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An Analysis of the Sources of COVID-19 Resilience and Vulnerability of Turkey in the First Wave of COVID-19

COVID-19 Salgınına Karşı Kırılganlık ve Kaynakların Dirençliliği Analizi: Türkiye Örneği

İlhan Can ÖZEN[1], Berna TUNCAY ALPANDA[2]

Abstract

This paper aims to analyze the effects of the macro prevention efforts undertaken in Turkey at three different levels. We particularly focus on the effect of COVID-19 prevention arrangements on the health system resilience and resistance at a systemic level. Similarly, the social and health vulnerability of the regional populations to COVID-19 was measured, to encapsulate, in the first wave, to what extent these populations were able to be protected from the worst of the epidemic. We use regional and provincial COVID-19 data set (Hayat-Eve-Sığar module) together with the socioeconomic parameters (TUIK), and health system parameters (Health Statistics Yearbook) to create a map for COVID-19 pandemic, prevention arrangements, and economic impact of the pandemic. The results suggest that especially the health equilibrium of the Southeastern and Eastern Anatolian sections of the health system was protected (for the duration of the 1st wave), as a result of the lockdowns, whereas the economic collateral effects have been much more equally distributed among the provinces. At this stage, it is possible to state that, for the next waves of COVID-19 in Turkey, there is a potential economic benefit to implement less prevention at a national level. Moreover, we look at the effect of COVID-19 testing capacity on controlling the pandemic in Turkey to investigate to what extent testing has been able to identify, and control outbreaks. We find that the Turkish testing capacity looks in line with the overall health system capacity in the country and provides a neutral effect for controlling the pandemic.

Jel Codes: *I11, I12, I14, I18*
Keywords: *Covid-19, lockdown, health system, health resilience, health vulnerability, mortality*

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Öz

Çalışma, Türkiye'de COVİD-19 döneminde alınan makro seviyedeki önlemlerin etkilerini üç farklı boyutta analiz etmektedir. Yapılan analizde özellikle, COVİD-19 salgınının kontrolü çerçevesinde alınan kararların sağlık sisteminin sistemik seviyedeki dirençliliği ve dayanma gücü üzerindeki etkisine yoğunlaşılmıştır. Benzer şekilde, bölgesel nüfusların COVİD-19'a karşı sosyal ve sağlık yönünden olan kırılganlıkları ölçülmüş olup bu nüfusların ilk dalga boyunca hangi boyutlarda pandeminin olumsuz etkilerine karşı korunabildiği gösterilmiştir. Bölgesel ve ilsel COVİD-19 verisi (Hayat-Eve-Sığar modulü), sosyoekonomik parametreler (TUİK) ve sağlık sistemi parametreleri (Sağlık Bakanlığı Yıllıkları) ile biraraya getirilerek hem salgının hem salgın hazırlığının hem de salgının ekonomik etkisinin haritası ortaya çıkarılmıştır. Sonuçlar göstermektedir ki; pandeminin ilk dalgasında, uygulanan sağlık sistemi ve alınan kapanma kararları çerçevesinde, ekonomik etkiler bölgeler arasında daha eşit bir şekilde dağılıyorken, sağlık yönünden özellikle Güneydoğu ve Doğu Anadolu bölgelerinde daha anlamlı olan bir koruma etkisi sağlanabilmiştir. Bu aşamada, Türkiye'nin bir sonraki pandemi dalgasında daha az ulusal bir koruma uygulaması yapmasının (test ve taramaya karşı daha hassas yaklaşmasının) ciddi bir iktisadi artışı olacağı argumanı yapılabilir. Çalışmada ayrıca, Türkiye'deki COVİD-19 test kapasitesinin pandeminin kontrolü üzerindeki etkisine bakılmıştır. Ülkedeki COVİD-19 test kapasitesinin mevcut sağlık sistemi kapasitesi ile paralel bir seyir gösterdiği ve salgının kontrol altına alınmasında nötr bir etki gösterdiği sonucuna varılmıştır.

Jel Kodları: *I11, I12, I14, I18*
Anahtar Kelimeler: *Covid-19, tam kapanma, sağlık sistemi, sağlıkta dirençlilik, sağlıkta kırılganlık, mortalite*

1. Introduction

The coronavirus epidemic has deeply affected all societies. It is no exaggeration to say that it is the biggest health and public health challenge that countries have faced in a global scale in the last 100 years (Horton 2021), and the degree of success they will show in the face of this challenge will not only determine their health outcomes, but also their long run economic performance. Understanding what can be done, and how effective it can be, and as a counterpart how much the limitations will cost the society is crucial, as the costs and benefits are significantly important to the society and economy. In this study, we aim to track the effect of the Turkish society level impositions, and the alternative control methods that Turkey could have used, to analyse the cost-benefit ratio of the policies that have been chosen. Firstly, we collect and project the time series development of COVID-19 cases in Turkey, and distribute it among the different provinces. The issue is to not only focus on the number of cases, but to create a projection of the severity of the cases, that is consistent with the Turkish data, in terms of its speed of transmission, and its resulting health pressure. We account for the health pressure applying the model characteristics of the System Utilization Research Model (SURM) that the Stanford Innovation Institute has developed. We discuss how the health pressure is distributed vis-a-vis the already existing capacities of the health system with a special emphasis on the necessary capacities for a fast multiplying infectious disease like COVID. We want to see in the first round how much match there was between the capacities and challenges for the Turkish health system, especially at the level of the distribution of health stress as measured by the demand for beds, ICU (Intensive Care Unit) beds, and skilled personnel. For these simulations, the epidemic data will be brought together as made public by the Health Ministry, the death numbers are used for robustness, as well as ultimate health outcome were made public by a selected set of the largest municipalities in the Turkish geography (this has been made available until the end of 2020), and the Turkish utilization figures during COVID-19 era were made public by the hospital data records. Socioeconomic and demographic characteristics (Brough et al. 2020, Brown et al. 2020), as well as the health system characteristics were controlled for, in this analysis. Projections for the future, and for the counterfactual situation without lockdown model, is made by projecting and extrapolating from the already established priors. The hospitalization rate from cases, and the doubling time is taken from the established Turkish data in the first wave. For the projection with the counterfactual (no significant NPIs (Non-Pharmaceutical Interventions)), we use the universally established doubling time for this strand of the COVID-19 virus (7 days a week), and establish an exponential increase model, with the sole mitigation coming from the changes in the social distancing (Attar and Tekin-Koru 2022, Attar and Tekin-Koru 2022), coming from the Google Mobility Dataset[3], and the crucial starting point coming from the established number of cases in April 7, where no important lockdown was announced. Finally, we aim to discuss to what extent the equilibrium match in the first wave that we analyse is sustainable and replicable. And specifically and relatedly, we aim to investigate what is the economic cost of creating the geographic pattern, and what would be the alternative level of the health system cost, under a completely different geographic pattern.

The paper is organized as follows: The next section provides information for modelling covid, and the following sections describe the data and the empirical strategy followed by the results section and then the conclusion.

2. Modelling Covid

COVID-19 preparedness must be understood as a coordination game between different health and government authorities, and in the micro level with individual decisions to self-distance, isolate, and self-protect. By dividing actions in the different sphere, we hope to both understand the efficacy of these actions on the developing epidemic, and the different excess-cost creation that non-action is some spheres creates for the other spheres. The capabilities and individual actors we identify is:

(A) Government Authority----Restricts Movement

(B) Public Authority----Identify, Isolate Individual Cases and Clusters

(C) Health Authorities----Diagnose, Treat and Prescribe.

Different countries have chosen different combinations of these three sources of resilience to withstand the pressure of COVID-19 epidemic. China after the big jump in patients in the Wuhan region, and a near asphyxia of the regional health system at the mid-point of January, decided to use more active government actions to restrict mobility, both between the different regions, and as the disease progressed in the rest of the world, restricted movement

[3] Accessed from https://www.google.com/covid19/mobility/TR

to China from the rest of the world. Japan followed a path of minimal restriction of movement, until late in April, using the public health authority to aggressively identify the clusters, and to isolate the clusters from the rest of the population. Countries like Brazil, which did not follow aggressive government decision making in restricting aggregate social movement, and did not aggressively track and control the spread of the initial clusters by their public health authority, suffered from the health facilities and the health system being over-worked in a lot of different regions (Thomas et al. 2020, Pisano et al. 2020, Shaw et al. 2020).

In this context using the stringency index as a policy strength parameter with a single dimension looks to be an incomplete explanatory variable, as we need to give importance to the multidimensional, and multi-sectoral nature of the right policies, and also capturing the timeliness of the policies. Stringency that occurs not in order to control the disease, but because the disease is already out of control, is not really a meaningful explanatory variable.

Figure 1: The Distribution of Tasks and Resilience for COVID-19

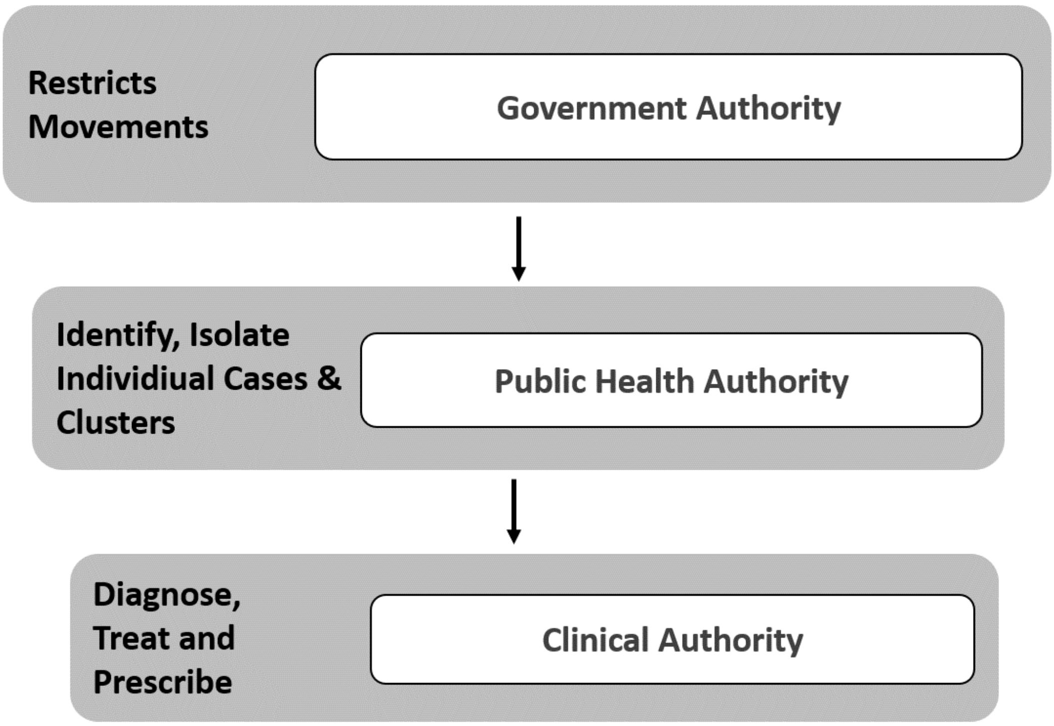


Figure 1 makes clear that the decision makers are situated in an upstream and downstream model, and concept. The government authorities determine the disease mass, that the Public Health Authority needs to analyze and identify, and the differentiated disease mass is the health patient pressure that the Health Facilities, and Health Workforce need to meet. Thus, although the COVID situation of a country, and its infection numbers, and its disease outcomes will be determined by all these three actors together, we believe that these dimensions should be differentiated, and the capacities of the country on these dimensions should be worked out. The simple discussion of state capacity, and the specific discussion of health capacity are not very informative, in the sense that the capacities of the health system and political system and the economic system in the crucial issue of COVID-19 control (as in control of the infection rate and infection mortality) are very important to capture (Bump et al. 2021). Especially in the first wave, important research has uncovered that static health capacity by itself has not been enough to bring the COVID-19 to rapid control, and it has created high mortality in regions (France, UK, Italy) which had high health development before the COVID-19 pandemic. Therefore, an up-to-date characteristic of the health system in this specific dimension of infection control will be crucial to measure, and to compare.

The crucial variable of our analysis which is health system pressure is determined indirectly by the public authority decisions, and non-decisions, and their degree of capacity, and also the government authority on the same dimensions. The health system effect literature in COVID-19, without figuring what is going on in these other dimensions is at risk of understanding how the direct and indirect costs that are created at the health facility dimension, is actually created by the capacity gaps, and decisions that are made in the earlier and other dimensions. The dimensions are easiest to capture at the government authority and health facility dimension, but we will be discussing that understanding the efficacy and changing effectiveness of the second dimension will also be critical for future research. Although in this research we will treat the public health authority as a black box, we suggest that it should not be so, for the effective estimation of total resilience of the health and social system of Turkey.

The health systems cost function is related to the outputs of other systems, determined by how in the earlier stages the level of infection transmission has occurred given the government decisions to restrict movement, and if the public health authority has been able to differentiate, and isolate specific cases and clusters. It is important to determine the degree of problem in understanding what will cause mortality in the presence of the COVID-19 crisis. The idea is to make mortality from the disease, a function of the health system being overpowered or not ($H_d > H_s$) so that the number of days (t_s) the health system is overpowered in one or more of its regions (x), positively influences the level of direct and indirect excess (M) deaths from COVID-19 at the level of the total country.

$$M = t_s * x + R_0 * S$$

In the next section, we provide detailed information about our dataset and empirical analysis.

3. Data Source and Empirical Analysis

3. 1. Epidemiological Data for COVID-19-1st Wave

The fundamental data source is the prevalence values for Turkey as announced by the Health Ministry of Turkey, starting with the 12th of March[4]. The provincial distribution, which is very critical, is estimated from the ''hayatevesigar application'' maps, and the 15th of April provincial distribution values that have been shared by the Turkish Health Ministry.

[4] We can reference https://covid19.saglik.gov.tr/ for the information about i-the total COVID case numbers at the national level, and ii-the geographical location of the cases at the local level (where the information for ii is temporally discontinuous.)

In terms of the outputs of the other systems that are important for the health system functioning as inputs, we have outlined the importance of COVID-19 Admissions and the degree of Patient Cohorting, which distinguished the applications by degree of severity. The more severe the case, the higher will be the weight put on the health system. The outputs of the health system will be the length of stay, the pharmaceutical expenditure, and degree of utilization and overutilization of the doctors and beds in the health system due to the COVID-19 outbreak.

We believe that the degree to which it will be able to withstand this increase in utilization, in the different points of its geography captures an aggregate health resilience index, in the context of COVID-19. The resilience index not only captures how Turkey has performed, but also puts that performance in an international comparative perspective. The definition of resilience is the ability to withstand the epidemic in the strong part of the health system, while creating the minimal economic collateral cost, and necessitates that one must rank the different regions in order of (potential) strength of health response and that we have also undertaken to measure the economic impact of the specific border to border closures among the provinces. Just as importantly, the resilience index will give a good idea about how Turkey would have performed under alternative scenarios, where the pace and pattern of transmission could have been different. We believe the sketching these scenarios will be critical for the second round of the epidemic, that has already started. The trade-offs will become more important, as the state authority will have the chance to evaluate the pluses and minuses of no lockdown, and full lockdown, which are the two cases we consider in this paper.

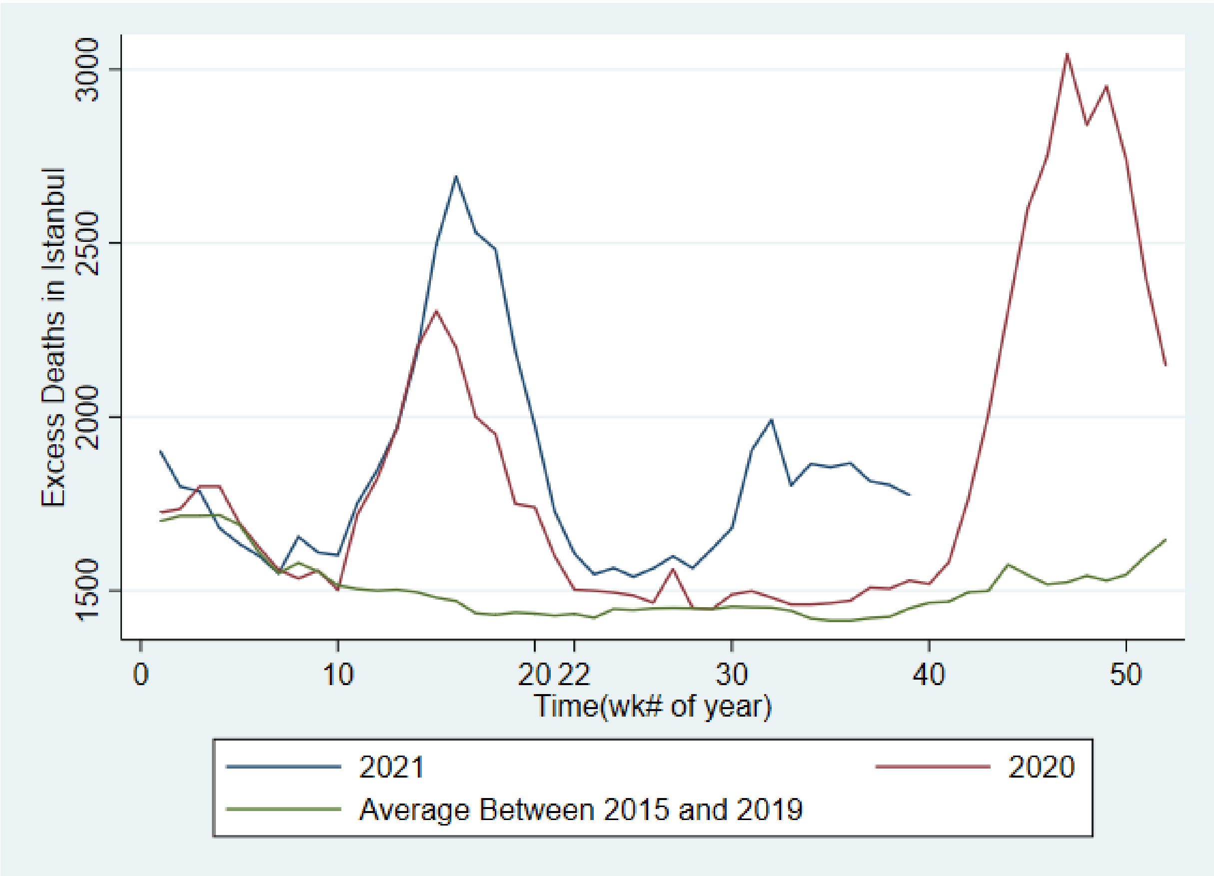
The unique advantages of our data approach and our model are obvious, as we are using the specific Turkish data to compute the health system function of Turkey, rather than borrowing the health system parameters, and COVID-19 treatment profiles of other countries. Firstly, the uniqueness of the Turkish health system in general, and its uniqueness of its reaction to the health system shock of COVID-19 in particular can mean that international studies are minimally applicable to the Turkish context. The second advantage is our more holistic approach to the COVID-19 crisis, and decision-making process. This is true because we are allowing for multiple stages of decision making, rather than focusing on how stringent the country is on a single axis, and single dimension, thus we are trying to capture how stringencies in some dimensions are effecting the cost function, and equilibrium action in other dimensions. We believe this approach is much more accurately portraying the multidimensional, multisectoral challenge that the countries like Turkey are confronting in the middle of the COVID-19 crisis.

Table 1 and Figure 2 make clear for the Turkish situation, and the Turkish health system functioning, how on average in the first wave the disease positions have progressed and transitioned during the disease. The second crucial variable is the amount of time it would take the patient to transition from one state to another. Our model comes from confidential Turkish data, imputed from a multi-center patient level data. The mortality rates, being one of the critical health outcomes, is determined by the transition for specific health conditions to the mortality condition. We are assuming that the mortality condition from the infection disease positions will stay constant for the first wave of conditions. The limited time period under question (2.5 months) is a potential supporting case, but the estimates can be overestimated if the clinical treatment is evolving by improving month after month.

Table 1: Transition and Application Probabilities for COVID-19

Ambulatory	9,50%
Floor	68,50%
Floor==>ICU==>Floor	9,90%
Floor==>ICU	1,10%
ICU==>Floor	9,90%
ICU	1,10%

Figure 2: COVID-19 Related Excess Deaths in Istanbul and the Identification of the First Wave[5]

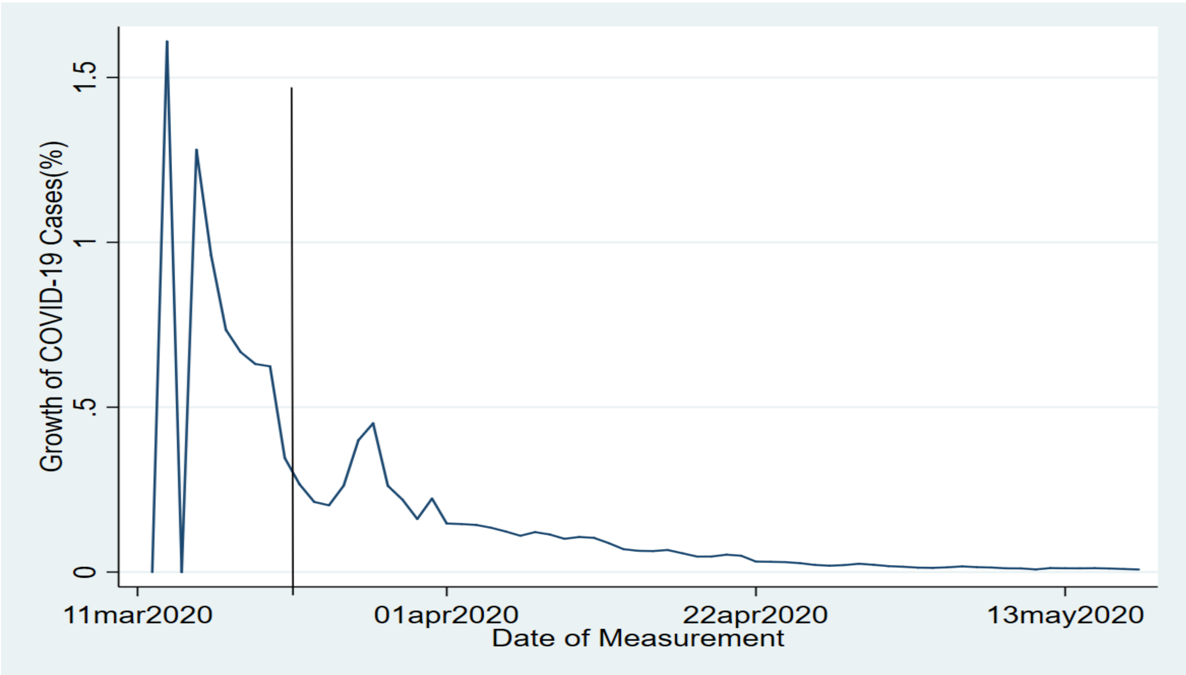


[5] First wave, from the current epidemiological data reported in Turkey, is estimated as the 12 weeks starting from the 10th week of 2020, to the end of the epidemic, when the epidemic was brought under control, and the lockdowns were lifted at the end of this 22nd week (25th of May 2020-31st of May 2020).

3. 2. Research Results

In this section, we summarize our empirical results. Figure 3 shows that the growth numbers are estimated at the level of the national level, with the majority of the growth occurring until early April, and the growth coming to a standstill when the limitations have been put in place at the start of April 2020.

Figure 3: The COVID-19 Case Growth Rate for Turkey (First Wave)



The timing of the government actions leads us to believe that the majority of the government actions to slow and stop the spread of the epidemic were taken during the month of March, and very early April. We will look at the effect of these decisions on the epidemic transmission rate between April and May 2020.

When we compare the effect on the health system in Figure 4, we do our computations by using the hospitalization averages in the Turkish health system sphere during the first stage, using the estimates of hospitalization from the hospital data, and the time spent in normal bed from the statistics of the Turkish COVID patients. The results suggest that the maximum of health pressure in the first wave occurred in the week of the 22nd of April, where only 3 percent of all public hospital beds were occupied by COVID-19 patients concurrently. In Figure 5, the national health stress is measured by the spike of ICU bed usage that is quantified in the first round of cases. A different set of transition parameters were used to quantify the health pressure being created on the specific ICU units. The 11 percent of all hospital applicants, with different time sequences will spend some time in ICU units, if the age and comorbidity picture stays constant from the 1st wave, to the second wave. The number of ICU health pressure is of course a lower number, but as the patient capacity and average fullness of ICU units in general is higher, the excess capacity that hospitals and health system have to cover the pressure of the COVID-19 crisis is much more limited.

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Figure 4: National Health Stress at the Normal Bed Occupancy Level

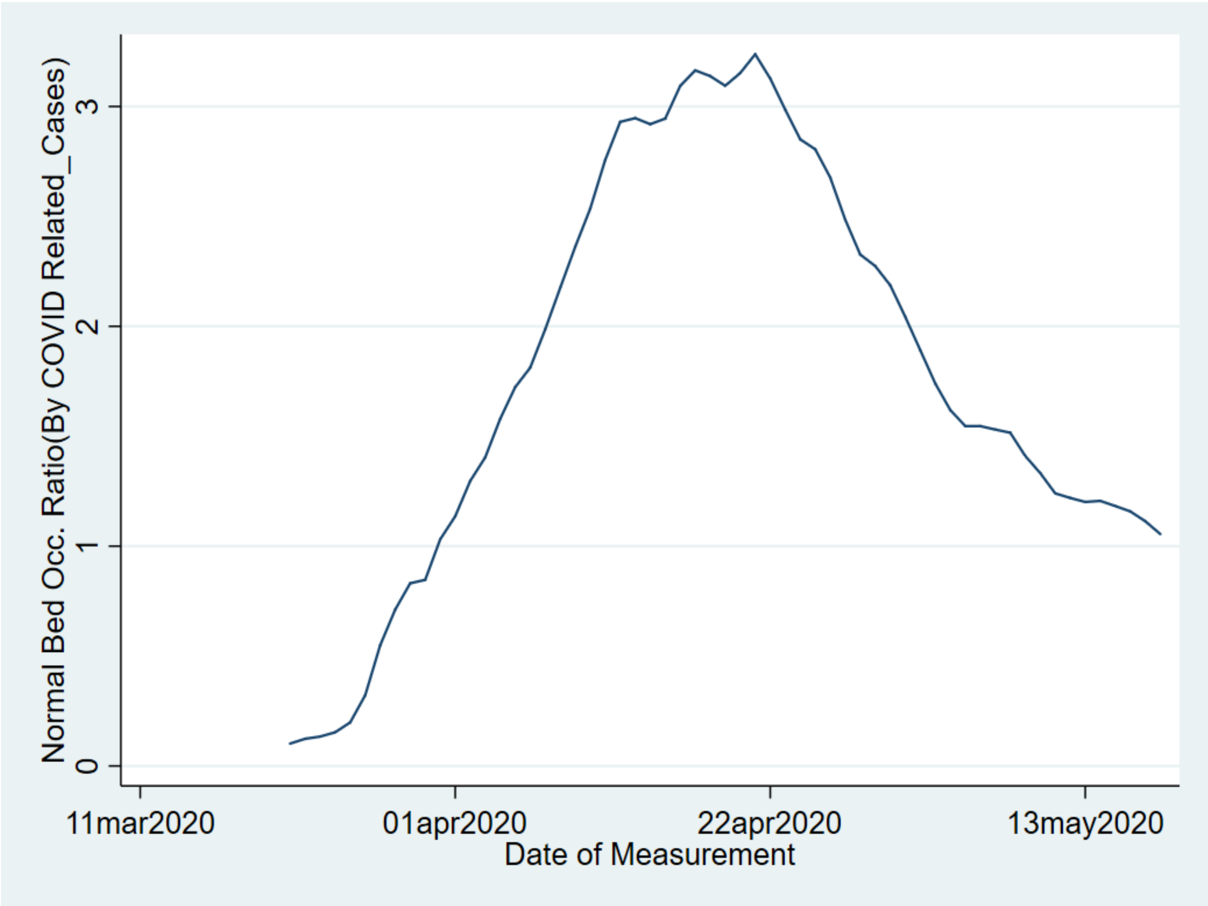
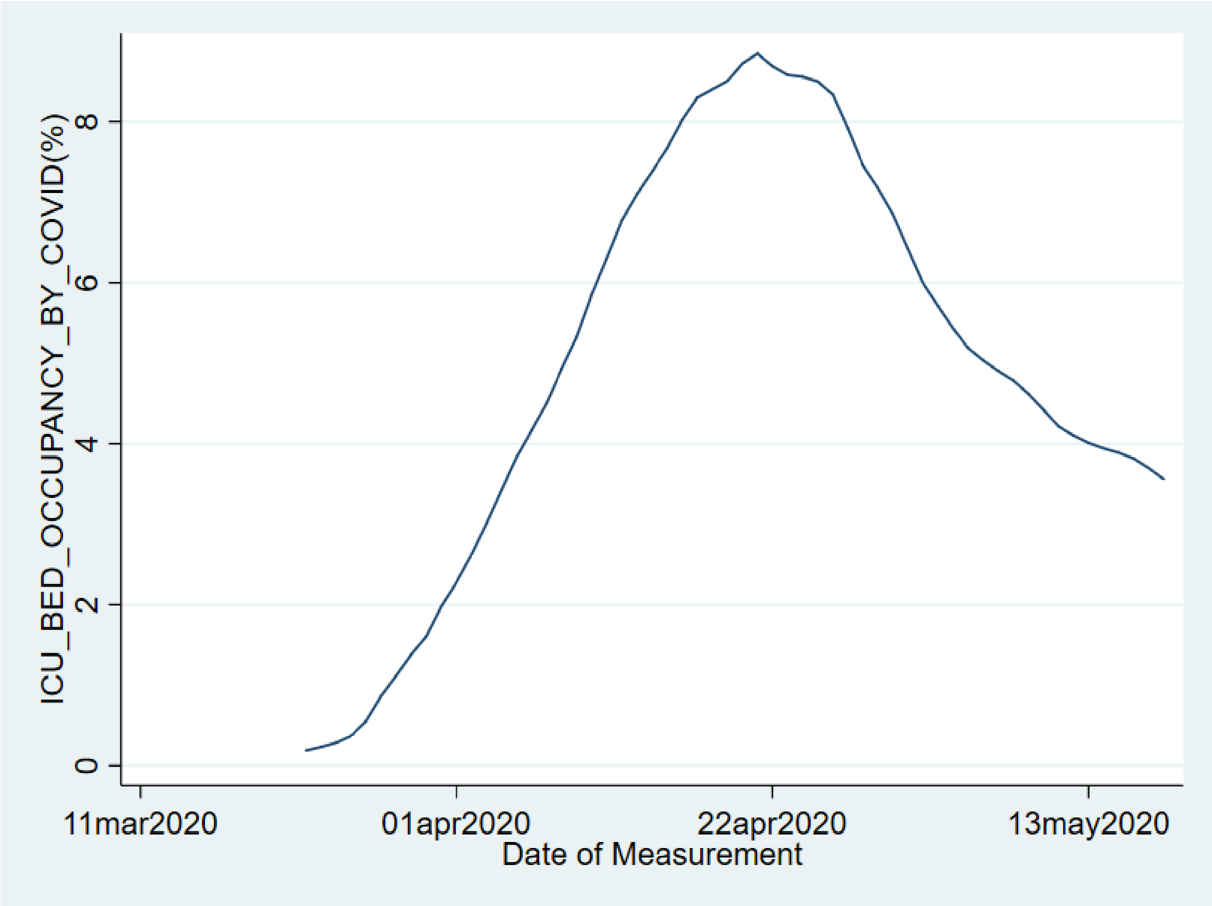


Figure 5: National Health Stress at the ICU Occupancy Level



When we divide the health stress into the regional distribution, we have to look at which health systems have been struck during the first wave of infections. Again, in terms of the ICU hospitals, even though the IBBS-1 1st region have the largest number of ICU beds and capacity, still they have withstood the largest effect in terms of the relative pressure, relative to the size of the regional health system (see Figure 6).

When we look at the distribution of COVID-19 together with the static health system ability (see Figure 5 and Figure 6), it is clear that health system is most prepared in the exact IBBS-1 regions, where it was hit by the COVID-19 epidemic in the first round. These two graphs together substantiate either the case for luck, or the case for the policies that were instituted by the Turkish government in the first local, being successful, if not controlling the level of the disease, then controlling the spread of the disease to the unprepared regions, and as a result limiting the excess mortality that would arise from system inefficiencies, and low quality care.

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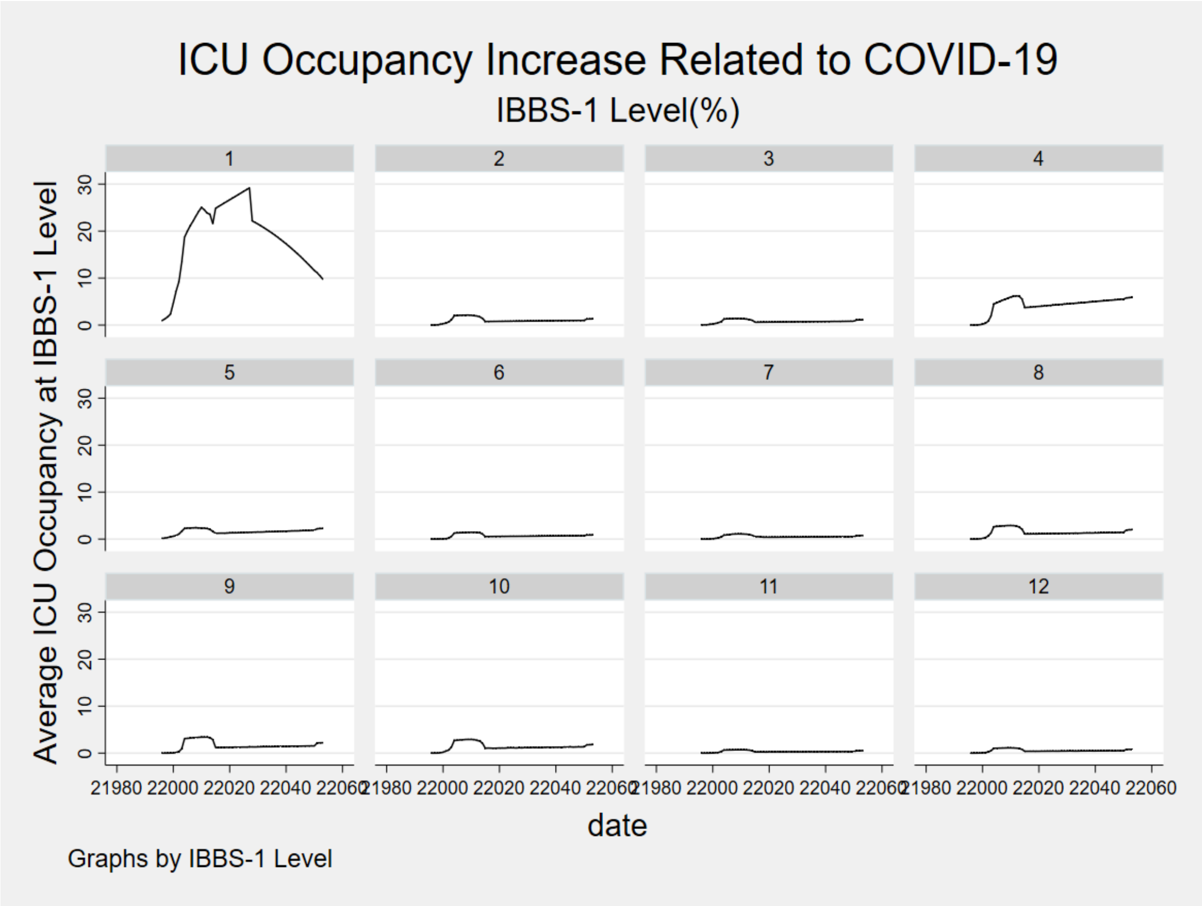
Figure 6: Health Stress at the ICU Level Distributed by IBBS-1 Levels



The correlation between the health capacity and health stress index is 0.2139, suggesting that the health stress from COVID-19 in this first wave is positively matched, so that the geographies which had the first stress and which are relatively well equipped to meet these challenges.

The paper, in the analysis between the indexed health system capacity, and the local level of COVID-19 during the first wave undertakes to measure the Spearman rank-order correlation coefficient. The basic rationale for this is that, the assumptions of normality on the distribution of the local health capacity, and the supposed linear relationship between health capacity and COVID-case proportions were found to be too restrictive. Pearson`s correlation coefficient supports the same empirical hypothesis, as the Spearman`s rank correlation. Statistical analyses in the paper are performed using Stata-15 Software.

Table 2 results make us think that more than by epidemiological design, the result is mostly in the second part of the epidemic achieved by the decisions of the government authority and the public health authority. Table 2 makes clear that there is a positive situation in the first 4 weeks, a contagion possibility in week 5 and 6 to the areas with low health development, and a return back to a situation with limited development in the health vulnerable regions by the end of the 6th week. This situates the discussion in the context of a temporal phenomenon, where the transportation limitations instituted in the end of the 4 weeks meaningfully might have affected the spread pattern of COVID-19 in the Turkish geography.

Table 2: Correlation Between Health Development and COVID-Case Growth Rate in Different Provinces

Dates	0-30	30-40	40-50	50-60	60-70
Spearman	0.0171	-0.0055	-0.0064	0.0037	0.0165

The spatio-temporal analysis is undertaken in QGIS Software to support this basic point. The hotspots of the disease, with a much more nationally equally distributed set of hotspots at the start, is much more clustered around Istanbul at the very end, with no significant breakouts, outside the crucial cluster for the first wave that was established at the end of the 1st month. Also we would like to point that the blue areas are the lowest part of the Turkish health geography, with a clear and strong pattern of cold spots being established in the most health vulnerable regions by the end of the process. As it turns out, we believe protecting the health vulnerable regions through movement control, and test-trace and isolate measures is just as effective in limiting the effect of the disease as it is to bolster the health system to meet the degree of health pressure. What we do in the next stage is through a reverse scenario of the universe in which the spatiotemporal pattern in day 30 is not limited, we look at what effect the epidemic would have on the Turkish geography for the next 50 days. In terms of Figure 8, the hotspot, and coldspot analysis supports the same basic assertion, that the actions taken after day 10 have limited the hotspots in the of the northwest, which are the most economically developed, integrated part of the Turkish geography, with the greatest amount of health capacities to be used for COVID-19 cases. In a similar way, the coldspots are recognized as the geographies where the least amount of health capacities exists, and would be least prepared to face the COVID-19 onslaught. The increase in the COVID cases after day 10, and really significantly after day 20 creates a situation where the disease is localized, in the area around Istanbul, and Kocaeli for the majority of the first 70 days. The spread pattern from Istanbul to the Southeast have receded, and the disease stays in the highest point of the health development in the Turkish geography, compared to the rest of the health system geography, as shown by Figure 7.

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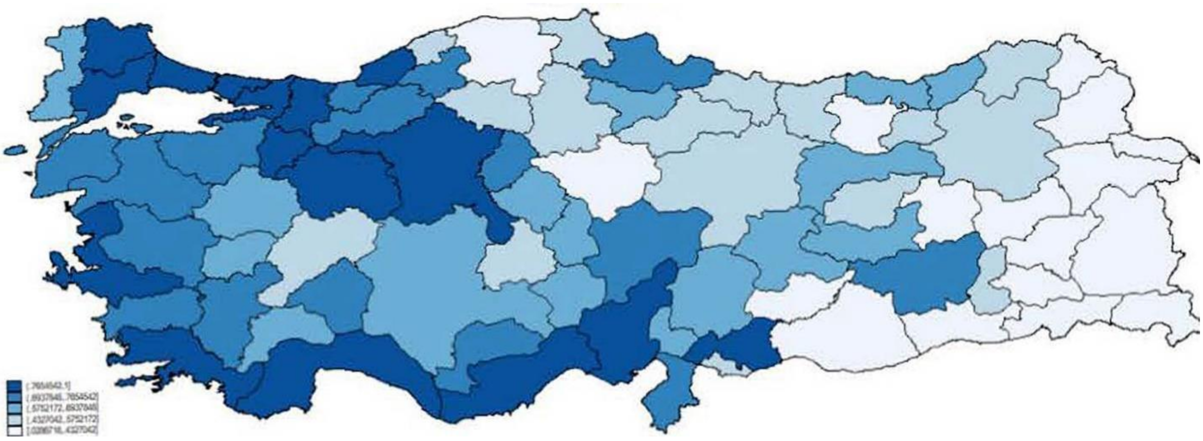
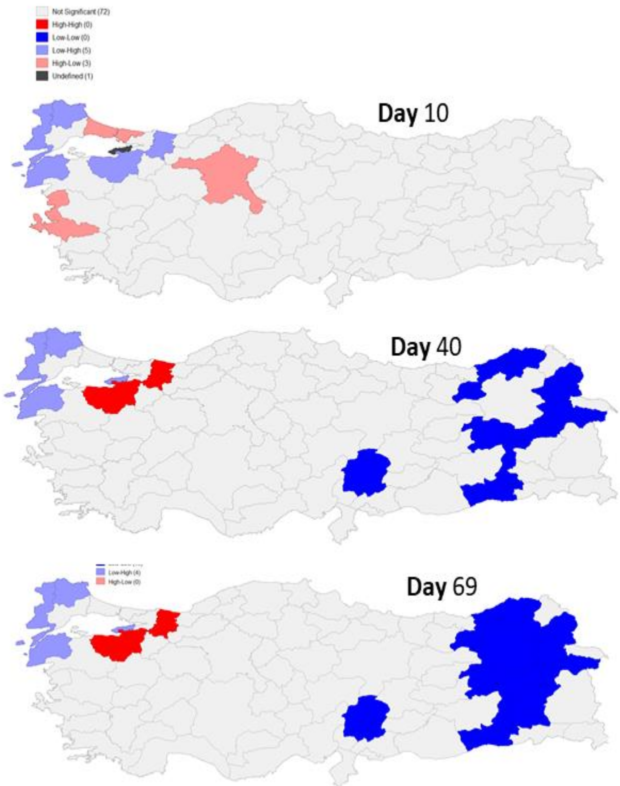
Figure 7: Health Development of Different Provinces-Health Resources Index



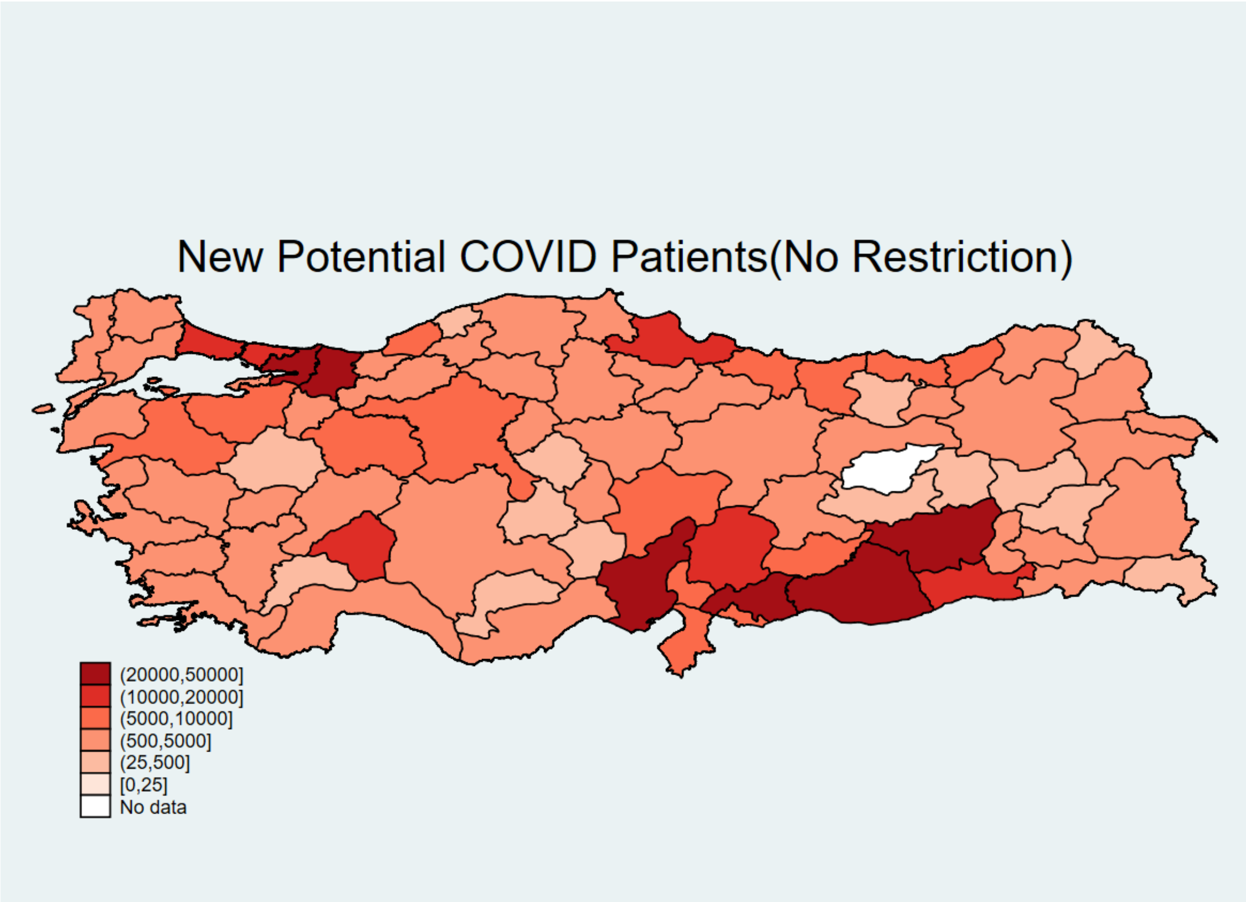
Source: TUIK, Health Statistics Yearbook-2009-2016

Figure 8: **Changing Hotspots and Coldspots of the COVID-19 Epidemic (1st Wave)**



Under different scenarios, we are also able to discuss the different provinces potential costs and benefits of restricting movement between the different provinces, when the initial epidemic has been clearly in Istanbul. In Figure 9, we represent the potential costs and benefits, looking at the different provincial epidemics that would be caused by propagation due to movement from Istanbul and that would continue increasing due to over-capacity of the health system, and low identification as a result of the development challenges of the regions and provinces. Figure 9 represents the new cases that would exist in the next three months if the pattern grew in the same direction and rate at which it increased in the first 30 days. The cluster of the worst effects regions is moving from the southwest from the original cluster center of Istanbul. The low health development level, and the high level of current occupation status in the southwest quadrant means that together with the disease spread pattern, that the mortality weight will be highest from COVID-19 in the southeastern region of Turkey. The preparation index, the possibility of the respiratory clinics to overflow, primary care doctors functioning to drop, and the infection growth pattern allows us to talk about the risk pattern of the disease, which is how intensely the disease will grow over the summer, when and if the internal movement restrictions are lifted.

Figure 9: Alternative Propagation Rates Under 69 Days of Disease Development with No Restriction



The benefits of the restriction in movement will be most felt as a result in the southeast of the country, roughly bordering the Syrian border, and the area that is exactly bordering Istanbul, all the way down to Ankara. The reason for this is the high propagation from Istanbul, low health system capacity that is left to combat with COVID-19, and the high density and high level of families and individuals in poverty conditions. In Figure 10, we represent the economic cost of these restrictions, mainly located in the northwest quadrant of the country, because of the extreme connectedness of the regional economy, with the Istanbul centre which would be cut off in the case of restriction, and also because the region is one of highest productivity part of the economy, and the restrictions harm this productivity profoundly. The analysis suggests that the restrictions were important, not only to keep the Istanbul regional pandemic under control, but also created positive externality effect for the other regions, in some cases regions far away from the Istanbul centre. The highest level of positive externality compared to the economic cost of the government restrictions were located in the southwest quadrant of the country, which benefited at the highest amount of movement restrictions. The smallest externalities were created in Artvin, and Hakkari which are the remotest provinces in the Turkish geography.

Furthermore, data from Interbank Card Center (ICC) and the TUIK on the GDP per capita and GDP per capita shock in the province level is collected together, to look at how limiting trade and movement in the Istanbul-Ankara main connection will affect the GDP per capita of different provinces in the suggested period of 5 months. Results show that significant negative shocks are distributed across the geography, with the strongest effect existing in the northwest quadrant, moving from Ankara to Istanbul, and covering the majority of industrial production and technology base of the Turkish economic geography.

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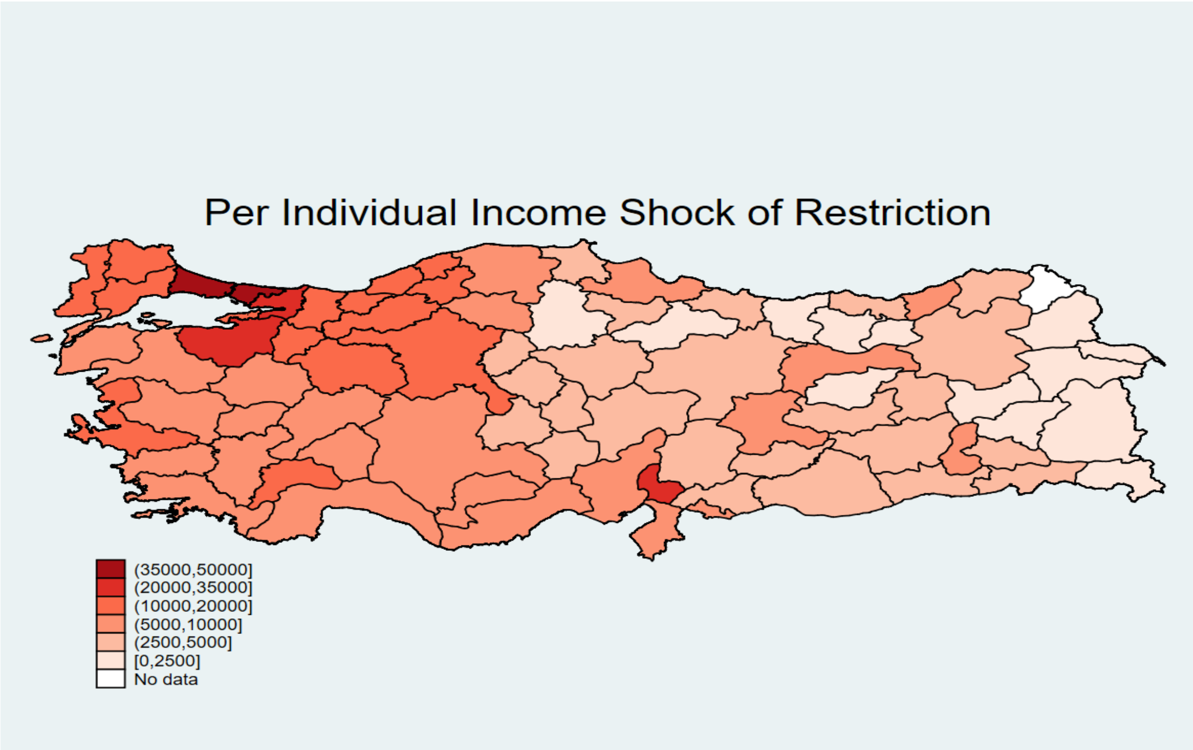
Figure 10: Per-Capita Income Effect of the Mobility Restrictions in the First Round (Istanbul-Ankara Oriented)



In the final part of the analysis, we want to check for the robustness of our estimation strategy, by looking at the provinces that were worst effected after the country wide return to normalcy starting on the 1st of June. Because identifying deaths related to COVID-19 using the virus case identification is incomplete[6], testing at the population were not all-encompassing, providers at the first months did not always have full information about the virus and its province to province breakdown has not been established in full, we rely on the excess death measures (collected by BBC Turkey for every province[7]), that are collected for the first 8 months of the year (until the end of August) and compared with the baseline provided with the earlier year totals from 2018 and 2019. The projected total deaths from excess death rate, from all causes of death for all age groups at the national level is 9953 which is slightly higher than the Turkish official national figure which is expected and in line with international estimations (Kiang et al. 2020), though still of very similar relative size. The part of the estimate of excess death that we want to focus on is how unequally distributed it between the different regions, including the time period after June 1.

In the robustness stage, we want to check for the correctness of our estimation by looking at the excess death of geographies in the period after month 5, when the internal movement was corrected. Figure 11 shows a positive correlation between the excess mortality and the

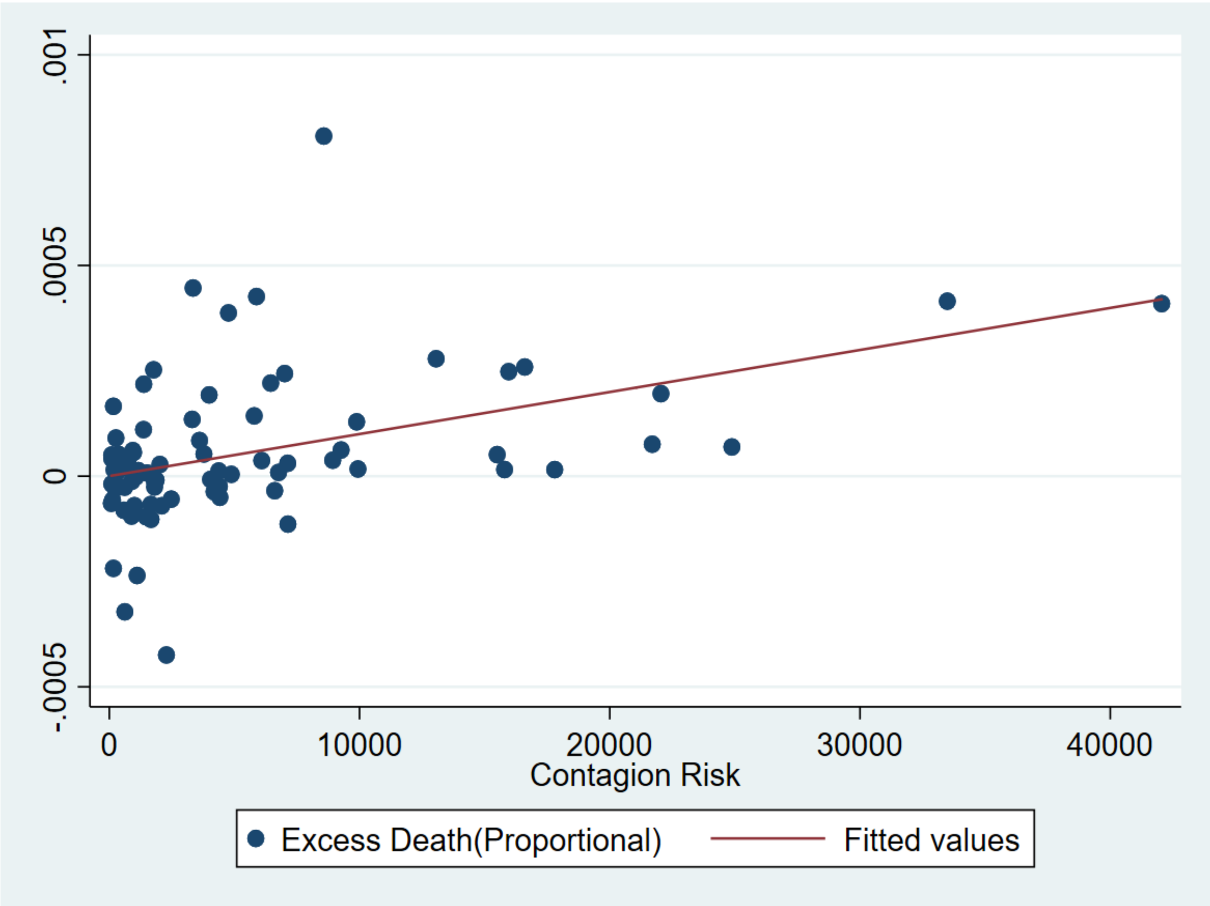
[6] The majority of the tests in the Turkish health system used for identification only has a 60-65% reliability of making a positive identification.
[7] Collected from E-devlet data, with a threshold of a 2018-2019 average.

1st round contagion risk, that was established by the propagation risk of the disease, the health system development of the provinces and the overall occupation of respiratory clinics during the time period after the 5th month. We want to see how close our estimates are to predicting the future spread of the disease, and resulting COVID mortality, once the movement restrictions have been lifted. If we consult Figure 11, the figure looks broadly in line with our expectation, that the areas that have been under the greatest excess contagion risk, were the populations and geographies that have the worst performances in the next 2 months of free mobility from the start of June, to the end of August. However, the Istanbul value is an outlier, but it could also be a reflection of the great weight of Istanbul in the Turkish geography and the Turkish population. Istanbul has clearly the greatest amount of COVID deaths both traditionally and in terms of excess death calculation specified, but perhaps there are regions who are just as hard hit, with simply smaller populations, smaller susceptibility numbers, and lower case numbers of mortality. In addition, controlling for the Istanbul excess mortality takes into account that unlike the other geographies, the majority of the excess mortality in Istanbul province occurred between March and April.

Figure 11: The Contagion Risk From the First Two Months of Data and Excess Death Data For 8 Months

Next, we focus on the proportional death effect in the population in Figure 12. Compared to the population size in the province, when we focus on the excess death figures in the months between month 5 and month 8, we see that the correlation is much stronger with the contagion risk we have calculated, which can be understood by the fact that (a) contagion risk spreading in the Turkish geography will not create the same amount of mortality numbers, as the size of the susceptible and vulnerable populations will not be the same in the different provinces, (b) and that the contagion risk is much more effective in the 5-8 months where there were no internal mobility restrictions, compared to the period before 1st of June, when there were many restrictions on these dimensions to control and diminish the level of contagion risk.

Figure 12: The Contagion Risk Vs. Excess Death Proportion For 5-8 Months (Province Level)



In order to correct for this, in Figure 12, we bring together the regions with the highest contagion risk, because of their (a) amount of vulnerable populations (b) amount of labor populations that are linked to the Istanbul economy (c) large household size (d) high number of respiratory cases in the non-peak months and high occupation of respiratory clinics and (e) large economic networks with the Istanbul economy, with the regions that have had the highest degree of excess death in the first 8 months of 2020. The ability of the contagion risk, established by data collected in the earlier part of 2020, and earlier to predict the excess death occurring in the later part of 2020, would suggest that, quite independent of the reverse-causality issue, the degree of contagion risk, constructed in a multidimensional multidisciplinary method, is predicting the propagation and the severity of the COVID-19 epidemic in the future periods. The fact that the contagion risk does not explain the pre-June COVID-19 rates as strongly would suggest that the mobility restrictions before this period had been successful in controlling the contagion effects in the Turkish health geography.

Now the picture is remarkably linear, with a clear case of greater contagion risk in the first two months of the epidemic, being translated into higher excess mortality values once the restrictions are eased. This suggests that both the economic burden of the mobility restrictions, and the health system and health outcome benefit of the COVID-19 epidemic in Turkey has been very unequally distributed between the regions, which suggest a certain transfer between the provinces in order (economically) to create a sustainable situation where the burdens, and benefits in the face of the crippling epidemic is distributed more equally among the geographies (Chang et al. 2021).

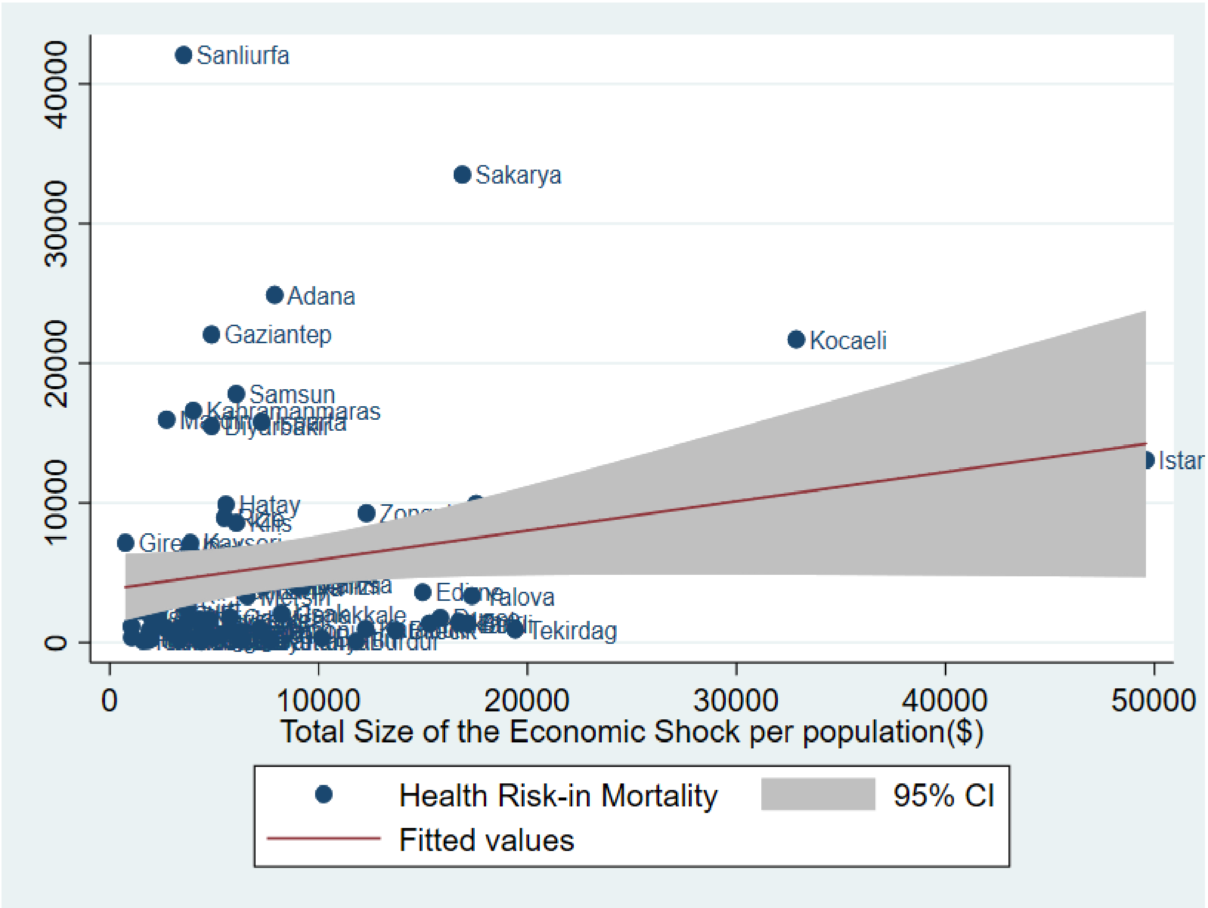
Table 3 supports this hypothesis. The epidemic has been in the main, Istanbul led, and have been spreading through Istanbul`s trade, economic and people networks. The facts about the epidemic, scientifically verified, and supported by crucial additional evidence, must inform the decisions we will make in the second round, as a new round of province close-downs, and mobility restrictions are being considered again. One important point of the paper is that we must learn the greatest amount from the first round, and from the research in the multidimensional fields of economics, epidemiology, public health before we reach our conclusions and decisions in order to control the COVID-19 epidemic in the second round. Table 3 is supporting this basic notion in the following fashion. The excess death figures come from the excess mortality figures of gucluyaman (https://github.com/gucluyaman/Excess-mortality-in-Turkey/tree/master/) and the BBC Turkey database, measured until the 1st of September from the end of 6th month, and we look at the contagion risk as measured from our data in terms of what happens in the first wave, until the end of the 5th month.

Table 3: Regression of Proportion of Excess Death in 8 months to Contagion Risk (First 2 months)

Model | 4.6738e-07	1	4.6738e-07	Prob > F = 0.0000			
Residual | 1.9496e-06	78	2.4994e-08	R-squared = 0.1934			
			Adj R-squared = 0.1830			
Total | 2.4169e-06	79	3.0594e-08	Root MSE = 0.00016			
Proportion Excess Death |	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
Contagion Risk |	9.98e-09	2.31e-09	**4.32*****	0.000	5.38e-09	1.46e-08
Constant |	1.97e-07	.0000217	0.01	0.993	-.0000429	.0000433

Figure 13 shows the distribution and the macro mobility constricting policies which create a significant economic cost in the short run and which will also play an important role controlling the epidemic if it grows out of the geographical pattern that is previously shown. As the disease progresses with a different geographical pattern, the cost/benefit ratio of distribution can be different. But we would also like to state that the geographical distribution is very high variety, with some geographies represented by high benefit and relatively low cost, and other areas described by low benefit and high cost.

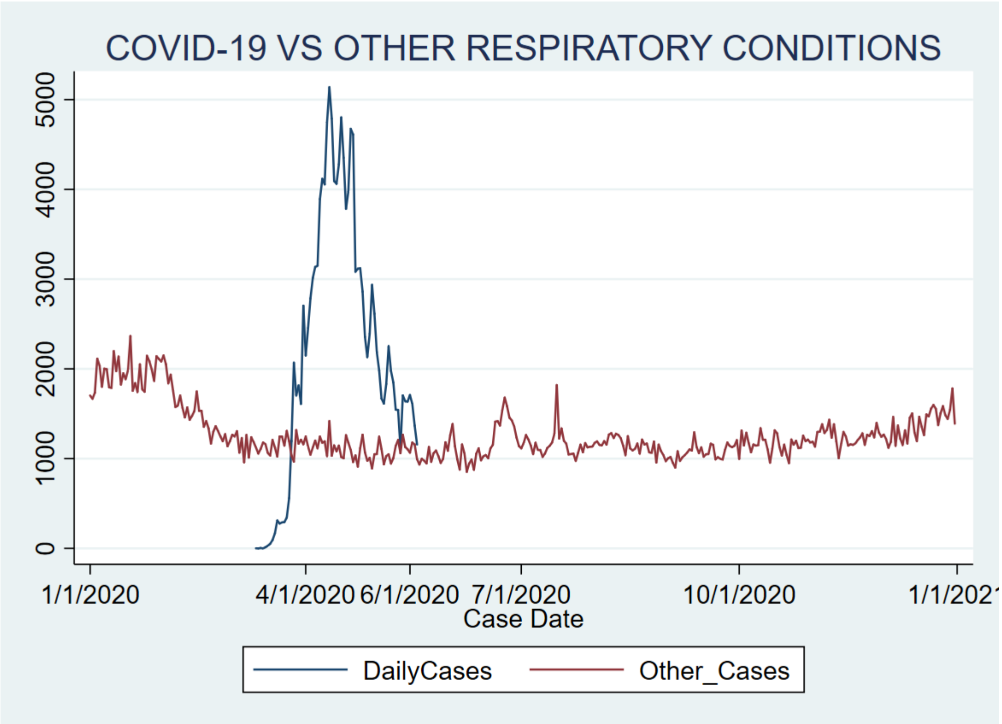
Figure 13: Economic Cost of COVID-19 Policies and the Potential Health Effect (Province Level)



Clearly, the choice of all-causes excess mortality has important limitations that must be remarked upon, both empirically and theoretically. The excess mortality figures do not tell us which are the medical causes of mortality, not making it clear if the problem is the health system solely focused on COVID, or if the problem is respiratory clinics going over-capacity with a sudden infusion of COVID-19 cases, or COVID-19 infections creating a mortality situation by weakening the immune system, and the reaction of the body against multiple conditions. At the minimum all respiratory infection mortalities should be compared from 2019 to 2020. However, incomplete data in this case-specific mortality rates mean that all-cause all-ages mortality is the best data that we can work with.

Also, in the case of COVID-19, with a very specific age-gradient in mortality and morbidity, an age breakdown of the deaths and the situation vis-à-vis vulnerable age groups and specific health vulnerabilities must be investigated. This excess deaths data is just to show that the specific contagion risk variable we have estimated is really positively correlated with the impact of COVID-19 for different provinces. Having established this, the further stages of analysis will be focused on both estimating the COVID-19 burden on provinces and the health system specific mortality much more clearly, and in a much more in-depth manner, with a specific emphasis on age and infection vulnerabilities.

Figure 14: Corona Health System Pressure Compared to Normal Respiratory Conditions



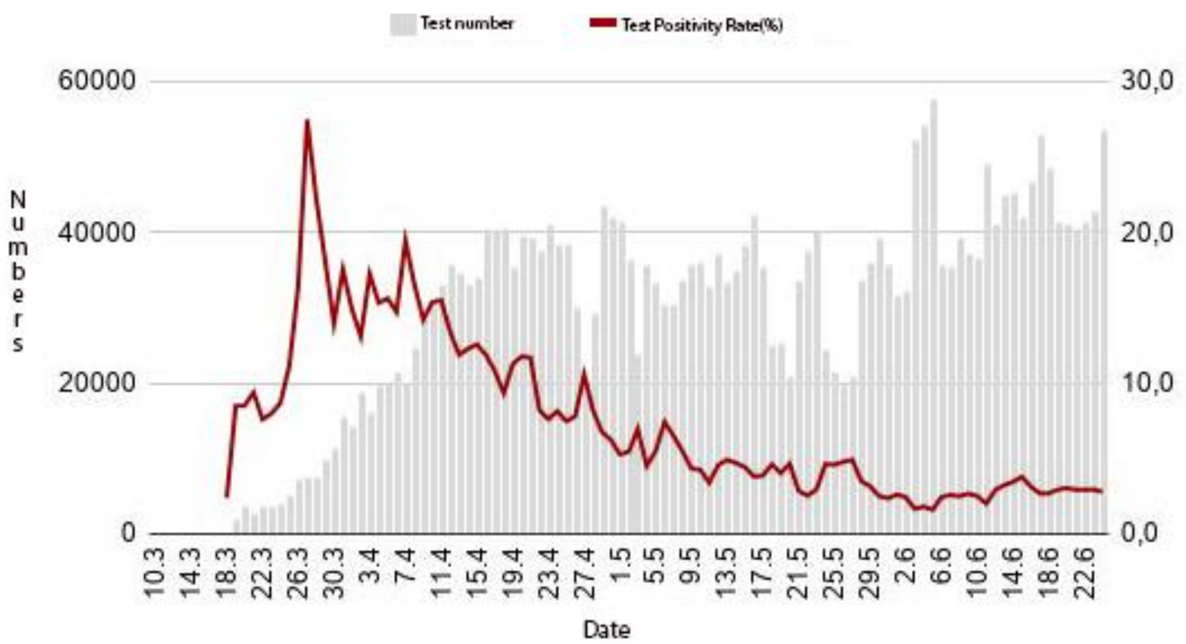
As Figure 14 shows when we assume the other respiratory cases, as case load will stay constant in 2020, compared to 2019, our health system is entering a new period where the COVID-19 respiratory infections will effect a part of the health system that is increasingly already occupied, heightening the risks of capacity diminishment, mis-identification and mix-ups, and non-adequate treatment in the health system. We must, using the multidisciplinary framework introduced in the start of the paper, take pressure away from the health system, by focusing on coordination between the different actors and decisions in the Turkish economy, public health system, and the health system geography.

One of the crucial points is that respiratory clinics, and respiratory doctors will meet with pressures from other respiratory infections, which themselves are seasonal, and grow around late Autumn and early winter as seen by Figure 14. The first wave of COVID-19 cases did not occur at a heavy day for new respiratory cases and infections, but there might be a time when the earlier existing cases might be most effective in already filling the bed capacity, and ICU bed capacity, and the respirator capacity.

We next show testing capacity as an independent variable for COVID-19 infection rates. Figure 15 shows the degree of test positivity, and after picking up at the start, as the number increases, and the epidemic transmits, the degree of positivity transitions to a lower rate after 5 weeks, with a fixed plateau that is reached after the 2nd of June. The idea that the paper puts forward is that in terms of testing capacity, the two characteristics are needed: (a) the fastest transmission from highest to lowest positivity rate (identification-containment-isolation) and

(b) identification of growing clusters. The measure we capture is looking at the range of maximum to minimum positivity, and also at the variation in the testing capacity after it has reached the minimum positivity, and after the disease has been kept under control. The ability to create a short range means that the testing system is created in a utilitarian way, used to identify the growing epidemic, controlling the level of the growth. The secondary characteristic, which is the degree of variation after the minimum positivity point, captures to what extent the testing system can pick up the oscillations in the local and national transmission rate, with the ability to pick up small perturbations. Testing systems where the positivity rate looks fixed after reaching minimum suggests a minimally sensitive system, that is not parsing the population finely enough to identify growing clusters in the data. We take the geometric average of these two different measures, and ranked the countries in terms of their position with respect to this index. Figure 15 summarizes the testing ability of the country, as measured by the positivity rate of the country. What needs to be understood is how this compares with other country, and whether it can be shown how valuable testing ability is and can the epidemic control utility of testing ability be shown.

Figure 15: Changing Public Health Test Capacity through Time[8]



4. Conclusion

The outbreak was quite regional in nature for the first two weeks, starting from the 13th of March. Outbreak settings shifted from travel and workplace in March, to mass transmission in April. Restrictions implemented on 1st of April extended to full lockdown on 12th of April. The cases peaked around the last week of April. Phased relaxation of restrictions commenced on 1st of June. Effective suppression of community transmission of COVID-19 was achieved by

[8] From the statistical calculations of Prof. Banu Cakir (Cakir, 2020)

the first week of June 2020. Significant healthcare place transmission was avoided, as well as significant region-to-region transmission. Although the long-term benefits of the policy are unclear, in the short run, the vulnerable spots of the Turkish geography were protected, the health system pressure was controlled within the boundaries of the system, and the death rate was kept at a lower rate, but compared to comparison countries, and compared to later disease waves (Dong et al. 2020, JHU 2021, Roser and Ospina 2019). The economic cost of the Istanbul-centric lockdown for different regions is also quantified. Points about the resulting policy vis-à-vis health inequality and economic inequality among regions can be readily made (Alvaredo et al. 2018, Marmot 2020, Stafford and Deeny 2020), when the protected regions are also the regions in many cases, from the bottom of the Turkish health distribution.

For the longer term, and the later rounds of the epidemic, the economic costs of a full-national lockdown are prohibitive at the social and economic levels to be sustainable. In this sense 'national lockdown' is a crude national level NPI (Non-Pharmaceutical Intervention) for the control of COVID-19, in the long term. The two suggestions for us in the next rounds are (1) a more flexible, and regional level lockdown policies, with elasticity in the regional level as well as between different levels and settings of NPI restrictions (2) the enlarged, and strengthened public health system and testing ability that will allow the state to see where the micro-outbreaks are, so faster, and more targeted interventions can be carried out without increasing macroeconomic effects for the entire country. States should prioritize health literacy to ensure maximal population compliance with individual level restrictions and thus prevent the need for crude population-level restrictions amounting to 'lockdown', in order to protect the health and well-being of the Turkish population in a sustainable way.

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Ethics Statement: The authors declare that ethical rules are followed in all preparation processes of this study. In case of detection of a contrary situation, Fiscaoeconomia has no responsibility and all responsibility belongs to the authors of the study.