for March and April, followed by a near-zero effect for May, while the estimates for total deaths suggest a strong effect for March that declines smoothly in April and May. Again, the effect on total deaths is larger than the estimate for Covid deaths, although not as much as with the

[31]These are 424 (March), 458 (April) and 492 (May). The 2015-2019 average for March is obtained by multiplying the 2015-2019 average for 20^{th}Feb.-31^{st}Mar. by three fourths. The 2015-2019 average for May is obtained by dividing total deaths for May 2020 by one plus the 2015-2019 growth rate for May. The 2015-2019 average for April is obtained by interpolating the averages for March and May.

Figure 2: Exposure to outbreak and number of total deaths by province for 20^{th}Feb.-31^{st}Mar.



Notes: Relationship between number of total deaths per million inhabitants and $ln(ExposureToOutbreak)$ partialled out of region FEs and province controls. Circles represent province population. Panels a)-b) correspond, respectively, to Table 1, Panel B, Columns 1-2.

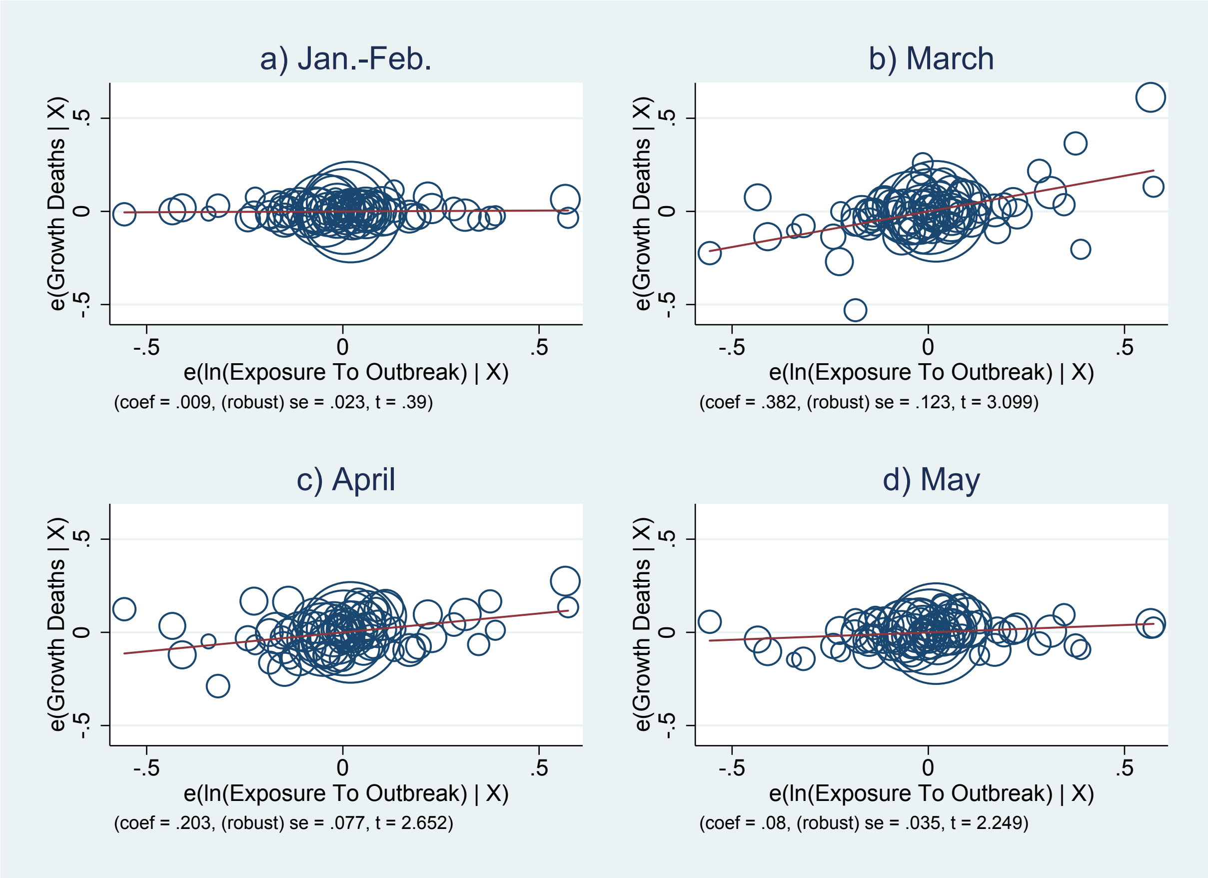
level estimates. This is consistent with one or both of the following: Covid deaths are under-reported; Covid emergency caused additional non-Covid deaths, either because of crowding out of health resources and personnel, either because of quarantine measures.[32]

Next, we estimate the effect on mortality using regional-daily data on Covid deaths. Figure 4 shows the coefficient estimates associated with the interaction between exposure to outbreak and week dummies.[33] Again, the effect on Covid deaths is large in March and declines smoothly afterwards.

[32]An obvious example of quarantine related deaths would be people in need of health care who do not dare going to the hospital or simply do not take care of themselves as good as before Covid. Another example would be suicides. Needless to say, one can think of quarantine reducing other causes of death, like car accidents. Future research should investigate this finding using micro-data on causes of death at the individual or health center level.

[33]See Table A.3 for the coefficient estimates associated with a specification that replaces week with "phase" dummies.

Figure 3: Exposure to outbreak and growth of total deaths by province-month



Notes: Relationship between growth of total deaths per province and $ln(ExposureToOutbreak)$ partialled out of region FEs and province controls. Circles represent province population. Panel a)-d) correspond, respectively, to Table 1, Panel B, Columns 3-6.

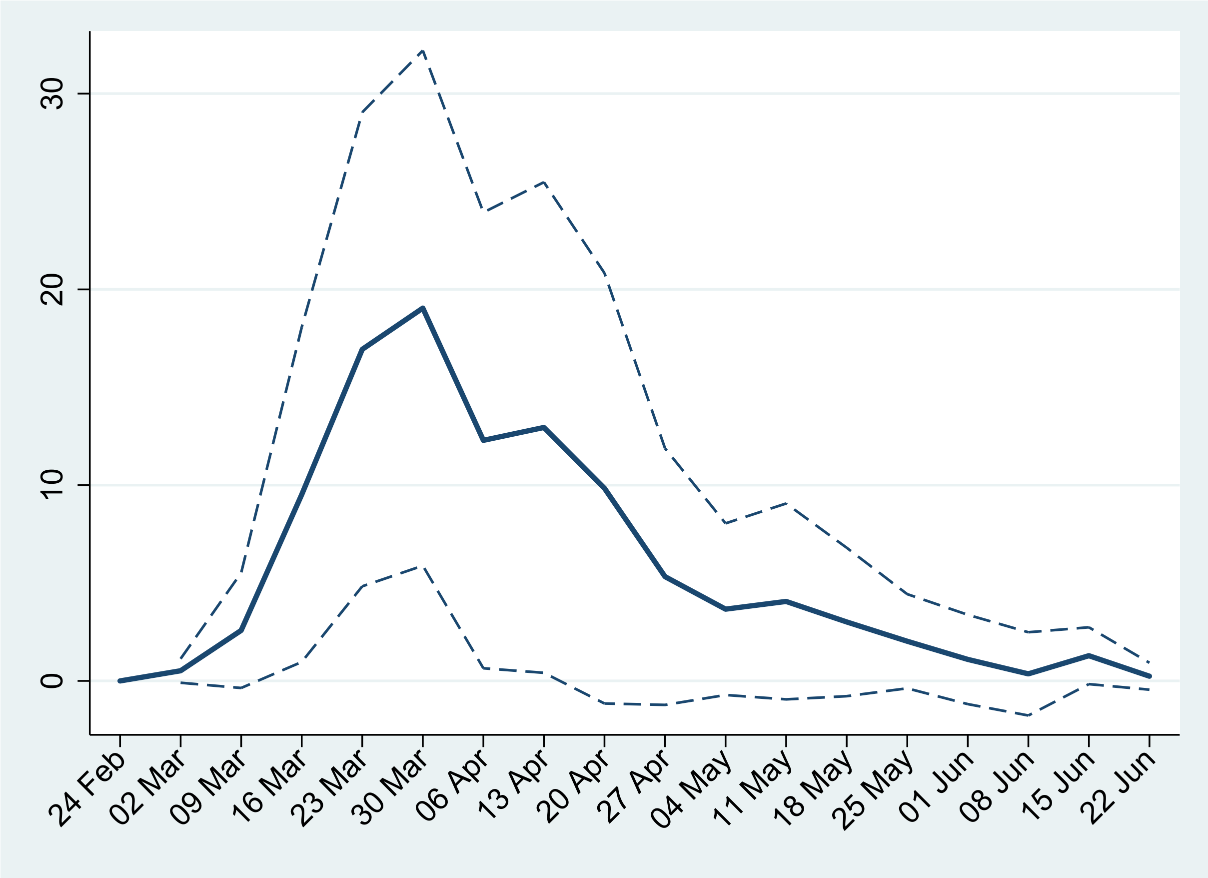
Overall, both regional-daily and provincial-monthly estimates suggest that exposure to outbreak areas is associated with an important increase in Covid deaths. The effect is large in March and April while small in May.

4.2 Effect on mobility

Next, we estimate the effect of exposure to outbreak on the number of trips from outbreak areas. Figure 5 shows the coefficient estimates associated with the specification with province FEs, region-week FEs and interactions between province controls and week dummies.

The estimates suggest the following patterns. First, there is no differential increase in trips from outbreak areas during normal times (*i.e.*, before the 24^{th}Feb.). Second, there is a differential increase in trips from outbreak areas after the outbreak but before

Figure 4: Exposure to outbreak and Covid-19 deaths by region-week



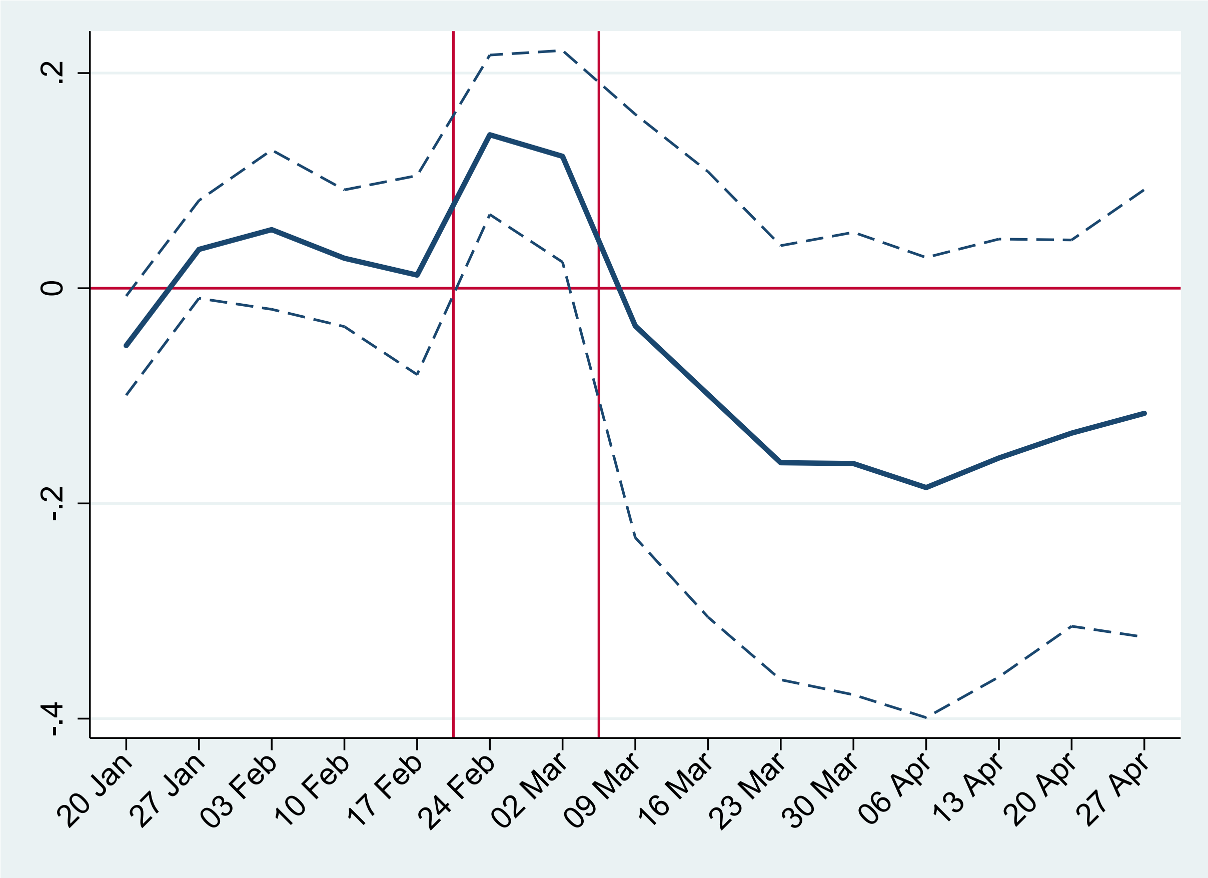
Notes: the figure is based on a regression of Covid deaths on exposure to outbreak areas interacted with week dummies, date FEs and various pre-determined regional characteristics interacted with week dummies and standard errors clustered at the regional level. The solid line represents the coefficient estimates associated with exposure to outbreak by week. Dashed lines represent 95 percent confidence intervals. Dates on the x-axis indicate the beginning of the week.

the national lockdown (*i.e.*, 24^{th}Feb.-31^{st}Mar.). Third, there seems to be a differential decrease in trips following the national lockdown, although estimates are imprecise.

The differential increase in trips form outbreak areas following the outbreak supports the hypothesis that recent migrants returned to their hometowns following the outbreak and the shutdown of economic activities in outbreak areas. The magnitude of the effect also seems non-negligible. According to Table 2, Column 6, a one percent increase in exposure is associated with 0.14 percent additional trips from outbreak areas,[34] which implies that a 50 percent increase in exposure relative to the mean (*i.e.*, about 2 additional migrants per thousand people) would be associated with 0.3 additional daily trips per

[34] See Bellemare and Wichman (2020) for a discussion of marginal effects in models including an Inverse Hyperbolic Sine transformation.

Figure 5: Exposure to outbreak and trips from outbreak areas by province-week



Notes: the figure is based on a regression of the Inverse Hyperbolic Sine (IHS) of the number of trips from outbreak areas (per 1000 inhabitants) on exposure to outbreak interacted with week dummies, date FEs, region-week FEs and the province controls (interacted with week dummies) used in Tables 1 and 2. This figure essentially is the same as Table 2, Column 6, with week dummies replacing phase dummies. Dashed lines represent 95 percent confidence intervals. Dates on the x-axis indicate the beginning of the week.

thousand people.[35]

Table 2 confirms these patterns and suggests an additional one: more exposed provinces receive more trips from outbreak areas also in normal times. By looking at the estimates associated with the specification without province FEs (Columns 1-3) and Column 3 in particular, we see that a one percent increase in exposure is associated with 1.56 percent additional trips from outbreak areas, which implies that a 50 percent increase in exposure relative to the mean would be associated with 3.5 additional daily trips per thousand people.[36] Hence, the differential increase in trips during the post-outbreak & pre-lockdown

[35]This is the result of 0.138 (coefficient estimate) * 50 (percentage increase in exposure) /100 * 4.5 (average trips during this period according to Table A.2).

[36]This is the result of 1.559 (coefficient estimate) * 50 (percentage increase in exposure) /100 * 4.5 (average trips during this period according to Table A.2).

Table 2: Exposure to outbreak and trips from outbreak areas by province-phase

	(1)	(2)	(3)	(4)	(5)	(6)
ln(Exposure To Outbreak)						
× (9^{th}Mar.-)	0.062	1.153***	1.294***	0.597***	-0.113	-0.126
	(0.306)	(0.251)	(0.275)	(0.185)	(0.141)	(0.095)
× (24^{th}Feb.-8^{th}Mar.)	-0.280	1.448***	1.559***	0.255***	0.183***	0.138***
	(0.439)	(0.206)	(0.267)	(0.090)	(0.054)	(0.038)
× (3^{rd}Feb.-23^{rd}Feb.)	-0.530	1.275***	1.458***	0.005	0.010	0.037
	(0.436)	(0.196)	(0.248)	(0.018)	(0.014)	(0.024)
× (13^{th}Jan.-2^{nd}Feb.)	-0.535	1.266***	1.420***			
	(0.446)	(0.202)	(0.254)			
Mean	0.985	0.985	0.985	0.985	0.985	0.985
R-squared	0.243	0.898	0.931	0.905	0.953	0.960
Number of clusters	76	76	76	76	76	76
Observations	8,512	8,512	8,512	8,512	8,512	8,512
Day FEs	Yes	Yes	Yes	Yes	Yes	Yes
Region × phase FEs		Yes	Yes		Yes	Yes
Province controls × phase			Yes			Yes
Province FEs				Yes	Yes	Yes

Notes: the dependent variable is the Inverse Hyperbolic Sine (IHS) of the number of trips from outbreak provinces (per 1000 inhabitants). "Exposure To Outbreak" is the number of people who moved from the province to one of the outbreak areas during 2015-2018 (per 1000 inhabitants). Province controls are the same as in Table 1. Standard errors clustered at the province level in brackets. *** p<0.01, ** p<0.05, * p<0.1.

period is only 9 percent of the total marginal effect.

Exposure has an effect on both regular and additional post-outbreak & pre-lockdown trips. The total effect is large. Even if recent migrants were to travel often between their current and former province of residence, they could hardly explain the entire effect. One possible explanation is that our exposure measure captures only a fraction of the true share of migrants. Some excluded but relevant migrants could be people who moved to outbreak areas in 2015 or earlier and therefore were not included in our measure even if they registered correctly at destination.[37] Some other excluded but relevant migrants could be people who moved or travel regularly to outbreak areas without changing their province of residence, like daily commuters,[38] weekly commuters,[39] or perhaps non-resident University

[37]If migration was highly correlated over time, then including earlier waves of migrants would increase our exposure index and decrease the magnitude of the effect on trips almost mechanically.

[38]Daily commuters might live in one province but travel daily to another one.

[39]Weekly commuters might live in one province during the weekend and in a different province during the week for work or study reasons.

students who live semi-permanently where they study but have not registered themselves at destination.[40]

4.3 Effect on mortality through mobility

Next, we investigate whether and to what extent trips explain the relationship between exposure to outbreak and mortality. To do so, we include the average number of trips from outbreak areas during February as additional controls in the mortality specification at the province-month level (eq. 2). Table 3 shows the results.

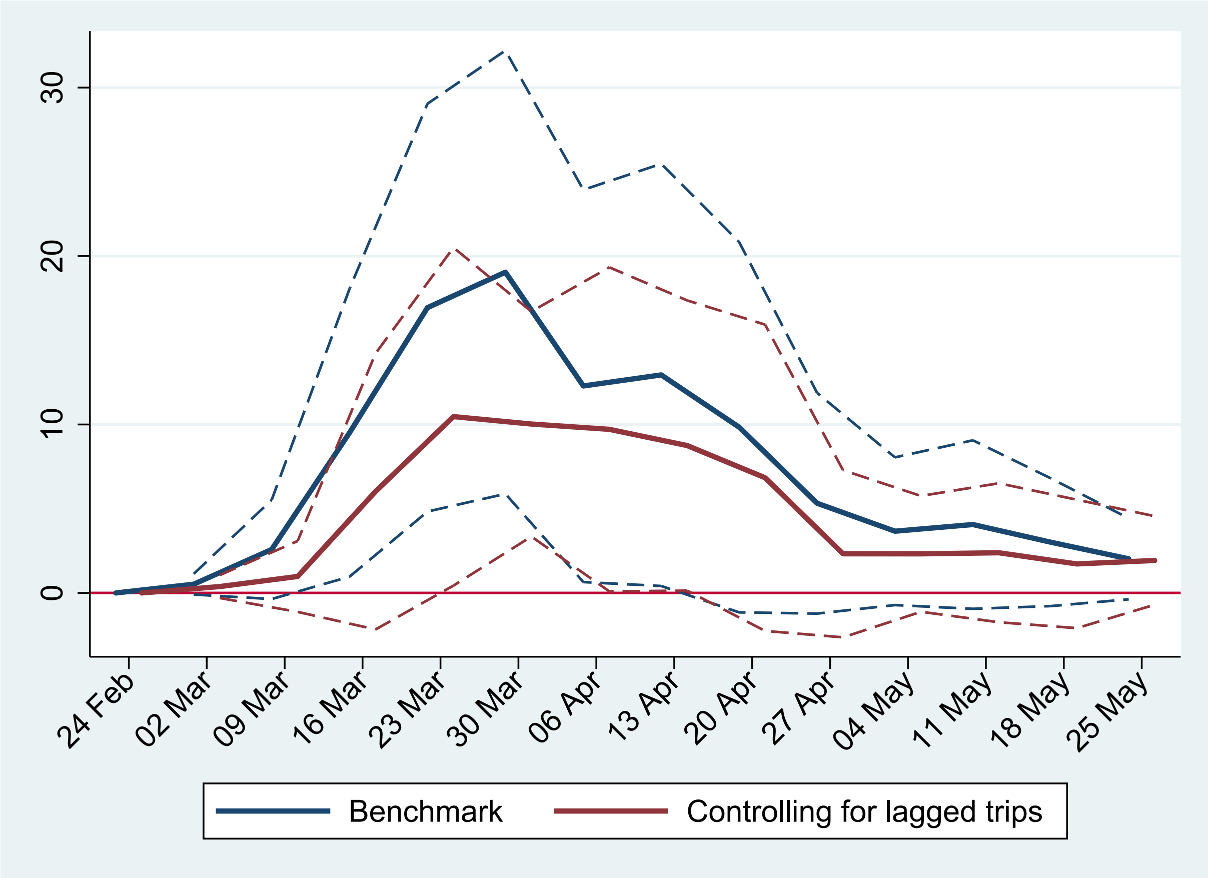
Table 3: Exposure to outbreak, trips from outbreak areas, and deaths

	(1)	(2)	(3)	(4)	(5)	(6)
PANEL A: Number of Covid Deaths (2020)						
Period	20Feb-31Mar	20Feb-31Mar	April	April	May	May
ln(Exposure to Outbreak)	169.347***	99.376*	241.456*	-72.239	28.844	-10.772
	(47.021)	(50.937)	(137.225)	(108.350)	(46.648)	(61.085)
IHS(# trips from outbreak areas)		47.225*		211.723***		26.738
		(27.253)		(61.626)		(22.784)
Mean	86.968	86.968	155.054	155.054	45.430	45.430
R-squared	0.915	0.923	0.812	0.884	0.782	0.790
PANEL B: Growth of Total Deaths (2020 vs 2015-2019)						
Period	March	March	April	April	May	May
ln(Exposure to Outbreak)	0.382**	0.097	0.203*	0.041	0.080	0.119
	(0.166)	(0.124)	(0.103)	(0.112)	(0.048)	(0.081)
IHS(# trips from outbreak areas)		0.193**		0.110**		-0.026
		(0.089)		(0.050)		(0.035)
Mean	0.203	0.203	0.167	0.167	-0.048	-0.048
R-squared	0.885	0.908	0.921	0.928	0.658	0.663
Region FEs	Yes	Yes	Yes	Yes	Yes	Yes
Province controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	76	76	76	76	76	76

Notes: "Exposure To Outbreak" is the number of people who moved from the province to one of the outbreak areas between 2015 and 2018 (per 1000 inhabitants). Trips from outbreak areas are per 1000 inhabitants and refer to February. Province controls are the same as in Table 1. Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

[40]We had also speculated that that recent migration might have been positively correlated with past migration, which in turn might have generated backward and forward linkages between firms located at origin and destination. However, our mobility data track the movement of people, rather than goods, and therefore limits the ability of this mechanism to explain the results.

Figure 6: Exposure to outbreak, trips from outbreak areas, and Covid deaths



Notes: the figure is based on two estimations. The first estimation corresponds to Figure 4. The second estimation is the same, except for the additional control for IHS(trips from outbreak areas per 1000 inhabitants) lagged by 4 weeks. Dashed lines represent 95 percent confidence intervals. Dates on the x-axis indicate the beginning of the week.

Overall, trips from outbreak areas explain a large share of the reduced form effect. When looking at Covid deaths (Panel A), controlling for trips causes the main coefficient estimate of interest to decline by 41 percent for 20^{th}Feb.-31^{st}Mar. (Columns 1-2) and by more than 100 percent for April (Columns 3-4) and May (Columns 5-6). When looking at the growth of total deaths (Panel B), the coefficient estimate of interest declines by about 75 percent for March (Columns 1-2), by about 80 percent for April (Columns 3-4), while it remains stable or even increases slightly for May (Columns 5-6). The importance of mobility from outbreak areas can also be seen using the regional-daily data (Figure 6), although there the mechanism seems to matter mostly for March. Hence, the evidence supports the hypothesis that internal migration matters for the diffusion of the virus.

Ideally, we would like to separate the role of regular and "extra" trips. In practice, this requires making additional assumptions on the likelihood of contagion and the behavior at destination of the people travelling. To the extent that travelers in regular and "extra" trips are similar along these two dimensions, regular trips should be 8-9 times more important as "extra" trips. In this sense, the evidence does not support the hypothesis that the effect of internal migration on the diffusion of the virus worked through panic mobility.

4.4 Alternative channels

The previous section showed that trips from outbreak areas explained a large share of the reduced form effect. What might explain the rest of the effect? Tian et al (2020) suggest that Mexican migrants in the US influence the diffusion of the virus in their Mexican hometowns by persuading people to respect self-isolation measures over the phone.[41] We measure compliance with self-isolation measures using the number of trips within a province in a given day and test whether it is affected by exposure to outbreak areas. Table A.6 shows the results. The estimates are all close to zero and always far from statistically significant.

4.5 Robustness and placebos

Table A.7 shows that dropping any entire region does not change affect the main results.

Table A.8 shows that replacing exposure to outbreak with exposure to another region does not generate results anywhere similar to the coefficient estimates we found in Table 1, except for the outbreak regions where the outbreak provinces are located (Veneto, Lombardy and Emilia-Romagna).[42] Even in this case, the coefficient estimate drops substantially once we control for exposure to outbreak provinces. Importantly, the last row shows that exposure to any province is not associated with any additional death. The

[41] They use data on the number of migrants between each Mexican municipality and each US county, then measure compliance with self-isolation measures in each US county, and finally compute, for each Mexican municipality, the average compliance with self-isolation measures of the US localities where its emigrants are located. Hence, they measure "exposure to US self-isolation norms", while we measure "exposure to outbreak areas". In addition, in their setting, the presence of an international border between the migrants and their hometowns possibly shuts down the mechanism we investigate here.

[42] A partial exception is exposure to Marche. Marche is the first region to experience a Covid death (2^{nd} of March) after Veneto, Lombardy and Emilia-Romagna. Hence, the effect is consistent with the argument of this paper.

latter result emphasizes the importance of having clearly defined outbreak areas and data on the number of migrants specific to these areas.

In the previous section, we showed that exposure to outbreak has no effect on within-province mobility. It might nonetheless be sensible to estimate the effect of exposure to outbreak on mortality controlling for within-province mobility, because the latter might capture some important omitted determinant of mortality.[43] Table A.9 shows the results. Again, the evidence does not support this mechanism.

4.6 Back of the envelope calculation

To assess the magnitude of the relationship between exposure to outbreak areas and deaths, we calculate how many fewer deaths non-outbreak provinces would have experienced, had they had an exposure equal to 10^{th} percentile of the exposure distribution.

To do so, we take the following steps. First, we pick the province at the 10^{th} percentile of the exposure distribution as a reference point. This is Frosinone (Lazio), which has an exposure of 2.47 migrants to outbreak areas per 1000 inhabitants.

Second, for each province, we calculate the decrease in exposure that would be necessary to be as exposed as Frosinone. For example, pick Verbano-Cusio-Ossola (Piedmont), which is at the 90^{th} percentile of the exposure distribution. Its exposure is 7.08 migrants to outbreak areas per 1000 inhabitants. For it to be similar to Frosinone, its exposure would have to decrease by 65 percent.

Third, for each province, we multiply such decrease by the marginal effects discussed in Section 4.1 (which refers to Table 1).[44] For example, according to our estimates, had Verbano-Cusio-Ossola had an exposure similar to Frosinone, it would have suffered 45

[43] Durante, Guiso and Gulino (2020) show that social capital in Italy is correlated with within-province mobility, which proxies violations of quarantine measures and therefore presumably leads to additional Covid deaths.

[44] To be as precise as possible when calculating the number of fewer Covid deaths, we use population numbers for each province, rather than the mean for the entire sample. Along similar lines, when calculating the number of fewer total deaths, we use 2015-2019 total deaths by province.

fewer Covid deaths,[45] and 72 fewer total deaths.[46]

Fourth, we compute the total for all provinces. Had all provinces had the same exposure as the one at the 10^{th} percentile, they would have suffered 5,895 fewer Covid deaths and 7,348 fewer total deaths. If we do not include provinces below the tenth percentile, provinces would have suffered 6,111 fewer Covid deaths and 7,599 fewer total deaths.

These are important quantities, because they constitute 60 percent of all Covid deaths in non-outbreak regions[47] and 18 percent of all Covid deaths in the country.[48]

5 Conclusions

In this paper, we asked whether internal migration helps spread viruses. The idea is that, once a virus outbreaks, its diffusion to the rest of the country is neither homogeneous nor random: it depends on pre-existing internal migration routes, either because people travel regularly more along these routes, either because the virus and its immediate consequences (*e.g.*, fear, social isolation measures and the shutdown of economic activities) lead recent migrants to move back to their hometowns.

To answer this question, we focussed on Covid-19 and used rich panel data on Italian provinces and regions, including highly disaggregated data on internal migration. Specifically, we used yearly data on the number of people who de-registered themselves from one province and registered themselves in another to measure, for each province outside outbreak regions, the number of people who moved to one of the outbreak areas. Our "Exposure to outbreak" indicator is the share of movers relative to the population in the province of origin. We then exploited variation in this exposure across provinces located in the same region to identify its effects on Covid and total mortality. A variety of robustness tests and placebo estimations lent credibility to this research design.

[45]There would have been approximately 18 fewer Covid deaths in March, 25 in April and 3 in May. Calculating these quantities requires the population for Verbano-Cusio-Ossola, which is about 0.16 million people. Note Verbano-Cusio-Ossola suffered 97 actual Covid deaths (55 in March, 32 in April and 10 in May), while Frosinone suffered 69 actual Covid deaths (10 in March, 37 in April and 22 in May).

[46]There would have been 43 fewer total deaths in March, 22 in April April and 8 in May. Calculating these quantities requires the 2015-2019 average total deaths for Verbano-Cusio-Ossola, which are 171 (March), 165 (April) and 159 (May).

[47]This percentage is based on 9,904 Covid deaths.

[48]This percentage is based on 32,218 total Covid deaths.

Results suggest that a 50 percent increase in exposure relative to the mean (*i.e.*, about one standard deviation increase in exposure) leads to 117 additional Covid deaths and 147 additional total deaths per province. This is a large effect. A back of the envelope calculation shows that, had provinces outside outbreak regions had an exposure equal to the 10^{th} percentile, they would have experienced 5,895 (*i.e.*, 60 percent) fewer Covid deaths and 7,348 fewer total deaths.

We then used mobile phone based mobility data to test whether more exposed provinces do indeed receive a greater inflow of people from outbreak areas and to what extent such greater inflow, if any, explains the reduced form effect on mortality. The evidence confirms that greater exposure leads to greater inflow, and suggests that such greater inflow explains between 41 and 100 percent of the reduced form effect (depending on the month and the mortality measure one looks at).

We also find evidence of a post-outbreak "rush" away from outbreak areas back to hometowns, but such effect seems small relative to the effect on regular trips and therefore is unlikely to be the primary driver of the effect.

In light of these findings, governments could build up a database of recent migrants to be ready to contact those located in future outbreak areas. They could also complement it with information on people studying or working in provinces other than those where they are registered in.[49] The behavioral literature on taxation suggests that small nudges might be enough to persuade many of them not to travel if personally reminded of the consequences that could have.

The exposure index provided in this study can be thought of as a simple risk measure. Local governments could check to see how exposed they are (and eventually communicate their citizens to strengthen voluntary self-isolation). Central governments could use it to improve the allocation of scarce emergency resources across administrative units.

[49]For Italy, this could be done using information from Universities (for students) and from the National Social Security Institute, called INPS (for workers).

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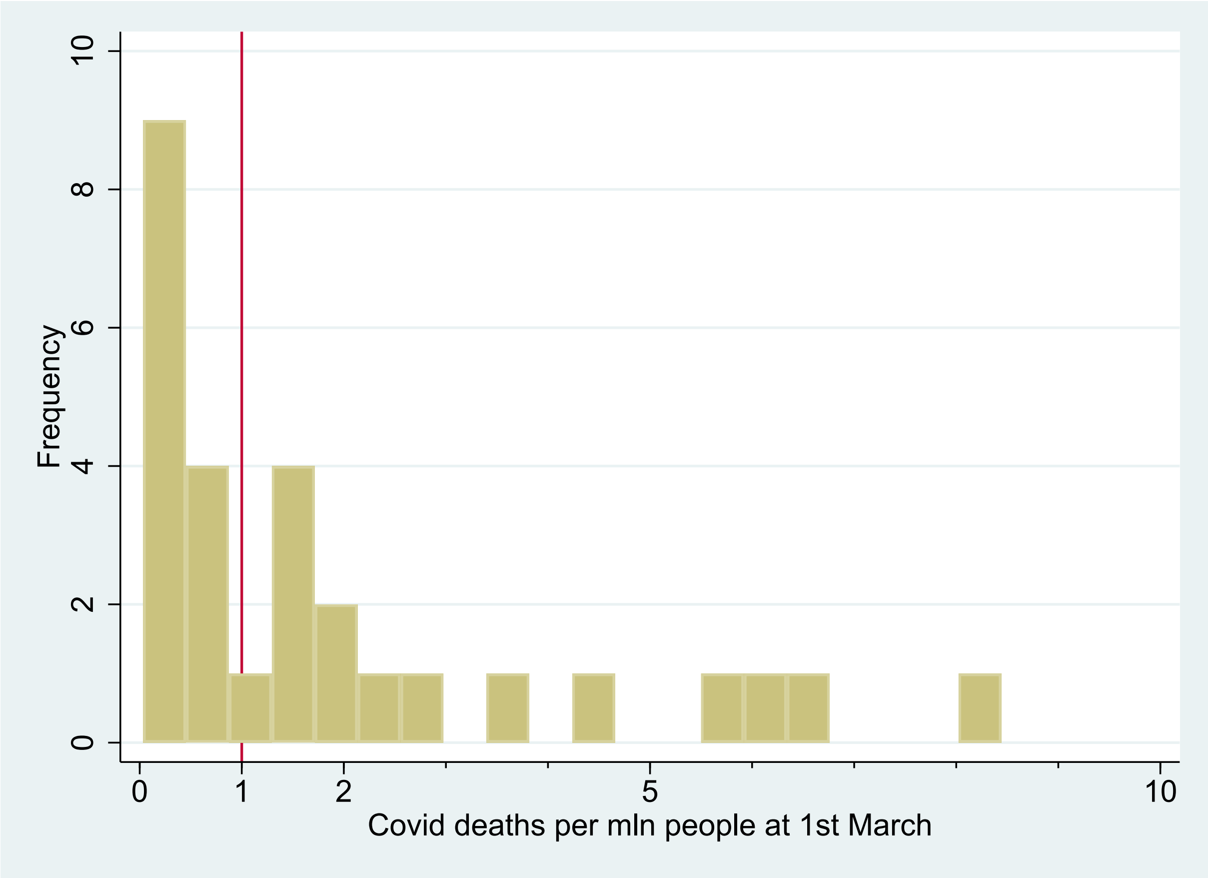
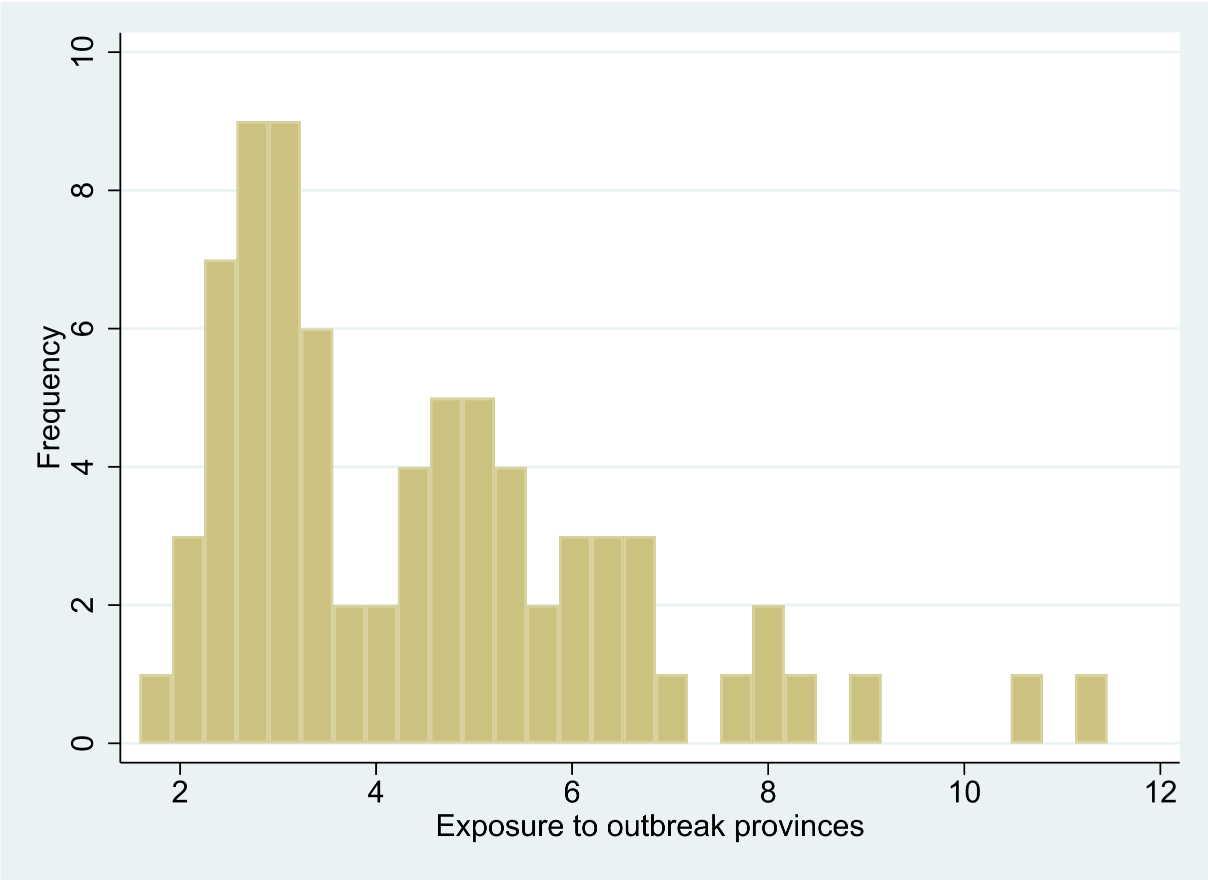
Online Appendix

Figure A.1: Covid deaths across provinces in outbreak regions



Notes: number of Covid deaths per million people (as of the 1^{th} March) across the 28 provinces of Lombardia, Veneto and Emilia-Romagna. The vertical line indicates the cut-off used to define the (15) outbreak provinces.

Figure A.2: Exposure to outbreak across provinces located outside outbreak regions



Notes: "Exposure to outbreak provinces" across the 76 provinces located outside the outbreak regions (Lombardy, Veneto and Emilia-Romagna). "Exposure to outbreak provinces" is the number of people who de-registered from a given province to register in one of the outbreak provinces during 2015-2018 (per 1000 inhabitants).

Table A.1: Summary statistics at the regional level

Variable	**N**	**Mean**	**Std. Dev.**	**Min.**	**Max.**
Indicators at the regional-daily level					
Covid deaths per mln people	1,984	2.51	4.74	0.00	45.90
# trips from outbreak areas per 1000 ppl. (13^{th}Jan.-3^{rd}May)	1,792	3.04	5.38	0.00	30.71
# trips from outbreak areas per 1000 ppl. (13^{th}Jan.-23^{rd}Feb.)	672	5.43	7.16	0.07	30.71
# trips from outbreak areas per 1000 ppl. (24^{th}Feb.-8^{th}Mar.)	224	4.00	5.69	0.02	25.50
# trips from outbreak areas per 1000 ppl. (9^{th}Mar.-3^{rd}May)	896	1.02	1.64	0.00	8.71
Indicators at the regional level					
Exposure to outbreak areas	16	4.10	1.40	2.19	7.30
Exposure to any area	16	25.64	4.40	14.20	32.97
Distance to outbreak provinces (km)	16	531.12	263.81	176.62	994.51
Compliance to quarantine					
People with High School or higher	16	0.46	0.05	0.40	0.57
People with Bachelor degree or higher	16	0.14	0.02	0.11	0.20
Newspaper readership (at least once a week)	16	0.38	0.09	0.26	0.58
Newspaper readership (five times a week)	16	0.32	0.08	0.22	0.45
Trust in others	16	0.20	0.06	0.13	0.37
State capacity					
Unemployment	16	0.12	0.05	0.04	0.22
Regional GDP	16	0.03	0.01	0.02	0.04
Intensive care beds (per 100,000 inh.)	16	8.46	1.49	5.75	11.56
Other indicators					
People over 70	16	0.17	0.02	0.13	0.22
Population	16	2,560,240.44	1,923,193.24	308,493.00	5,896,693.00

Table A.2: Summary statistics at the provincial level

Variable	N	Mean	Std. Dev.	Min.	Max.
Mortality indicators: Covid deaths					
Number of deaths per mln ppl, 20^{th} Feb.-31^{st} Mar. 2020	76	86.97	118.54	0.00	523.37
Number of deaths per mln ppl, April 2020	76	155.05	177.45	6.94	841.37
Number of deaths per mln ppl, May 2020	76	45.43	61.47	-25.93	263.92
Mortality indicators: total deaths					
Number of deaths per mln ppl, 20^{th} Feb.-31^{st} Mar. 2015-2019	76	1,106.67	283.83	17.05	1,633.76
Number of deaths per mln ppl, 20^{th} Feb.-31^{st} Mar. 2020	76	1,291.92	507.04	25.57	2,826.67
Growth for Jan-Feb, 2020 vs 2015-2019	76	-0.07	0.06	-0.17	0.09
Growth for March, 2020 vs 2015-2019	76	0.20	0.28	-0.09	1.25
Growth for April, 2020 vs 2015-2019	76	0.17	0.28	-0.18	0.84
Growth for May, 2020 vs 2015-2019	76	-0.05	0.09	-0.26	0.18
Indicators at the provincial-daily level					
# trips from outbreak areas per 1000 ppl. (13^{th}Jan.-3^{rd}May)	8,512	3.42	9.15	0.00	82.74
# trips from outbreak areas per 1000 ppl. (13^{th}Jan.-23^{rd}Feb.)	3,192	6.09	12.74	0.00	82.74
# trips from outbreak areas per 1000 ppl. (24^{th}Feb.-8^{th}Mar.)	1,064	4.50	9.99	0.00	65.13
# trips from outbreak areas per 1000 ppl. (9^{th}Mar.-3^{rd}May)	4,256	1.15	3.17	0.00	36.10
# trips within own province per 1000 ppl. (13^{th}Jan.-3^{rd}May.)	8,512	583.16	328.81	13.95	1584.20
Indicators at the provincial level					
Exposure to outbreak areas	76	4.48	2.04	1.59	11.46
Exposure to any area	76	28.08	6.52	11.24	45.66
Distance to outbreak provinces (km)	76	543.61	296.67	159.71	1,059.29
Share of people with High School (or higher)	76	0.31	0.03	0.24	0.39
Share of people with Bachelor degree (or higher)	76	0.03	0.00	0.02	0.04
Number of firms per capita	76	0.07	0.01	0.04	0.11
Value added per capita	76	21,151.99	5,765.97	13,260.33	40,431.74
Median financial wealth	76	7,857.23	5,521.42	0.00	23,891.21
Median income	76	25,730.38	5,786.63	15,400.00	38,762.48
Intensive care beds (per 100,000 inh.)	76	7.79	3.44	2.87	20.68
Share of people over 70	76	0.18	0.02	0.12	0.23
area (km2)	76	2,965.04	1,747.43	212.51	7,398.38
Altitude (meters)	76	354.54	172.49	33.12	849.71
Share of seaside cities	76	0.16	0.18	0.00	0.79
Population density	76	224.62	325.40	49.34	2,630.35
Share of males	76	0.49	0.01	0.48	0.50
Whether there is an airport	76	0.26	0.44	0.00	1.00
Share of urban areas	76	0.03	0.07	0.00	0.57
Province includes region capital	76	0.21	0.41	0.00	1.00
Number of people (2018)	76	532,507	634,308	85,237	4,355,725

Note: sources of data described in the Data section.

Table A.3: Exposure to outbreak and Covid deaths by region-phase

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ln(Exposure to Outbreak)							
× (4^{th}May.-)	-0.420	1.873**	4.004**	3.632**	0.744	-0.371	2.067
	(0.665)	(0.829)	(1.690)	(1.250)	(0.818)	(0.704)	(1.200)
	0.495	0.154	0.240	0.065	0.410	0.565	0.289
× (6^{th}Apr.-3^{rd}May.)	-1.368	8.711***	19.473***	14.949**	3.355	-0.634	10.101**
	(3.207)	(2.879)	(6.391)	(5.472)	(3.082)	(3.464)	(4.691)
	0.675	0.007	0.006	0.020	0.321	0.867	0.167
× (9^{th}Mar.-5^{th}Apr.)	-1.214	6.003***	16.159***	11.020***	2.192	-0.376	12.020***
	(2.643)	(1.498)	(3.623)	(3.075)	(2.487)	(2.734)	(4.025)
	0.675	0.006	0.002	0.016	0.416	0.918	0.008
× (24^{th}Feb.-8^{th}Mar.)	0.013	0.098*	0.270**	0.212**	0.074	0.021	0.259*
	(0.039)	(0.055)	(0.095)	(0.075)	(0.050)	(0.038)	(0.140)
	0.735	0.062	0.069	0.005	0.129	0.559	0.132
Mean	2.527	2.527	2.527	2.527	2.527	2.527	2.527
R-squared	0.227	0.611	0.602	0.564	0.494	0.252	0.676
Number of regions	16	16	16	16	16	16	16
Observations	1,968	1,968	1,968	1,968	1,968	1,968	1,968
Day FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log(distance to outbreak) × phase	-	Yes					Yes
Compliance to quarantine × phase	-	-	Yes	-	-	-	Yes
State capacity × phase	-	-	-	Yes	-	-	Yes
Pop. at risk × phase	-	-	-	-	Yes	-	Yes
Total emigrants × phase	-	-	-	-	-	Yes	Yes

Notes: Dependent variable is the number of Covid-19 deaths (per million people). "Exposure to Outbreak" is the number of people who moved to one of the outbreak areas during 2015-2018 (per 1000 inhabitants). Distance to outbreak is the average distance to the outbreak provinces. "Compliance with quarantine" is the first principal component of: share people with higher school education, share people with university education, newspaper readership (at least once a week), newspaper readership (at least five times a week) and share people who trust others. "State capacity" is the first principal component of: unemployment share, regional GDP per capita and number of intensive care beds per 100,000 inhabitants. "Population at risk" is the share of people with 70 years old or more. "Total emigrants" is the log of the number of people who changed residence to any province between 2015 and 2018. For each interaction, the table reports coefficient estimates on the first row, standard errors clustered at the region level (in brackets), and p-values for wild cluster bootstrap standard errors la Cameron, Gelbach and Miller 2008). *** p<0.01, ** p<0.05, * p<0.1.

Table A.4: Exposure to outbreak and Covid-19 deaths by province-month

	(1)	(2)	(3)	(4)	(5)	(6)
Dep var.	Number of total deaths 20Feb-31Mar 2015-2019	Number of total deaths 20Feb-31Mar 2020	Growth of total deaths Jan-Feb 2020 vs 2015-2019	Growth of total deaths March 2020 vs 2015-2019	Growth of total deaths April 2020 vs 2015-2019	Growth of total deaths May 2020 vs 2015-2019
ln(Exposure To Outbreak)	118.218	520.788***	-0.010	0.331***	0.230***	0.120***
	(89.410)	(171.308)	(0.018)	(0.092)	(0.054)	(0.035)
Mean	1107	1292	-0.065	0.203	0.167	-0.048
R-squared	0.524	0.747	0.461	0.830	0.873	0.498
Observations	76	76	76	76	76	76
Region FEs	Yes	Yes	Yes	Yes	Yes	Yes
Province controls	No	No	No	No	No	No

Notes: the number of total deaths (Columns 1-2) is per million inhabitants. The growth of total deaths (Columns 3-6) is per province. "Exposure To Outbreak" is the number of people who moved from the province to one of the outbreak areas during 2015-2018 (per 1000 inhabitants). Province controls as in Table 1. Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table A.5: Exposure to outbreak and trips from outbreak areas by region-phase

ln(Exposure To Outbreak)				
× (6^{th}Apr.-3^{rd}May)	-0.412	1.014	0.924***	-0.324
	(0.420)	(0.630)	(0.289)	(0.333)
	0.326	0.179	0.026	0.424
× (9^{th}Mar.-5^{th}Apr.)	-0.451	1.069	0.885***	-0.268
	(0.449)	(0.725)	(0.252)	(0.244)
	0.356	0.216	0.019	0.376
× (24^{th}Feb.-8^{th}Mar.)	-1.047	1.561	0.289**	0.223*
	(0.736)	(0.931)	(0.116)	(0.111)
	0.203	0.167	0.032	0.122
× (3^{rd}Feb.-23^{rd}Mar.)	-1.349*	1.296	-0.012	-0.042
	(0.661)	(0.885)	(0.022)	(0.064)
	0.116	0.198	0.556	0.586
× (13^{th}Jan.-2^{nd}Feb.)	-1.336*	1.338		
	(0.667)	(0.937)		
	0.120	0.206		
Mean	1.094	1.094	1.094	1.094
R-squared	0.297	0.843	0.927	0.962
Number of regions	16	16	16	16
Observations	1,792	1,792	1,792	1,792
Day FE	Yes	Yes	Yes	Yes
Regional controls × phase	-	Yes		Yes
Region FEs			Yes	Yes

Notes: Dependent variable is the Inverse Hyperbolic Sine (IHS) of the number of trips from outbreak areas (per 1000 inhabitants). "Exposure To Outbreak" is the number of people who moved from the province to one of the outbreak areas during 2015-2018 (per 1000 inhabitants). Regional controls are: log distance to outbreak; compliance to quarantine; state capacity; population at risk; total emigrants. Distance to outbreak is the average distance to the outbreak provinces. "Compliance to quarantine" is the first principal component of population share with higher school education, population share with university education, newspaper readership (at least once a week), newspaper readership (at least five times a week) and trust in others. "State capacity" is the first principal component of unemployment share, regional GDP per capita and number of intensive care beds per 100,000 inhabitants. Population at risk is the share of people with 70 years old or more. Total emigrants is the log of the share of people who changed residence to another Italian region between 2015 and 2018. For each interaction, the table reports coefficient estimates on the first row, standard errors clustered at the region level (in brackets), and p-values for wild cluster bootstrap standard errors la Cameron, Gelbach and Miller 2008). *** p<0.01, ** p<0.05, * p<0.1.

Table A.6: Exposure to outbreak and within-province mobility

	(1)	(2)	(3)	(4)	(5)	(6)
ln(Exposure To Outbreak)						
× (9^{th}Mar.-)	-0.026	-0.231***	-0.030	0.069	-0.015	-0.076
	(0.151)	(0.086)	(0.125)	(0.049)	(0.056)	(0.060)
× (24^{th}Feb.-8^{th}Mar.)	-0.092	-0.216**	0.055	0.002	-0.000	0.009
	(0.159)	(0.100)	(0.102)	(0.020)	(0.010)	(0.017)
× (3^{rd}Feb.-23^{rd}Feb.)	-0.108	-0.210**	0.056	-0.014	0.007	0.009
	(0.151)	(0.103)	(0.101)	(0.010)	(0.005)	(0.009)
× (13^{th}Jan.-2^{nd}Feb.)	-0.095	-0.216**	0.046			
	(0.147)	(0.106)	(0.099)			
Mean	6.865	6.865	6.865	6.865	6.865	6.865
R-squared	0.709	0.886	0.934	0.974	0.978	0.982
Number of clusters	76	76	76	76	76	76
Observations	8,512	8,512	8,512	8,512	8,512	8,512
Day FEs	Yes	Yes	Yes	Yes	Yes	Yes
Region × phase FEs		Yes	Yes		Yes	Yes
Province controls × phase			Yes			Yes
Province FEs				Yes	Yes	Yes

Notes: Dependent variable is the Inverse Hyperbolic Sine (IHS) of the number of trips within a province (per 1000 inhabitants). "Exposure To Outbreak" is the number of people who moved from the province to one of the outbreak areas during 2015-2018 (per 1000 inhabitants). Province controls are the same as in Table 1. Standard errors clustered at the province level in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table A.7: Exposure to outbreak and deaths: drop one region at the time

Dep var.	Number of Covid deaths 20Feb-31Mar 2020	Number of Covid deaths 01Apr-30Apr 2020	Number of total deaths 20Feb-31Mar 2015-2019	Number of total deaths 20Feb-31Mar 2020	Variation in total deaths Jan-Feb 2020 vs 2015-2019	Variation in total deaths March 2020 vs 2015-2019	Variation in total deaths April 2020 vs 2015-2019
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Region dropped							
Marche	126.575***	79.339	56.206	302.439	-0.022	0.170*	0.124
	(45.874)	(74.827)	(143.574)	(184.902)	(0.027)	(0.084)	(0.089)
Liguria	159.312***	228.708	52.293	504.912**	0.022	0.368**	0.184*
	(47.471)	(144.420)	(136.870)	(216.791)	(0.033)	(0.171)	(0.102)
Piemonte	148.956**	367.838**	110.496	591.268**	0.015	0.472**	0.231*
	(60.661)	(143.510)	(190.656)	(271.245)	(0.047)	(0.215)	(0.126)
Trentino A.A.	172.308***	239.270*	58.439	520.541**	0.018	0.406**	0.171
	(48.243)	(141.629)	(129.808)	(218.403)	(0.029)	(0.166)	(0.108)
Friuli V.G.	171.416***	232.307*	100.518	559.378**	0.006	0.383**	0.206*
	(48.606)	(125.029)	(106.972)	(229.518)	(0.030)	(0.164)	(0.104)
Abruzzo	167.647***	233.251*	55.760	500.309**	0.008	0.376**	0.196*
	(46.013)	(136.348)	(127.610)	(216.389)	(0.031)	(0.167)	(0.101)
Basilicata	169.430***	241.681*	59.467	510.655**	0.008	0.383**	0.204*
	(47.001)	(137.181)	(124.849)	(212.881)	(0.032)	(0.165)	(0.103)
Calabria	177.611***	287.520*	-47.734	437.575*	0.008	0.421**	0.215*
	(52.618)	(149.325)	(139.176)	(229.312)	(0.036)	(0.185)	(0.118)
Campania	169.335***	244.191*	33.768	486.597**	0.010	0.389**	0.187*
	(48.169)	(134.136)	(116.789)	(224.345)	(0.031)	(0.166)	(0.106)
Lazio	166.120***	235.989	66.844	529.403**	0.030	0.406**	0.199
	(51.508)	(154.009)	(142.805)	(240.635)	(0.031)	(0.177)	(0.121)
Molise	170.200***	242.692*	74.260	525.070**	0.008	0.384**	0.204*
	(47.214)	(138.361)	(127.448)	(214.978)	(0.032)	(0.167)	(0.105)
Puglia	166.881***	231.560	59.960	502.840**	0.008	0.372**	0.188*
	(48.609)	(146.094)	(127.569)	(213.056)	(0.032)	(0.177)	(0.106)
Sardegna	172.992***	246.306*	80.061	534.589**	0.009	0.387**	0.206*
	(48.255)	(139.500)	(123.643)	(225.675)	(0.028)	(0.169)	(0.105)
Sicilia	192.248***	257.704*	161.763	657.015***	0.012	0.417**	0.263**
	(45.376)	(143.659)	(117.039)	(213.577)	(0.029)	(0.174)	(0.106)
Toscana	210.574***	288.978	-89.541	428.250	-0.006	0.457**	0.237*
	(44.818)	(192.847)	(166.653)	(275.196)	(0.039)	(0.187)	(0.140)
Umbria	169.528***	242.560*	68.424	516.447**	0.010	0.383**	0.206*
	(47.116)	(138.291)	(123.773)	(211.052)	(0.030)	(0.167)	(0.103)
Region FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Provincial controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: each row corresponds to a separate set of estimations that excludes provinces belonging to the region stated on the left column. Mean of dependent variable, R-squared and number of observations are omitted to keep the table readable. Province controls as in Table 1. Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table A.8: Exposure to other regions and deaths

Dep variable	Number of Covid deaths 20Feb-31Mar 2020	Number of Covid deaths 20Feb-31Mar 2020	Number of Covid deaths 01Apr-30Apr 2020	Number of Covid deaths 01Apr-30Apr 2020	Growth of total deaths March 2020 vs 2015-2019	Growth of total deaths March 2020 vs 2015-2019	Growth of total deaths April 2020 vs 2015-2019	Growth of total deaths April 2020 vs 2015-2019
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln(Exposure To..								
Lombardia)	94.935**	-136.221**	40.023	-503.110***	0.128	-0.586***	0.111	-0.174
	(44.731)	(50.908)	(75.026)	(109.366)	(0.097)	(0.162)	(0.087)	(0.166)
Emilia-Romagna)	118.337***	50.799	259.808**	200.734**	0.343**	0.221	0.170*	0.100
	(39.869)	(34.393)	(112.512)	(92.022)	(0.153)	(0.133)	(0.096)	(0.103)
Veneto)	76.763	-0.039	-73.113	-202.520	0.021	-0.168	0.116	0.026
	(61.938)	(54.640)	(132.014)	(159.740)	(0.132)	(0.170)	(0.100)	(0.105)
Marche)	16.681	2.644	70.204*	64.430	0.094**	0.079**	0.042	0.029
	(22.852)	(19.772)	(37.015)	(38.376)	(0.039)	(0.039)	(0.043)	(0.043)
Liguria)	10.927	-4.353	54.998*	34.670	-0.001	-0.037	-0.015	-0.034
	(20.319)	(18.072)	(32.458)	(33.288)	(0.050)	(0.048)	(0.037)	(0.037)
Piemonte)	37.145	-27.871	75.758	-90.007	0.070	-0.152	0.115	0.033
	(25.821)	(31.480)	(64.543)	(82.067)	(0.091)	(0.098)	(0.098)	(0.130)
Valle D'Aosta)	13.530	17.612	-7.273	-1.659	0.042	0.051	-0.023	-0.018
	(16.689)	(13.947)	(33.225)	(34.368)	(0.051)	(0.048)	(0.044)	(0.042)
Trentino A.A.)	74.424	2.660	105.667	6.504	0.172	0.003	0.019	-0.064
	(55.076)	(40.370)	(89.928)	(62.037)	(0.138)	(0.085)	(0.098)	(0.091)
Friuli V.G.)	4.844	-1.772	-69.184	-78.234	0.048	0.033	-0.180*	-0.189**
	(40.397)	(32.867)	(71.892)	(65.067)	(0.124)	(0.115)	(0.097)	(0.088)
Abruzzo)	-31.167	-24.328	-45.786	-36.285	-0.085	-0.070	-0.050	-0.042
	(34.578)	(26.442)	(60.685)	(44.010)	(0.102)	(0.080)	(0.046)	(0.037)
Basilicata)	22.333	21.824*	21.174	20.448	0.070*	0.069*	0.030	0.029
	(16.666)	(12.173)	(25.873)	(24.936)	(0.041)	(0.035)	(0.030)	(0.030)
Calabria)	30.633	24.431	8.332	-1.815	0.068	0.053	0.044	0.036
	(33.747)	(23.089)	(62.302)	(48.422)	(0.081)	(0.067)	(0.070)	(0.061)
Campania)	45.093	36.752*	20.282	8.099	0.119	0.100	0.028	0.019
	(30.985)	(20.933)	(50.544)	(41.887)	(0.073)	(0.060)	(0.067)	(0.065)
Lazio)	-27.725	-21.340	-109.044	-100.147*	-0.055	-0.039	-0.111	-0.103
	(36.196)	(26.244)	(65.648)	(59.015)	(0.104)	(0.078)	(0.080)	(0.073)
Molise)	0.490	-9.162	23.202	10.234	0.020	-0.001	0.009	-0.003
	(11.238)	(10.111)	(22.613)	(22.350)	(0.026)	(0.027)	(0.026)	(0.024)
Puglia	20.220	27.115	-19.038	-9.602	0.069	0.085	-0.082	-0.074
	(26.352)	(17.922)	(44.037)	(45.093)	(0.064)	(0.055)	(0.062)	(0.056)
Sardegna)	13.713	30.386	-93.484	-70.859	-0.009	0.028	-0.064	-0.045
	(33.176)	(24.960)	(98.117)	(96.658)	(0.105)	(0.094)	(0.072)	(0.067)
Sicilia)	64.756	41.058	-34.984	-68.508	0.133	0.082	-0.004	-0.038
	(57.971)	(41.481)	(125.468)	(101.205)	(0.174)	(0.132)	(0.102)	(0.091)
Toscana)	-30.825	5.257	-62.937	-14.652	-0.083	-0.005	-0.153**	-0.119*
	(25.584)	(21.438)	(54.792)	(52.906)	(0.076)	(0.072)	(0.065)	(0.062)
Umbria)	8.308	2.395	-35.445	-44.202	0.019	0.006	-0.009	-0.017
	(17.634)	(11.263)	(34.948)	(27.060)	(0.032)	(0.025)	(0.041)	(0.033)
any province)	-20.896	-127.134**	-101.810	-253.286*	-0.086	-0.326*	0.018	-0.110
	(44.824)	(48.356)	(81.008)	(140.031)	(0.127)	(0.173)	(0.105)	(0.128)
Region FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Provincial controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ln(Exposure To Outbreak)		Yes		Yes		Yes		Yes

Notes: each row corresponds to a separate set of estimations that replaces "Exposure To Outbreak" with exposure to a given region. Provinces located in that region are excluded from the sample. Columns 2, 4, 6 and 8 include ln(Exposure to Outbreak) as control. Mean of dependent variable, R-squared and number of observations are omitted to keep the table readable. Province controls as in Table 1, except for the last row (where overall propensity to migrate is shown explicitly). Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table A.9: Robustness test: does within-province mobility matter?

	(1)	(2)	(3)	(4)	(5)	(6)
PANEL A: COVID DEATHS						
Dep var.	Number of deaths 20Feb-31Mar	Number of deaths 20Feb-31Mar	Number of deaths April	Number of deaths April	Number of deaths May	Number of deaths May
ln(Exposure To Outbreak)	99.376*	93.033*	-72.239	-83.298	-10.772	-18.001
	(50.937)	(52.136)	(108.350)	(110.836)	(61.085)	(59.906)
IHS(# trips from outbreak areas)	47.225*	50.926*	211.723***	218.175***	26.738	30.956
	(27.253)	(27.026)	(61.626)	(63.352)	(22.784)	(22.741)
IHS(# trips w/i own province)		-34.728		-60.540		-39.579
		(48.391)		(91.653)		(50.504)
Mean	86.968	86.968	155.054	155.054	45.430	45.430
R-squared	0.923	0.924	0.884	0.885	0.790	0.795
PANEL B: TOTAL DEATHS						
Dep var.	Number of deaths 20Feb-31Mar 2015-2019	Number of deaths 20Feb-31Mar 2020	Growth of deaths Jan-Feb 2020 vs 2015-2019	Growth of deaths March 2020 vs 2015-2019	Growth of deaths April 2020 vs 2015-2019	Growth of deaths May 2020 vs 2015-2019
ln(Exposure To Outbreak)	0.097	0.098	0.041	0.006	0.119	0.102
	(0.124)	(0.131)	(0.112)	(0.107)	(0.081)	(0.077)
IHS(# trips from outbreak areas)	0.193**	0.192*	0.110**	0.130***	-0.026	-0.017
	(0.089)	(0.096)	(0.050)	(0.046)	(0.035)	(0.035)
IHS(# trips w/i own province)		0.006		-0.189		-0.091
		(0.158)		(0.121)		(0.077)
Mean	0.203	0.203	0.167	0.167	-0.048	-0.048
R-squared	0.907	0.908	0.928	0.931	0.662	0.671
Region FEs	Yes	Yes	Yes	Yes	Yes	Yes
Province controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	76	76	76	76	76	76

Notes: trips from outbreak areas and within own province are per 1000 inhabitants. "Exposure To Outbreak" is the number of people who moved from the province to one of the outbreak areas during 2015-2018 (per 1000 inhabitants). Province controls as in Table 1. Robust standard errors in brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.1$