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A Synthetic Index on the COVID19 Impact on Italian Regions

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A Synthetic Index on the COVID 19 Impact on Italian Regions

Giorgia Giovannetti[$], Filippo Santi[$], Margherita Velucchi[&]

Abstract

The COVID 19 pandemic has generated a worldwide health and economic crisis. Italy has been the first OECD country to be hit at the end of February 2020 and therefore the first to decide on the measures to contrast it. From March 10 to May 18, 2020 Italy locked down the entire country. It was a Governmental emergency decision, taken to limit the spreading of the pandemic, to reduce its impact on the health system and to protect the population. Health was considered the top priority in front of the exponentially increasing numbers of cases and deaths. Different regions in Italy were hit with different strengths, with on average northern regions more affected. This paper studies the evolution of the COVID 19, based on the burden it imposed over the regional health system during that first wave of the COVID 19 pandemic. Relying on detailed regional information, we calculate a measurable and comparable metric to track the evolution of the pandemic across region, over the entire lockdown period in Italy. We propose two different indices, one with fixed base and one with a mobile base, highlighting and comparing two different perspectives over the same phenomenon and showing how different regions have been hit by the pandemic. These indices could also be used in a comparative and long run perspective analyzing different countries and phases of the pandemic over time and possible reaction curves.

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1. Introduction

The COVID 19 pandemic has triggered a worldwide health and economic crisis and is a major source of uncertainty for the global economy. In the attempt to mitigate and contain the virus, different countries introduced different policies to restrict foreign and countrywide travel, close businesses and schools, trace and quarantine individuals at risk of contracting the virus, and require mandatory masks and gloves. A country's ability to treat those infected by the virus and protect health care workers varied significantly, given differences in health care capacity. What is true between countries, is also true within countries. Often lockdown and measures were specific for regions[1].

Italy was the first OECD country to be severely hit at the end of February 2020 and therefore the first beside China and Korea to devise containment measures. On March 9, 2020 a decree was released on the website of the Italian Ministry of Health, limiting the movement of individuals in the whole Italian national territory unless strictly motivated by reasons of work or health. Schools, universities, museums, cinemas, theatres, and any other social, recreational, or cultural center had to close. Any assembly in public spaces was forbidden, including sporting events, weddings and funerals. Most shops and other forms of productive activities were also forced to suspend operations. Those selling essentials, such as supermarkets or pharmacies, could remain open, but had to comply with strict regulations: a minimum distance among customers, restricted entry, sanitation of shops etc. These measures were without precedent and aimed at containing (COVID 19 in Italy, after the initial exponential growth in the number of infected people recorded in the previous week (culminated with a 100% increase in the number of deaths in the 48 hours before the decree).[2] The complete lockdown lasted almost three months, until May, 18th , when the number of new cases stabilized (temporarily), and containment measures where gradually lifted. A slow and cautious process of re-opening began (named "Phase II"), with a continuous monitoring of the epidemic curve. Up to August 13, 2020, Italy had 252000 total certified infected and 35225 deceased[3].

The social, economic and psychological impact of the Italian lockdown has been enormous and is still largely to be fully investigated. The economic and epidemiological literature started analyzing the main effects of the lockdown, also in view of the expected second wave, in the fall (October, 2020. See for instance, Chintalapudi et al., 2020; Wu et al., 2020; Gatto et al., 2020). An analysis of

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[1] For instance, in China, at the start of the pandemic, "the strictest control measures were applied in Wuhan with a complete lockdown of the population. Starting at 10 a.m. on 23 January 2020, Wuhan city officials prohibited all transport in and out of the city of 9 million residents. Within the rest of China, the interventions included nationwide traffic restrictions in the form of increased checkpoints at road junctions to reduce the number of people travelling and self-isolation of the population at home to reduce outside activities. Hundreds of millions of Chinese residents had to reduce or stop their inter-city travel and intra-city activities due to these measures" Zhemin Yuan et al, 2020, p. 1

[2] With the number of cases keeping to go up in the following weeks, new restrictions followed. The number of positive cases, as of March 16 counted 27980 cases, almost 3 times higher than it was just 1 week before (10149 cases recorded on March 10). Even if the sharp increase reflected both the incubation period of the virus and the increase in swab tests, the figure tells a lot about the pressure the Italian Health system was subject to at the time.

[3] Data stabilized at the end of the summer, but in October 2020 they started increasing again at an exponential rate. Different regional measures are in place at the moment of writing (end of November 2020), depending on a very high number of parameters (21) used by the Ministry of Health (DCPM, April 30th 2020, https://www.trovanorme.salute.gov.it/norme/renderNormsanPdf?anno=2020&codLeg=77099&parte=1%20&serie=null in Italian).

these complex impacts is outside the scope of this note, where we aim at providing some new statistical evidence at regional level for the Phase-1 lockdown.

Exploiting epidemiological distribution data collected by the Italian authorities, this note studies the regional evolution of the COVID 19 pandemic in Italy during the national lockdown, enforced between March, 9th and May, 18th (though inter-regional mobility was limited until June, 1st 2020). In particular, the note investigates the strength and the severity of the infection exploiting the regional variation in terms of both contagion and pressure on the regional health system. We apply the Balanced Worth methodology (Herrero et al., 2018) to compute a regional measure of severity for the pandemic based on measurable outcomes of the infection (namely, the number of deaths, Intensive Care Unit (ICU) patients, hospitalized patients, and cured people). We then use such a measure to build a Gross Index of COVID 19 infectivity. Our approach, though similar to Herrero and Villar (2020), differs from the index they propose and apply to the case of Spain with respect to both the perspective and the representation adopted to discuss the index. More precisely, we compute the Covid19 indices across regions over time, rather than within region over time, as they do. In addition, to better capture the heterogeneous spread of the pandemic we propose two alternative representation of the index, that give us a more detailed representation of the impact of the pandemic over time. Section 2 expands on the methodology followed to ensure replicability.

2. The Methodology

The objective of this note is to comparatively highlight the heterogeneous evolution of the infection as experienced in the different Italian regions during that period, to provide a measure of regional exposure to COVID 19. Over the last few months, many models have been developed to describe the course of the COVID 19 pandemic at national level or at the global scale. No univocal consensus has been achieved on the different compartments that should be included in a proper model. In this note, we follow the Balanced Worth (hereafter, BW) methodology proposed by Herrero et al. (2013, 2018) to compute an index of severity of the infection at regional level. The idea behind the BW is that it is possible to weight and aggregate any ordinal set of related achievements (in our cases, stages of a pandemic), to obtain a measure of pervasiveness/severity for a given phenomenon of interest. In a nutshell, the BW compares the probability for an individual randomly extracted from the population of interest to end up in a stage that is relatively worse than the one the same individual could experience should he belong to a different population. We compute the BW vector to obtain a day-by-day measure of severity of the infection at regional level for our period of interest. We then use it to build an index of pervasiveness of COVID 19, by weighting severity by a measure of the scope of the infection at regional level (overall number of cases over regional population).

$$Gross\ Index_{r,d} = Severity_{r,d} * Incidence_{r,d} = Severity_{r,d} * \frac{Affected\ Population_{r,d}}{Population_{r,d}}$$

The Gross Index of COVID 19 infectivity that we obtain in this way is comparable in what concerns both the behavior and the temporal trend, to the one reported by Herrero and Villar (2020) for the Spanish regions.[4]

2.1 The Proposal: a COVID Index Revised

As mentioned above, we partially depart from Herrero and Villar (2020), since we compute the severity component of the Gross Index as a repeated daily cross-section rather than as a list of time series: in other words, we compute the BW among regions across time, rather than within regions over time.

To better capture the heterogeneous spread of the pandemic across each and every Italian region and time, we compute the index applying two different bases, a fixed and a mobile one. The two alternative representations have different statistical and explanatory characteristics and we maintain that their comparison allows to get better insights over the evolution of the pandemic over time. We believe the two indices should be jointly investigated and considered since their joint comparison can offer a more comprehensive view on the pandemic.

Fixed Base Index (FBI)

We build the Fixed Base Index as:

$$FBI_{r,d} = \frac{Gross\ Index_{r,d}}{Gross\ Index_{r,d=March,7}} * 100$$

The FBI assumes the value of the index for each region in March 7 as its base value (100). This decision implies that we show the regional trend starting from the early days of the pandemic. In terms of behavior, the index has an exponential growth in the early period of our analysis, reaching a plateau (or even a reversed trend) at the end of the lockdown in all regions. However, since the base is not Italy but each individual region, the pattern (and the scale) is very different across regions and offers a region-specific, long run perspective on the behavior of the pandemic. As a drawback, the FBI index strongly depends on the choice of the day considered as a base.[5]

Mobile Base Index (MBI)

The MBI is computed by comparing the Gross COVID 19 index with its 1-day lagged value.

$$MBI_{r,d} = \frac{Gross\ Index_{r,d}}{Gross\ Index_{r,d-1}} * 100$$

The adoption of a rolling base offers a short run representation that is, a conjunctural view on the pandemic's evolution. As we could expect retrospectively, the behavior of the mobile index shows that each region reached the peak of infections in different moments over the observed lockdown period.

[4] Even thought, because of data consistency issues, the comparable period is limited to a shorter time span.

[5] For the purpose of this note, the base has been chosen to emphasize the effect of the pandemic, starting from the first day of lockdown. In this sense, the index gives a clear insight of the spread and recovery behavior.

3. Data and Descriptive Trends

We use data on COVID 19 related cases as provided by the Italian Civil Protection agency (Dipartimento di Protezione Civile). The reliability of the data collected at national level is a matter of the utmost importance: a change in the criteria used to count/register COVID 19 cases, either over time or across regions, would in fact undermine the time-consistency and cross-sectional comparability of the time-series. These issues are made particularly relevant by the nature of the Italian health system, which underwent a substantial set of reforms at the end of the 1990s, culminated in an extensive regional devolution in the year 2001. Luckily for us, none of the potential systematic threats to data consistency realized. On the one side, the systemic nature of the COVID 19 pandemic pushed the Italian Ministry of Health to homogenize the guidelines for the treatment and registration of potential infections, while at the same time requesting daily reports on the number and severity of COVID 19 patients. On the other hand, such guidelines have not been updated during the period of our analysis, though they underwent a substantial revision in July 2020. The stability of the criteria followed to register the data makes the Italian data particularly reliable to make comparisons over time and across sub-national administrative units.[6]

Figure 1: Total Cases by region

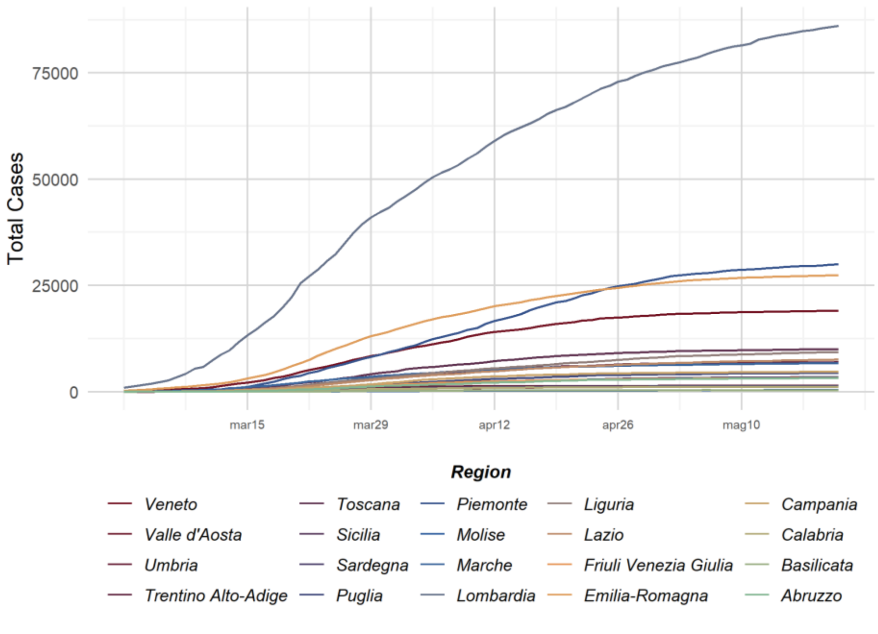

Figure 1, which shows the evolution of the pandemic from March, 7th (the first day for which at least one case was reported in all regions) to May 18th, suggests that the lockdown has been effective in limiting the spread of the virus across the Italian territory. What these figures do not show is the very high economic costs entailed by the measures, but to discuss those is outside the scope of this note.

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[6] Not all countries maintained the same criteria over time (for instance Spain changed criteria during the pandemic, making it difficult to have a serious statistical analysis). Despite change in the criteria followed to register the evolution of the infection might be due to efficiency considerations, it has the side effect of making it difficult to perform significant intertemporal comparisons.

Table 1 reports a picture of the COVID 19 overall situation on the last day of the Phase 1 of the Italian Lockdown, divided by region.

Table 1: Cases recorded on May, 18th 2020

Region	Total Cases	Deaths	ICU	Hospitalized: Severe	Recovered	Ranking: Total Cases	Ranking: Deaths	Ranking: Total Hospitalized
Lombardia	86091	15727	226	4119	43649	1	1	1
Piemonte	29990	3742	83	1479	17538	2	3	2
Emilia-Romagna	27417	4025	92	592	18466	3	2	4
Veneto	19038	1841	15	237	13911	4	4	8
Toscana	10000	1004	41	169	7119	5	6	9
Liguria	9344	1397	22	283	5872	6	5	6
Lazio	7558	662	68	1110	3259	7	9	3
Trentino Alto-Adige	6965	746	11	90	5903	8	8	13
Marche	6689	990	16	111	3867	9	7	11
Campania	4723	403	9	312	2947	10	11	5
Puglia	4413	478	20	236	2096	11	10	7
Sicilia	3417	268	11	107	1627	12	14	12
Friuli Venezia Giulia	3215	323	2	72	2314	13	13	15
Abruzzo	3212	391	5	175	1549	14	12	10
Umbria	1429	74	2	17	1294	15	18	18
Sardegna	1356	127	12	64	911	16	16	14
Valle d'Aosta	1176	143	1	26	990	17	15	17
Calabria	1156	96	1	47	734	18	17	16
Molise	423	22	2	8	207	19	20	20
Basilicata	394	27	1	15	307	20	19	19
Italy (Totals)	**228006**	**32486**	**640**	**9269**	**134560**			

Notes: ***the figures in this table refers to the final day of the complete lockdown (Phase 1). It reports therefore a picture of the situation as it was on May, 18th.***

Observing Figure 1 together with Table 1 shows how the regions most hit by the pandemic during the first wave were those where the infection was already spread before the enforcement of the national lockdown. Indeed, the real extension of the infection went largely unreported and maybe unknown at the time (these regions are Lombardia, Emilia-Romagna, Veneto and Piemonte). Not only, these same regions also reached the end of Phase 1 still recording the highest number of ongoing cases (as pointed out by the figures of Table 1).

Throughout this note, we chose to set the starting date of our analysis two days before the official lockdown. We did this for two main reasons: first, that date coincides with the last weekend before the lockdown was extended to all regions. Up to the 9th of March, the confinement measures were only applied to a group of “red zone” areas in Lombardia and Emilia-Romagna. Due to a leak from the government, the news of an extended lockdown generated a wave of panic that resulted in a massive outflow of non-resident workers and students from the most affected areas to the rest of the country (mostly from the northern regions to the southern ones). This scramble is likely to have facilitated the spread of the virus to the whole country. Second, March 7th is also the first day for which all regions reported at least one case of COVID 19. Hence, we consider the 7th of March as the beginning of the pandemic at a national scale. The end date coincides with the termination of the complete lockdown.

4. The regional Indices: fixed and mobile base

In this section we report and discuss the COVID indices for each Italian region, computed as described in section 2, For each region, the blue and yellow lines indicate the fixed base index (FBI)and the day-to-day rolling window (MBI), respectively.

From the graphical representation of FBI, we can note the scale and the exponential growth in some regions (Lombardia, Marche, Umbria and Emilia-Romagna on top) in the early days of the pandemic, compared to the smoother trend of the rest of Italy (e.g.Veneto and Friuli Venezia-Giulia). This effect is more evident thanks to the choice of the base: as its value is initially very low, the index shows an impressive increase in the first weeks, clearly representing the spreading effect of the early days. This behavior is common to several other regions (Basilicata, Calabria, Sardegna and Valle d'Aosta) but the scale is very different. The graphical inspection confirms the huge impact of the virus in the northern regions of Italy (most affected during the early spread of the infection) but it also allows us to notice that, *mutatis mutandis*, the effect was very strong in other regions, too. In particular, in most Italian regions, the percentage of people hit by the virus was lower than in Lombardia but both the speed of the spreading and the pressure posed on the regional health system were very similar.[7]

To better highlight the FBI behavior across regions, we decided to group the graphical representations in three sub-groups, according to their FBI profiles after peak: the profile remains stable (S-group), it dramatically or slowly decays (D-group) or it keeps rising (R-group). Our classification highlights that, although less hit by the pandemic, regions in R-group did not easily recover after peak. This may represent a big warning for the regional health authorities and a deep weakness in sight of a second wave of the pandemic. Regions in D-group, instead, have reacted fast after peak, showing that the pervasiveness of the pandemic has been lower and kept under control. S-group regions finally show a slow and constant degree of infectivity and pervasiveness of COVID 19 after peak, showing a persistent incidence of the virus.

The parabolic shape of the FBI, however, only provides a partial view of the phenomenon, which we extend comparing also the trends shown by the rolling window representation of the index (MBI).

The MBI representation shows some other, interesting features, hidden in the fixed-base representation. Regional MBI profiles are different from each other, showing that pandemic growth rates have been very different across regions, when analyzing it in a rolling perspective. Despite the fact that all regions peaked at end of March, , most of them experienced an highly volatile trends and after it and a slow decay even in a rolling perspective. This is particularly evident in Lombardia, Puglia, Sardegna, Toscana and, to a more limited extent, Abruzzo, Basilicata and Liguria. Such heterogeneity may be ascribed to both the timing and the severity of the infection, which spread unevenly across Italy, as well as to the responsiveness of the health system and the number of swabs

[7] Note that the regions that were initially hit the most by the pandemic coincide with some of the best functioning regional health system in Italy.

in different regions. The short run, rolling perspective highlights that some regions grouped in S-group above show an impressive daily reaction after peak even in presence of an overall strong persistence of the pandemic (see, for instance, the Lombardia, Provincia Autonoma di Bolzano and Val d'Aosta MBI profiles). Lombardia FBI and MBI profiles, in particular, show how this region has been heavily and steadily hit by the pandemic during and after the peak.

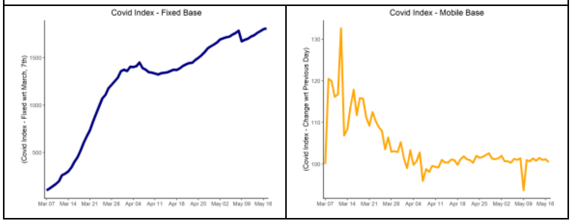
Focusing on specific regions, most of the cases were initially concentrated in few, circumscribed areas, characterized by a strong industrial sector and many international connections. From these areas (located across Emilia-Romagna, Veneto and Lombardia), the virus spread to a limited extent before the lockdown was imposed over the entire national territory. The fact that some of the regions experienced a volatile trend with the infection may relate to the length of the incubation period, as well as to differences in lockdown compliance. Finally, it is worth noticing that some regions show a different pattern. For instance, the MBI profile of Emilia-Romagna, Veneto and Lazio, though reaching the peak around mid-March like most of the remaining Italian regions, experienced a much slower decay. Piemonte showed two peaks in March, a clear outlier on March, 20th, followed by a very slow decay ever since. This seems to suggest that some caution should be used, as some mistakes or delays in data registration are possible, especially given the circumstances[8].

Our analysis confirms the huge impact of the pandemic on some regions (Lombardia, Veneto, Emilia-Romagna and Piemonte) but highlights different responses to that impact. These differences may in turn lead to regionally differentiated social and economic long-term impacts.

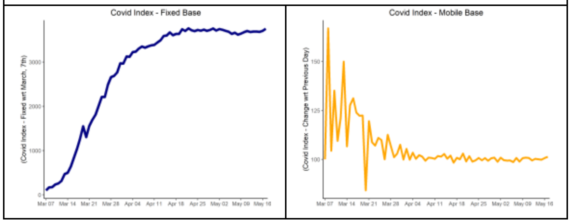
[8] The issue of the data recording is obviously very important if one wants to describe regional trends and especially wants to extract policy implications. The recording in Italian regions is pretty accurate even though there is some misreporting, usually corrected in the following days.

After Peak trends: Rising

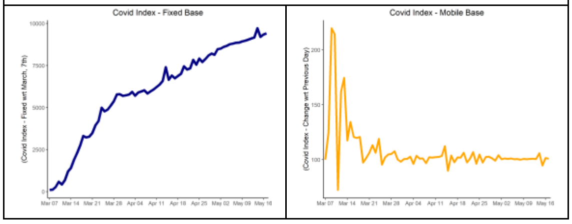
VENETO



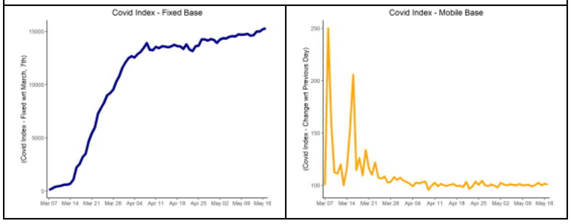
PIEMONTE



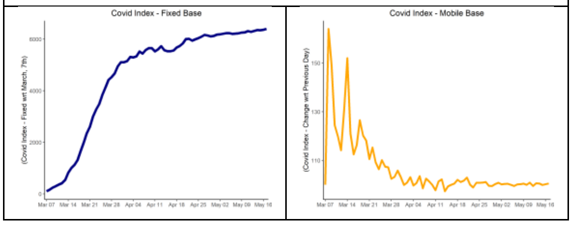
FRIULI VENEZIA GIULIA



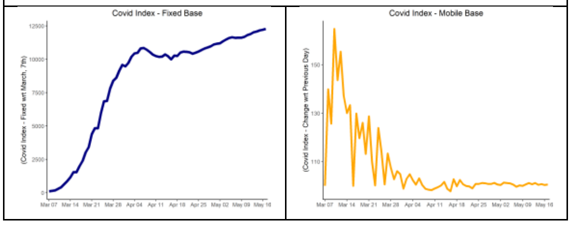
SARDEGNA



LIGURIA

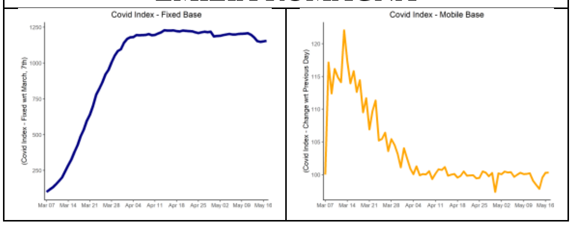


PROVINCIA AUTONOMA TRENTO

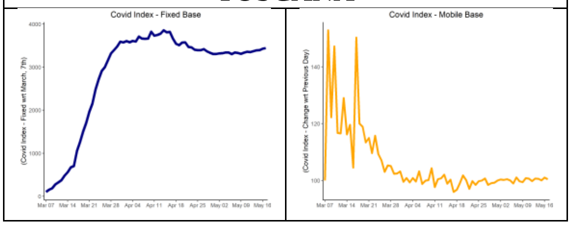


After Peak trends: Stable

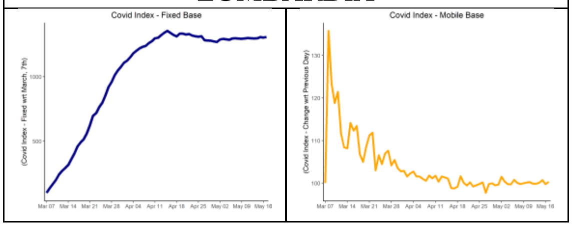
EMILIA ROMAGNA



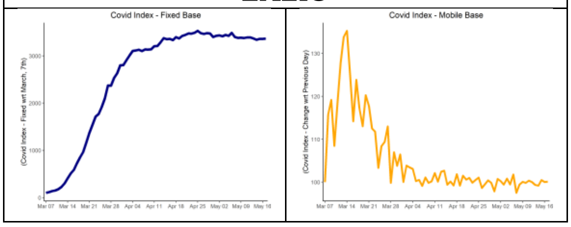
TOSCANA



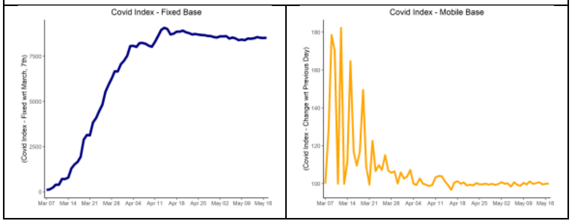
LOMBARDIA



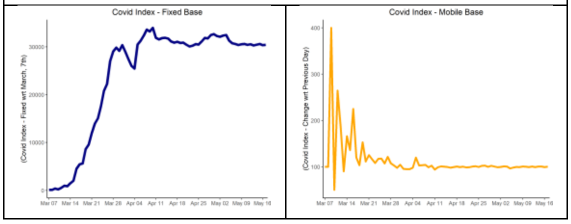
LAZIO



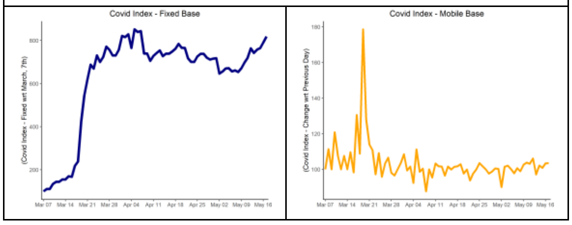
ABRUZZO



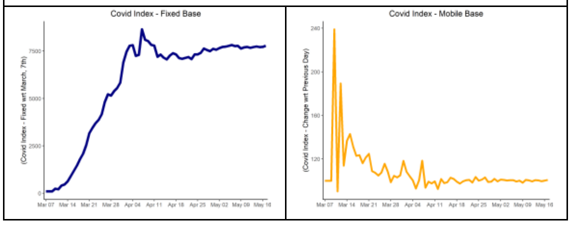
VALLE D'AOSTA



MOLISE

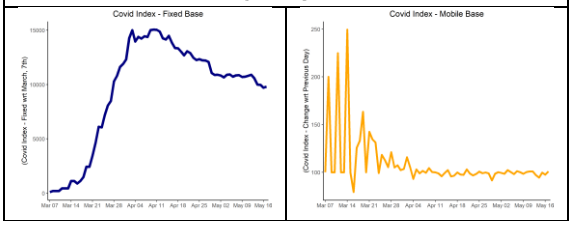


PROVINCIA AUTONOMA BOLZANO

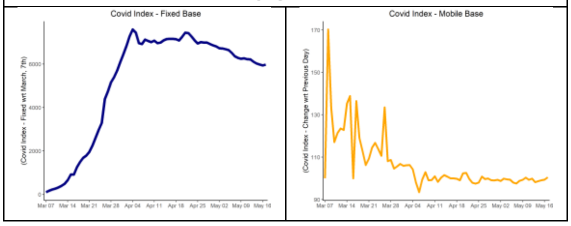


After Peak trends: Decreasing

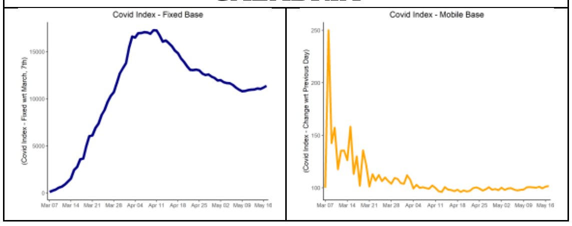
BASILICATA



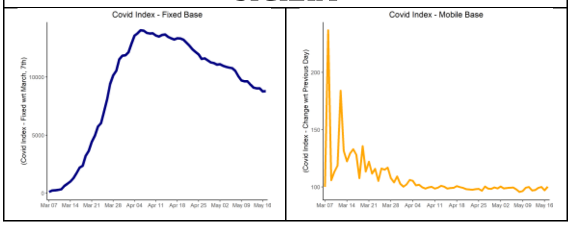
PUGLIA



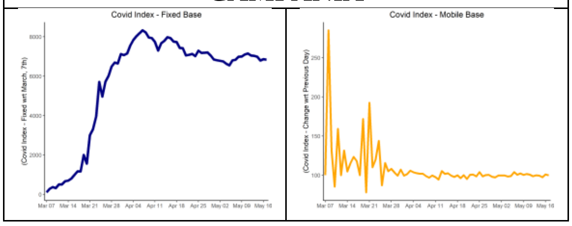
CALABRIA



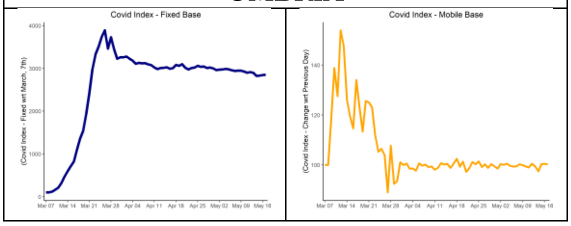
SICILIA



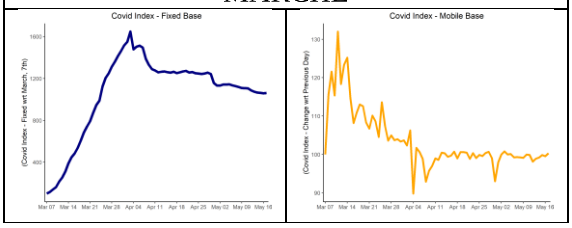
CAMPANIA



UMBRIA



MARCHE



Notes: *Regional graphs, divided according to the post-peak trend recorded. The blue line on the LHS refers to the FBI. MBI is reported by the yellow line on the RHS of each graph. Source: Author computation based on data from the Dipartimento di Protezione Civile of the Italian Government*

4. Conclusions

This note aims at proposing an Index of severity that modifying the Balanced Worth Methodology (Herrero et al, 2018) allows us to study the impact of COVID 19 on Italian regions during the lockdown in Italy. Our analysis covers the whole lockdown period in March-May 2020[9]. Using the epidemiological information available (namely, the number of people who deceased, ICU, hospitalized and cured) for the Italian regions, we first compute a day-by-day severity index for the period of interest. We then calculate a severity index, the Gross COVID Index, and we compute the severity component like a repeated daily cross-section. This means that we compute the index between regions rather than within regions, over time.

In addition, to better capture the heterogeneous spread of the pandemic across Italian regions and time, we propose two alternative representation of the index over time, showing a more detailed representations of the pandemic impact (a fixed-base index and a mobile-base index). Focusing on both the fixed and mobile base indices proposed we note the impressive increasing slope on the first days of the pandemic for some regions as Lombardia, Marche, Umbria, Emilia-Romagna and a smoother slope for instance for Veneto and Friuli Venezia Giulia. We grouped the regions in three groups according to their patterns after peak, showing that regions most heavily hit by the pandemic are also those most at risk, since the pervasiveness of the virus has been stable over the period. We also noticed that a group of regions show a persistent stability of the Gross COVID Index and only few have a fast decay after the peak. These results are consistent both using a long run, fixed base index and using a short run, rolling perspective through the mobile base index.

Our results suggest very heterogeneous reactions and effects of the pandemic on Italian regions and could be further investigated adding some other relevant dimensions like externalities on pollution or emissions. Since the method we suggest is very simple and flexible (we use a parsimonious number of relevant variables, only three) can be easily generalized to compare different countries and different waves (first wave, second wave and recovery, for instance). Finally, the long run and short run viewpoints could provide further ground for policy prescriptions.

[9] At the moment of writing (end of November 2020), Italy is facing a (different) second lockdown where a complicated algorithm based on the 21 Indices proposed by the Ministry of Health has established different "colours" for regions with different degree of resilience or apparent capacity to face the pandemic. The algorithm used has been openly criticized because it is complicated, because 21 indices are too many, because different regions ability to provide timely data on such a high number of indicators can create discrepancies of treatment and also because of the reliability of some of the data (see for instance T. Boeri and R. Perotti articles in la Repubblica available at http://didattica.unibocconi.eu/mypage/index.php?IdUte=48791&idr=31571&lingua=eng). It would be interesting to compute our proposed Indices (both fixed base and mobile base) at the endo of the lockdown period and see whether there are significant differences in the patterns.

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