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Working Paper

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Working Paper, No. 2012

Provided in Cooperation with:

Koç University - TÜSİAD Economic Research Forum, Istanbul

Suggested Citation: Bilgin, Nuriye Melisa (2020) : Tracking COVID-19 spread in Italy with mobility data, Working Paper, No. 2012, Koç University-TÜSİAD Economic Research Forum (ERF), Istanbul

This Version is available at:

<https://hdl.handle.net/10419/227919>

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KOÇ UNIVERSITY-TÜSİAD ECONOMIC RESEARCH FORUM
WORKING PAPER SERIES

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Working Paper No: 2012
May 2020

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Tracking COVID-19 Spread in Italy with Mobility Data

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May 25, 2020

Abstract: This paper provides insights for policymakers to evaluate the impact of staying at home and lockdown policies by investigating possible links between individual mobility and the spread of the COVID-19 virus in Italy. By relying on the daily data, the empirical evidence suggests that an increase in the number of visits to public spaces such as workspaces, parks, retail areas, and the use of public transportation is associated with an increase in the positive COVID-19 cases in a subsequent week. On the contrary, the increased intensity of staying in residential spaces is related to a decrease in the confirmed cases of COVID-19 significantly. Results are robust after controlling for the lockdown period. Empirical evidence underlines the importance of the lockdown decision. Further, there is substantial regional variation among the twenty regions of Italy. Individual presence in public vs. residential spaces has a more significant effect on the number of COVID-19 cases in the Lombardy region.

Key Words: COVID-19, Coronavirus, Italy, Regional Heterogeneity, Mobility

JEL codes: I10; I18; I31.

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1 Introduction

There is a heated debate about the necessity of lockdown measures all over the world. Interestingly, the implementation of these measures to fight against infectious diseases is not new. The word “quarantine” dates back to 700 years of its Italian origin for forty days: “quarantine giorni” when ships arriving in Venice were required to wait for forty days before landing to the city. Today, COVID-19 spread to a much more globalized world. COVID-19 has been infected more than four million people all over the globe with significant damage to Italy. Two weeks after reporting its first death, Italy established a lockdown policy to control the spread. Still, these measures were not able to decrease the losses.

This paper focuses on understanding the link between individual presence in public spaces and the spread of COVID-19. For this reason, the data for both number of positive verified cases and mobility across different spaces collected for each region of Italy on daily frequency. The regional-level mobility data, provided by Google (2020), constructed with the aggregation of the location histories of the anonymized sets of data from users in the regions. In this way, this paper tracks the changes in confirmed COVID-19 cases with the individual presence in public and residential spaces.

Empirical evidence suggests that the increase of duration of the stay in the transit stations, retail, workplaces, and parks is positively associated with the number of confirmed cases in the subsequent week. Conversely, the expanding population density in residential areas, which can be a proxy for staying at the home policy, reduces the number of reported cases. Therefore, the impact of complying with the social isolation measures slows down the COVID-19 spread significantly. Interestingly, places like grocery markets and pharmacies, have no significant relation to spread. Nevertheless, after introducing the lockdown dummy, results point that visits to groceries and pharmacies can also lead to propagation areas of the disease.

While tracking the spread with the mobility measures, it is essential to control for the lockdown periods. By relying on the SIER model, Favero (2020) reports the reproduction numbers of 2.2 for pre-lockdown and 0.95 for the post-lockdown in Italy. Besides, Engle et al. (2020) presents how stay at home restrictions reduce mobility more than seven percent in the U.S. Studies are also pointing to the regional characteristics of the contagion in Italy. Kuchler et al. (2020) provides evidence on how social connectedness may induce the spread with a particular focus on Lodi comune. Accordingly, this study tracks the COVID-19 spread in Italy at a regional level. The results suggest a regional heterogeneity among the twenty regions of Italy.

The link between mobility and spread of COVID-19 also studied in Yilmazkuday (2020), which shows that less movement associated with lower COVID-19 cases and deaths among 127 different countries. Nevertheless, it might be too general to investigate the spread at the county level for policy recommendation purposes without considering lockdown controls. Going one step further, this study tracks the COVID-19 spread in Italy at a regional level and assess the impact of lockdown policies.

2 Data and Empirical Methodology

COVID-19 pandemic in Italy first reported among the two Chinese tourists in Rome who confirmed to be positive on the 31th of January. Still, the cluster of the multiple confirmed cases reported first in Lombardy on the 21th. In 22th of February, Italy reported the first death due to coronavirus. Following these developments, the government of Italy imposed a lockdown policy for northern and central provinces, including Lombardy, Piedmont, Emilia-Romagna, Veneto, and Marche on the 8th of March. Further, the lockdown decision extended to the whole country two days later. Still, the cases reported increased day by day. Figure 1 presents the cumulative number of daily positive cases reported in Italy starting from 24th of February to 17th of April. This data aggregated

for daily confirmed cases for 20 different ¹ Italian regions. The COVID-19 data collected from the Italian Dipartimento della Protezione Civile covers the dates from February 24th to April 17th.

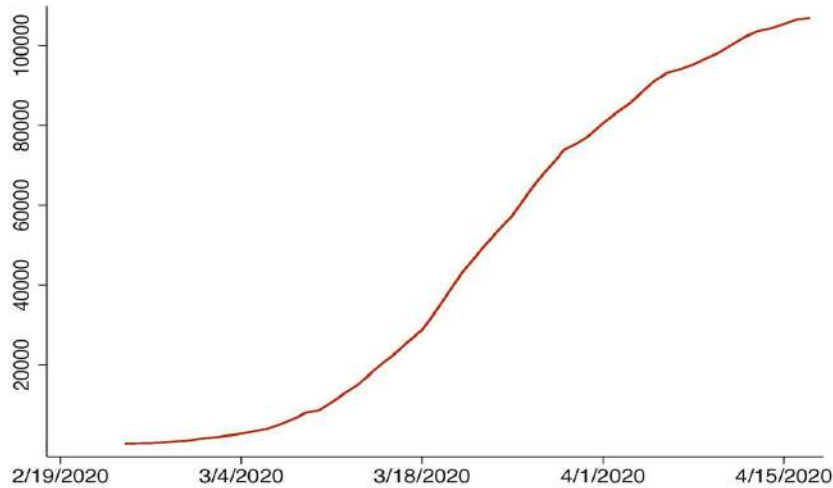


Figure 1: Cumulative Number of Daily Confirmed in Italy. *Notes: The data derived from the Dipartimento della Protezione Civile (Civil Protection Department) of Italy.*

The crucial part of this research is to track the movement trends by comparing the population densities at six distinct areas classified by Google Maps. The daily data for these trends at the regional level provided by Google (2020) and Chan et al. (2020). The construction of these measures relies upon the location histories of the individuals. For each day, this data aggregated and anonymized among the sets of users to track the trends. The six distinct zones are Retail & Recreation, Grocery & Pharmacy, Parks, Workplaces, Transit Stations, and Residential Areas. Trends for Transit Stations cover the public transport hubs by incorporating subway, bus, and train stations. Retail & Recreation data refers to the mobility trends of spaces of gathering, including restaurants, cafes, and shopping centers.

Figure 2 exhibits shifts in mobility for the six public or residential spaces in Italy. These indices aggregated for 20 different regions to inspect the general picture in during pre- and post-lockdown. Thus, Figure 2 covers the dates from the 16th of February to

¹There are twenty regions of Italy which are the first-level constituent parts including: Abruzzo, Aosta, Apulia, Basilicata, Calabria, Campania, Emilia-Romagna, Friuli-Venezia Giulia, Lazio, Liguria, Lombardy, Marche, Molise, Piedmont, Sardinia, Sicily, Trentino-South Tyrol, Tuscany, Umbria, Veneto

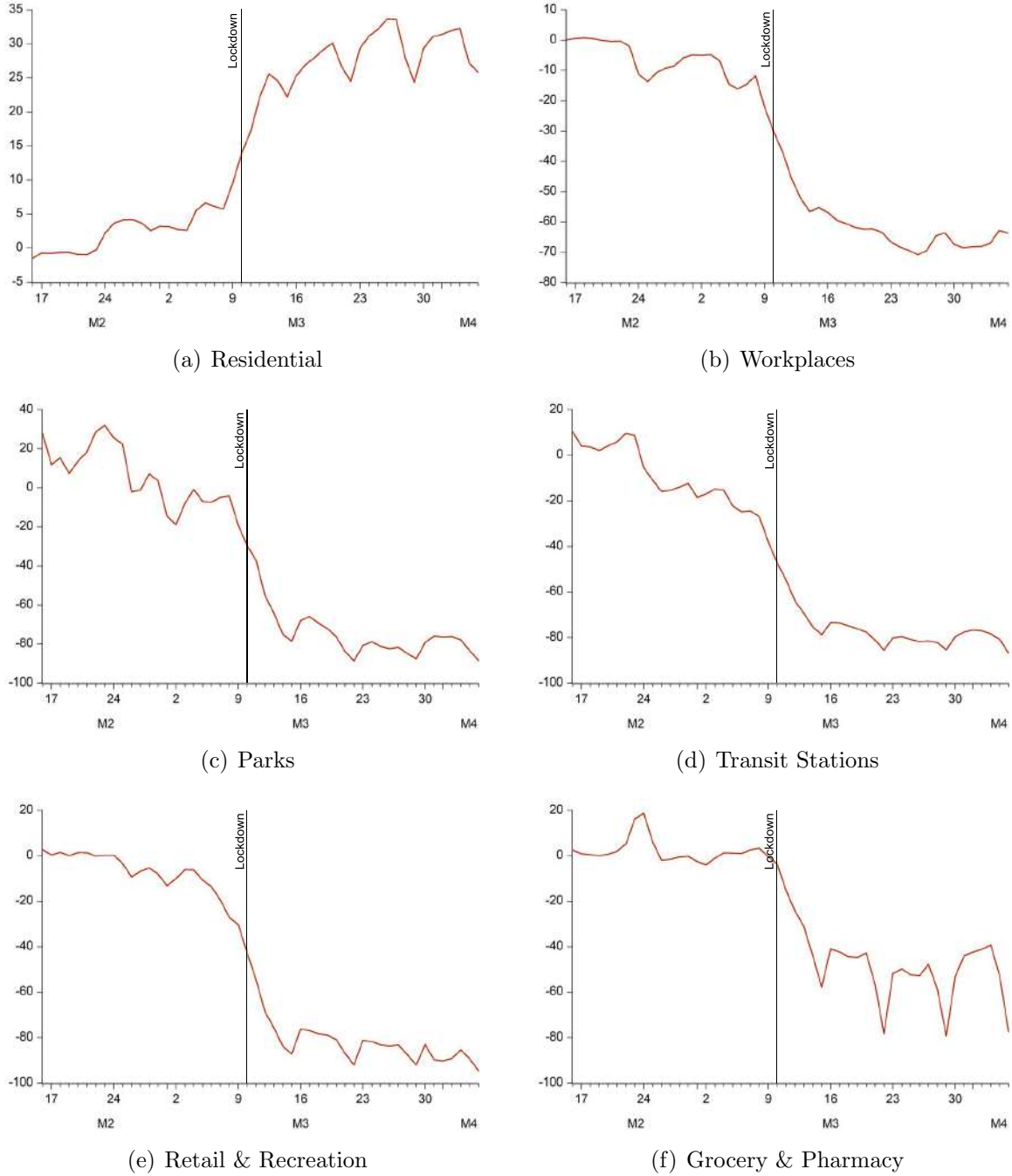


Figure 2: Google Mobility Reports for Italy

Notes: The calculation of these measures based on the aggregation of the regional-level data for Italy.

5th of April. In February 23th, schools closed with the suspension of public events in Lombardy, Veneto, Friuli-Venezia Giulia, and Emilia-Romagna regions in with the rise in the number of cases. After this date, mobility trends changes in an unexpected direction, as shown in Figure 2. The time spent in the parks and public transportation stations

increased abnormally more than their typical values following the announcement. The mobility index remained almost constant for the restaurants, cafes, and shopping centers presented in the Retail & Recreation group. There was a drop in the workplaces following the suspensions and jump in groceries & pharmacies, as anticipated. The time spent in residential areas increased, but it is almost negligible as compared to lockdown.

It was until the lockdown announcement to achieve radical increases in the residential areas. Not surprisingly, following the lockdown period, not only the time spent at the residential places grow. During the national lockdown, only locations for requirements continue to operate, mostly classified as Grocery & Pharmacy. The mobility index that corresponds to public spaces such as parks, transit stations, and retails are close to -100 following the lockdown.

This paper aims to evaluate how much of the density among different spaces associated with the number of positive cases in Italy. With the mobility trend changes shown in Figure 2, these concerns lead to the following designation of regressions to determine the spread of COVID-19 through mobility in these locations:

$$\Delta P_{r,t} = \beta_0 + \beta_1 \Delta M_{r,t-7} + l_{r,t} + \gamma_r + \epsilon_{r,t} \quad (1)$$

where $\Delta P_{r,t}$ is the dependent variable, which defined as the weekly changes of the positive cases, explanatory variables defined as $\Delta M_{r,t-7}$, and these are the weekly changes of mobility indices. Since the coronavirus symptoms can take a while, we use seven days of lagged mobility data. The regional characteristics of the regions captured with r , also l is the lockdown dummy. In this specification, the main interest is whether changes in positive cases of COVID-19 is related to the visits to various locations. To be more precise, we are checking whether there is a relation between these measures by concerning the regional differences and lockdown period.

3 Results

This section illustrates the empirical evidence for how stay at home precautions and lockdown policies help to fight against the spread of the virus. Results calculated by daily panel regression of the positive cases on the one week lagged measures of mobilities in each region with region fixed effects. In this way, estimations present how the changing population density in various spaces determines the number of recorded cases in the subsequent week in Table 1.

Table 1: Confirmed COVID-19 Cases and Mobility Measures

	[1]	[2]	[3]	[4]	[5]	[6]
Residential	-0.89*** (0.15)					
Workplaces		0.31** (0.06)				
Parks			0.15*** (0.04)			
Transit Stations				0.52*** (0.07)		
Retail and Recreation					0.23*** (0.06)	
Grocery & Pharmacy						0.10 (0.06)
Regional	Y	Y	Y	Y	Y	Y
R ²	0.54	0.54	0.53	0.56	0.54	0.53
Obs.	840	840	840	840	840	840

Notes: This table presents estimates of the confirmed COVID-19 cases regressions on different mobility measures. All regressions include fixed effects for different regions. The robust standard errors reported in parentheses. ***, **, and * indicate the significance at the 1%, 5% and 10% levels, respectively.

According to this table, only being in the locations defined as the residential places tends to reduce the number of reported COVID-19 cases. In contrast, other areas, including workplaces, parks, transit stations, and retail recreation, are positively associated with the reported spread of this infection. The empirical evidence in Table 1

suggests that the rise in the residential spaces led to a reduction in the number of reported positive COVID-19 cases. Among the other places, an increment in the public transportation hubs led to the most leading number of reported cases as opposed to the remaining places followed by workplaces, parks, and retail areas. Further, changes in

Table 2: Confirmed COVID-19 Cases and Mobility Measures with the Lockdown Control

	[1]	[2]	[3]	[4]	[5]	[6]
Residential	-1.06*** (0.17)					
Workplaces		0.38** (0.07)				
Parks			0.19*** (0.05)			
Transit Stations				0.49*** (0.06)		
Retail and Recreation					0.34*** (0.04)	
Grocery & Pharmacy						0.24*** (0.06)
Lockdown	-2.36*** (0.29)	-2.31*** (0.29)	-2.31*** (0.30)	-2.03*** (0.26)	-2.52*** (0.31)	-2.46*** (0.31)
Regional	Y	Y	Y	Y	Y	Y
R ²	0.58	0.57	0.58	0.59	0.58	0.57
Obs.	840	840	840	840	840	840

Notes: This table presents estimates of the confirmed COVID-19 cases regressions on different mobility measures by controlling the dates for lockdown in Italy. All regressions include fixed effects for different regions. The robust standard errors reported in parentheses. ***, **, and * indicate the significance at the 1%, 5% and 10% levels, respectively.

visits to supermarkets and groceries have no significant effect on the number of reported cases. Nevertheless, this specification misses one specific aspect of the mobility trends: The periods covering pre- or post-lockdown can affect the results.

A dummy captures the period through lockdown used to control for the pre- and post-lockdown dates. The dummy changes according to each lockdown date of the region. During this period, the government only allowed exceptions regarding movements for

the purchase of food and medicines. Table 2 repeats the same exercise by controlling for the lockdown period. There are distinctive features of this estimation. The most important point to underline is that the lockdown dummy is significant, and it has the most considerable influence on the decrease of the reported cases. Another point to mark is that after the introduction of the lockdown dummy, the visits to places covering markets and pharmacies become significant. Still, results are robust after controlling for the lockdown period.

Individual presence in public vs. residential spaces has a more significant effect on the number of COVID-19 cases in the Lombardy region

4 Regional Heterogeneity

The previous measures evaluated with the fixed effects to cover the regional differences or cluster of the first occurrence of the disease. Figure 3 is a heat map showing the number of confirmed cases for twenty administrative regions in Italy. Furthermore, Figure 4 reveals the significant coefficients of the regressions of new cases on the changes in the residential mobility index. These residential areas identified by Google Maps and used as a proxy for stay at home precautionary measures for each region in Italy.



Figure 3: Total Positive Cases Reported in Each Region *The data derived from the Dipartimento della Protezione Civile (Civil Protection Department) of Italy.*

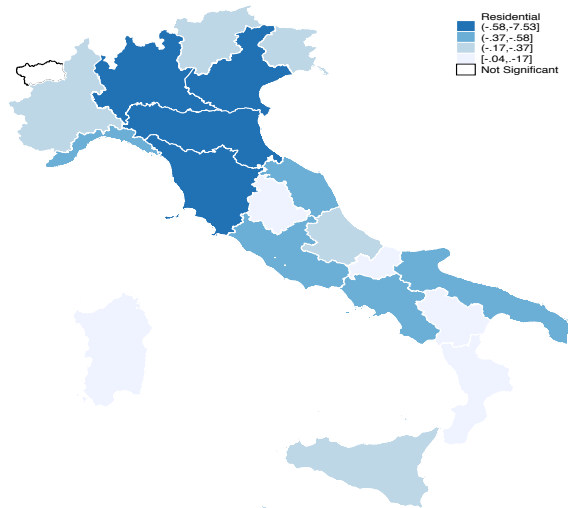


Figure 4: Impact of Increasing Presence in the Residential Areas *Regressions of the number of new cases on the changes in the seven days lagged residential mobility for each region. Only significant coefficients colored.*

Table 3: COVID-19 Cases and Mobility Measures in Lombardy

	[1]	[2]	[3]	[4]	[5]	[6]
Residential	-7.53*					
	(2.93)					
Workplaces		3.26*				
		(1.41)				
Parks			0.42			
			(0.49)			
Transit Stations				4.59***		
				(0.99)		
Retail and Recreation					2.52**	
					(0.91)	
Grocery & Pharmacy						0.59
						(1.11)
Regional	Y	Y	Y	Y	Y	Y
R ²	0.12	0.10	0.01	0.34	0.11	0.00
Obs.	42	42	42	42	42	42

Notes: This table presents estimates of the confirmed COVID-19 cases regressions on different mobility measures in Lombardy region. The robust standard errors reported in parentheses. * * *, **, and * indicate the significance at the 1%, 5% and 10% levels, respectively.

Both of these maps hint at the regional heterogeneity, and how increasing presence in residential areas with lockdown policies related to the spread of disease. As foreseen, the consequence of these procedures is more distinguished for regions that report more cases. All in all, Lombardy is the region of interest by being the center of disease propagation.

Having highlighted the regional differences in the propagation of the COVID-19 for the Lombardy region, this exercise inspects whether visits to different areas have a distinct impact on the primary region. Thus, the empirical analysis repeated by only considering the Lombardy region. Tables 3 and 4 present the results for Lombardy with and without controlling for lockdown.

Table 4: COVID-19 Cases and Mobility Measures in Lombardy with Lockdown Control

	[1]	[2]	[3]	[4]	[5]	[6]
Residential	-5.10 (2.52)					
Workplaces		2.01 (1.21)				
Parks			0.55 (0.53)			
Transit Stations				2.95** (0.99)		
Retail and Recreation					2.06** (0.79)	
Grocery & Pharmacy						1.41 (0.85)
Lockdown	-1.89*** (0.14)	-1.69*** (0.15)	-1.87*** (0.22)	-1.13*** (0.19)	-1.75*** (0.19)	-1.96*** (0.27)
Regional	Y	Y	Y	Y	Y	Y
R ²	0.37	0.36	0.34	0.41	0.39	0.35
Obs.	42	42	42	42	42	42

Notes: This table presents estimates of the confirmed COVID-19 cases regressions on different mobility measures by controlling the dates for lockdown in Lombardy region. The robust standard errors reported in parentheses. ***, **, and * indicate the significance at the 1%, 5% and 10% levels, respectively.

Like the whole country, the rise of the population density in the residential areas negatively correlated to the number of cases. Similar to the previous results, regions identified as public transportation hubs, workspaces, and the retail areas can induce the cases reported after seven days. Yet, in each case, lockdown yields to lower cases for the Lombardy region. Unlike all parts reported in 2, only retail and transportation zones positively associated with the spread.

5 Concluding Remarks

This study provides insights for policymakers to evaluate the impact of stay at home and lockdown policies on the spread of the COVID-19. It starts by tracking the changes in

daily mobility across different public and individual spaces. This information enables us to investigate how population changes in various spaces alter the propagation. By controlling for regional differences and lockdown periods, the increase in visits and duration of stay in residential areas decrease the number of cases significantly. Conversely, the empirical evidence suggests that time spent in public spaces, such as workspaces, parks, retail areas, and public transportation, is linked with an increase in the number of reported cases.

The empirical evidence also points out the effect of the lockdown period. After introducing the lockdown dummy, results point that visits to groceries and pharmacies are part of propagation areas of the disease. The other results are robust to lockdown control. There is also regional heterogeneity on disease propagation across Italy, especially for the Lombardy region.

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