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Perceptive risk clusters of European citizens and NPI compliance in face of the covid-19 pandemics

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Abstract

Despite promising announcements on an effective vaccine, the control of the covid-19 pandemic is critically dependent on the maximal compliance of citizens to a set of non-pharmaceutical interventions (NPI for short). We use statistical clustering to partition European citizens with regards to their perceptive risks and social attitudes during the first wave of the covid-19 pandemic and find ten segments to predict, both the extent and mix of protective behaviors adopted. Those segments demonstrate a clear divide in the population, with on one extreme, a segment (standing for 8% of the population) that is self-centered and exhibits low self-risk perception as well as low NPI compliance. The other extreme is composed of a segment (11% of the population) that is more socially oriented, and quite responsive to all protective measures.

As data are survey-based, we adjust responses based on information gap (by reaction time, RT, measurement) of both worry expression and NPI compliance, to confirm the robustness of our results. Further, we extend the notion of worries to be not only health-related but to include financial risk (like losing a job) as well as psychological worries (e.g., feeling alone, or being unable to meet with family and friends), as they prove to drive different NPI behaviors among the population.

Keywords: Covid-19 pandemics, Clustering, Non-pharmaceutical interventions, Europe

JEL codes: I12, J22, J23, J33

1. Introduction

The worldwide pandemic of the covid-19 has entered its second wave recently, with significant morbidity and mortality costs.

By early August, covid-19 had led officially to more than 700,000 fatalities. This is a figure matching the worse cases of annual flu, and already twice larger than the global pandemic of the H1N1 by 2009 (Bughin, 2020). By mid-October, a new inflection point was visible. Along with the softening of lockdown in many parts of the world, the pandemic has made a comeback. By early December, the number of worldwide fatalities has reached 1.5 million individuals or a doubling of death cases in a few months. The number of seriously ill active cases worldwide, which has been stabilized, at roughly 60-65 thousand daily cases in Q2-Q3, has been regrowing, close to reaching 100,000 cases a day, by end of November.¹

While there have been significant announcements of effective vaccine recovery, e.g. from corporations like Moderna, or Pfizer with BioNtech, controlling the pandemic at the current stage must continue to rely on compliance with a set of non-pharmaceutical interventions (NPI, for short). This is even more important to date, as the full blanket lockdown put in place by many governments in the first wave of the pandemic is difficult to re-impose as it has entailed a major drop in economic activities up to 5 to 10% impact on an annual basis for worldwide GDP (Coibion et al., 2020). It also has led to a significant amount of 200 million job losses among others, according to the ILO.²

In the absence of hard lockdown, regaining control of the pandemic must be based on quarantine of (the closely exposed to) the contaminated, as well as the general compliance to a set of NPIs, like social distancing, and hygiene habits like wearing masks, or cleaning hands and objects. But for the quarantine to be effective, one needs to have the tracing tools to spot contaminated - which has appeared complex in practice -, while NPIs to be extensively practiced by the population, require good communication and (dis-)incentives.

Casual information suggests that NPIs are more or less being applied, sometimes because it is imposed strictly, sometimes because of large penalties leading to major dis-incentives.

¹ <https://www.worldometers.info/coronavirus/worldwide>

² <https://news.un.org/en/story/2020/04/1061322>

In general, the economics of pandemics also hint at different NPI compliance segments, with the simplification that, NPI will be mostly practiced *by the susceptible* to the extent that the contact benefit is smaller than the health risk of being infected (Bethune and Korineck, 2020). This entails in practice that protective behavior is correlated with age, and with co-morbidity risks, as both drive a large part of the severity of the incidence of covid-19 (Riou et al., 2020). In contrast, the segment of the infected is likely not to follow NPIs, as the segment is no longer to be infected, at least soon.

The merit of integrating economic behavior into a pandemic model is to show that diffusion paths are endogenous to behaviors, but also that under certain parameters, behaviors themselves may lead to an acceleration of the disease. It also puts rationale as to why the combination of strong negative health externalities in a covid economy with a large concentration of incidence and severity, leads to poor NPI compliance at the start of the covid-19 pandemic, except when too late, hence requiring stringent policy interventions such as quarantines.

Nevertheless, the segmentation used in those models may be both too schematic for policy setting, and even inaccurate. Consider the susceptible segment. It is well known that people may have a hard time estimating their own health risk and thus may suffer cognition bias in their trade-off between social benefits and the risk of being contaminated (Niepel et al., 2020). Nevertheless, the segmentation used in those models may be both too schematic for policy setting, and even inaccurate. Consider the susceptible segment. It is well known that people may have a hard time to estimate their own health risk, and thus may suffer cognition bias in their trade-off between social benefits and risk of being contaminated (Niepel et al., 2020).³ Second, if health risk has been often recognized as one of the most stable predictors of health-protective behavior (Harper et al., 2020), other risks are clearly being expressed by citizens (like the risk of losing their employment), that can cause them to adapt their behavior.

Finally, the risk to self-contamination is possibly a too narrow view of stimulus to behavioral change during major shocks like the covid-19. In many cases of natural disasters, a large portion of individuals shows a sign of care for others. Even, before risk materializes, exposure may make people very socially aware (see Bollier, 2020 among others). For example,

³ In that study made in the early months of the disease, many US adult residents had severely underestimated their fatality risk compared to what is induced by the covid-19 epidemiological figures.

healthcare professionals' worries at pandemic times are typically altruistic. For instance, in the case of the covid-19 outbreak in the Wuhan region, major worries quoted by healthcare professionals were first, infection of colleagues (more than 7 out of 10) and second (for 2/3 of healthcare workers) risk of contamination of family (Dai, 2020⁴).

Now assume a covid economy where, instead of the traditional socio-economic assumptions, citizens are very altruistic about others' health, incorporate not only health but financial risks increasing with contaminations, and/or suffer cognitive bias of over-estimating the morbidity risks of the disease. Such an economy will possibly be able to stop the virus dynamics early in its diffusion. Consider another covid economy, where risk is totally understated despite rapid health penalty, and recovered cases engaged in even more socialization as an overshoot reaction to the number of social interactions lost during their infection, this economy is of course bound to become largely infected.

1.1. Article scope and fit with the literature

This paper develops a detailed segmentation of citizens risk perception to self and others, as a further driver of NPI differentiated compliance.

We believe that the originality of this article is many-fold. First, if there are many studies looking at *health* risk perception of a pandemic, this paper develops a detailed segmentation of how citizens perceive a broader set of risk archetypes (health, financial, etc) that are congruent to the pandemic. Second, those risk perception studies are often country-specific, e.g. Harper (2020) for the UK, Wise et al. (2020) for the US, Faasse and Newby (2020) for Australia, or Zickfeld et al. (2020) for Norway, Bughin et al. (2020) for France among others. This research relies on a sample of more than 5,000 European citizens, above 18 years old, out of France, Germany, Italy, Spain, and Sweden, so that one can assess the generality of country-specific behavior. Countries were indeed chosen to reflect a spectrum of lockdown policies and health systems. Also, we cover 5 of the largest countries that make the core of Euro-27.

Third, on purpose, we look at risk perception to self *and others*, as this drives key externalities, but also because it may well be that those risk perceptions are not covid-19 related but can

⁴ The same is visible for the population in general. The data used in this paper have been collected in the first wave of the disease spread, and the official part of the population infected was less than one percent in the European countries we focused on. But focusing on those, the anecdotal evidence is that infected people were more worried about the health risk linked to their kids (55% of them) and elderlies (80% of them) than their *own health* risks. This is in contradiction to the characterization of the contaminated segment in the socio-economic model of pandemics.

arise as critical social traits. Do et al. (2017) have argued that risk-taking and prosocial tendencies are two inherently intertwined personality dimensions, and that high risk-taking behavior and low social tendency may lead to negate all social protective behaviors. We find evidence of this in the segmentation results, in line with other recent surveys (Howard, 2020).

Fourth, the study uses cluster analysis as a powerful way to assess where the population can be represented by some cohesive attitudinal segments, as highlighted for early epidemic outbreaks such as SARS or H1N1 (see Vaughan, 2011; Leppin and Aro, 2009). Regarding covid-19, Massaad and Cherfan (2020) leverage tweets to demonstrate the prevalence of clusters linked to the extent of perception of morbidity risk of the covid-19 disease. Bodrud-Doza et al. (2020) use a survey in Bangladesh to assess the type of risk perception linked to covid and find four cluster groups that are linked to mortality risks and food scarcity, socio-economic issues, or mental health issues. Those early studies confirm that the prevalence of cohesive risk profiles clusters around the covid-19 pandemics, while our study further informs on how social orientation, and experience of infections/quarantines, may also be important segmentation factors, that furthermore are critical drivers of externalities in the economics of pandemics. Also, Bodrud-Doza et al. (2020), based on a relatively small sample of 400 individuals in Bangladesh, does not link worry segmentation to NPI compliance, as we perform in our current research.

Fifth, when it comes to NPIs, a part of the literature has been looking at the effectiveness of interventions on controlling the pandemics (e.g., Haug et al., 2020; Ferguson et al., 2020). Another part has attempted to understand drivers of compliance (Gialama et al., 2020). Webster et al. (2020) confirm that adherence to quarantine is linked to the intensity of knowledge about the disease outbreak, risk of disease, or social norms, during the covid-19 pandemics. The results corroborate early studies looking at quarantine compliance during the SARS outbreak (Cava et al., 2005). Our study in contrast first clusters risk attitudes and then successfully looks at how they predict some of the variances in NPI compliance.

But we also find that attitude segments also build up different segments of NPI, e.g. one segment is especially reluctant to hygiene measure, two other segments are broadly averse to any NPI, with one slightly less reluctant to quarantine.

Last, but not least, our analysis uses an online survey which makes us at the mercy of the validity of the answers provided. We leverage a powerful data collection technique based on the neuroeconomics field to both filter the non-credible answers and assess the information strength of the answers received (Ohme et al., 2020). Neuro-economics suggest among others that people's speed of answers guides the reliability of the information responses. Our analysis uses an algorithm (Ohme et al., 2020) that measures both, the explicit answer as well as the speed of answering making it possible to identify the confidence of attitudes. Additionally, too quick or much too long response times also suggest non-reliable answers as people either escape questions or do struggle to answer.

Also, the response time uncovers new insights. For instance, segments that are claiming to be the most worried tend to have *faster* response time than average, reinforcing the idea that they are worried. This contrasts with the segment that claims to be less self-worried, and least NPI compliant, which has produced a longer response time, in virtually all questions than the average respondent.

1.2. High-level findings

Taking all our findings together, the following picture emerges:

1. 10 covid-19 risk/NPI segments prevail into the continental European population, a larger set of segments than what has been found so far in the literature using a more restrictive set of attitudes, e.g. Massaad and Cherfan (2020).
2. Dimensions that clearly profile the segmentation are the type and intensity of worry, self versus others orientation, in line with Do et al. (2017). Exposure to the virus and socio-demographics also play a mediating role.
3. Health is the most expressed worry but is far from being exclusive. Among others, financial or job preservation risks are of extensive worry; in particular, a segment (10% of the population) is more worried about financial risk than a health risk.
4. Regarding social orientation, about 40% of the population expresses worries towards their children/family or is acknowledging the crucial role of workers in essential jobs, among other health workers.
5. Three attitudinal segments, concentrating about 30% of the population, are the less inclined to NPIs, and are clearly a valuable target to policy actions.

6. The information gap analysis has proven that the tendency to distort the given answers differs by question type.⁵ The highest distortion between declarations and confidence is observed for compliance and the lowest for expressing worries. In the face of the pandemic, people feel authorized to express worries but obliged to confirm compliance. Thus, it is easy to overestimate the usage of the NPI measures by relying on the pure statement made by respondents.

The rest of the paper reads as follows. The next section discusses data method and collection and high-level statistics from the research. Section 3 presents the clustering analysis, as well as the links to NPI attitudes. The final sections discuss implications of findings and layout conclusions, including proposed avenues beyond this research.

2. METHODS AND DATA

2.1. Scope

The research is a part of an extensive multinational covid-19 Fever project aimed at understanding people's attitudes, emotions and behaviors connected with the pandemic. Based on the experience that attitudes/opinions and risk perceptions are critical drivers of protective actions during a health crisis (Harper et al. 2020), 50 questions were selected (see Appendix 1).

The list of questions includes among others (see Tables 2a, b, c, and d) the most often raised questions in the burgeoning literature on the covid-19 regarding concerns (such as worries to get infected) (Lee et al., 2020; Mertens et al., 2020) and behavioral change (such as practicing social distancing) (Asmundson and Taylor, 2020; Banerjee et al., 2020; Harper et al., 2020; Lunn et al., 2020; Oostertoff, 2020; Wise et al., 2020).

For the purpose of this paper, we focus on data from the continental European Union. Five countries are being analyzed: France, Germany, Italy, Spain, and Sweden. Those countries are among the largest of the EU and/or are representative of different socio-economic models (Esping-Andersen, 1999), as well as have chosen different policy responses in the first wave of the covid-19, by March to June 2020 (notably Sweden and Germany have chosen no, or lighter

⁵ Information gap is a measure of the proportion of explicit answers given without confidence (see Section 2.3).

lockdown than other countries). By pooling the countries together, we are then looking at attitude segmentation that is robust to country idiosyncrasies.

2.2. Data Collection

The data collection was performed online⁶, based on country representative samples for age (above 18 years old) and gender, and recruited via a panel agency in April 2020 (See Table 1). The total sample amounts to about 5,000 answers or a minimum of 1,000 per country.⁷

Table 1. Number of respondents and demographic split per country

	Total	Gender		Age		
	N	Females	Males	18-35	36-49	50+
FRANCE	1,024	51%	49%	29%	28%	43%
GERMANY	1,017	49%	51%	27%	24%	50%
ITALY	1,021	51%	49%	26%	30%	44%
SPAIN	1,019	50%	50%	32%	32%	36%
SWEDEN	1,006	51%	49%	30%	20%	49%

Respondents received email invites and the samples were gathered within the first day from the start of the study. Respondents were also informed that the study tests opinions about the pandemic and that it is anonymous. No personal data were collected.

The task of the respondents was to evaluate if they agree with the statements presented on the screen.⁸ To avoid people being « forced » to respond, or respond with answers that are not reflective of actual behavior, each question was structured to respond, on a 3 point scale (yes, hard to tell, no) with “hard to tell” allowing not to force an answer.

A common issue linked to surveys is however that what people report does not always overlap with actions making it hard to predict behavior based solely on explicit answers. In the case in hand, declarations on the compliance with some of the NPI measures can be especially

⁶ We would like to thank Neurohm and Syno for collecting the data in all six countries.

⁷ Full descriptive statistics on the data are available [here](#).

⁸ Again, see Appendix 1.

susceptible to distortions due to auto-presentation needs, post-conscious rationalization, or simply for some respondents to hide ill-perceived behaviors.

To avoid this, we have applied response time measurement. As shown by Fazio et al. (1989) correlations between attitudes and behaviors are higher among people with fast reaction time when expressing their opinions. iCode Smart test was used to collect the data (Ohme et al., 2020), with response time (RT) being measured for each answer, making it possible to derive a measure of the reliability of attitudes. In this respect, responses given too fast suggest speeding through the test without giving meaningful answers, or responses given too slow, suggest a person got distracted from the test (Greenwald et al., 2003). For each variable, RT given with a latency lower than 500 milliseconds (ms) (suspected to be given randomly) or higher than 10,000 ms (suspected to have been given after distraction) were replaced by the average of each variable. In total, this amounts to only 0.48% of dubious responses.⁹ The latency values were also divided by 10,000 to obtain re-scaled values between 0 and 1.

2.3. High-level statistics

To account for individual differences in reaction speed, we have standardized reaction time data measured in ms, with STD-RT being the z-score of $\log(\text{RT})$, with mean = 0 and standard deviation = 1.

The next step was to create a combined measure, taking into account both the explicit answer as well as the reaction time (RT) needed to produce the answer. The RTC index takes values between $-2 < \text{RTC} < 2$ and is defined as the difference between a measure of strong Yes, given by $\text{RTC}(Y) = 1 - (\text{STD-RT}/2)$ and a measure of strong No, $\text{RTC}(N)$, as given by $(\text{STDRT}/2) - 1$.¹⁰ Hard to tell answers are marked as 0 value. From this, we build a re-scaled RTC' index $0 < \text{RTC}' < 1$, where $\text{RTC}' = (\text{RTC}+2)/4$.

⁹ Furthermore, to ensure high quality of data and eliminate test biases a calibration phase and control screen have been added. Calibration preceded the test phase and consisted of 3 steps:

- a. Familiarization with the scale. The task of the respondents was to press certain answer options – this task made sure respondents are aware of the position of the buttons on the screen.
- b. Familiarization with the purpose of the task. A few statements were presented describing the test and the task. After each screen respondents had to press a button. This part served as a motoric warm up.
- c. Increasing the focus on the task. During the study, a screen appeared asking to indicate the statement that was presented last. This task aimed to make sure respondents focus their attention on the presented statements. Such a screen was presented twice. The control screen was introduced to eliminate the effect of the position of the mouse on the screen. It was presented before each statement, forcing a standardized position of the mouse (the distance to the yes and no answers was always the same).

¹⁰ STD-RT values above 2 and below -2 were truncated and given the value 2 or -2 respectively (this accounts for around 3% of data).

We note that (STDRT/2) (= GAP, for short) can be seen as an information gap, as GAP grows with the rate of explicit answers given without confidence. At the extreme, the highest bound of 2 standard deviation leads to an information gap of 100%, that is the answer given, even though not coded as I do not know, has so much uncertainty that we recalibrate it to an “I do not know” answer.

Tables 2a, b, c, and d provide the RTC' and GAP statistics computed for the most common questions and statements analyzed in the emerging literature on covid-19 pandemics and assembled in four categories. The first table 2a looks at the statement regarding the category of covid-19 health hazard.

Table 2a. Health hazard of covid-19

Worries Type	Statement	RTC'	S.D.	Information GAP
Dangerousness	Covid-19 is dangerous for my health	71%	0.25	11%
Occurrence	My chances are high to get infected	46%	0.20	14%
Treatment	If infected, I will have the appropriate health treatment	62%	0.15	21%
Vaccine	I will take the opportunity of a vaccine	62%	0.14	19%

For any indicator, $RTC' > 50\%$, except for occurrence, just below, but close to 50%. One might expect this, as the infection rate during the first wave remains below 5%, but epidemiologists have made clear that, without restrictive behavior and/or vaccine, the reproduction rate (R-naught) of the virus may affect a dominant portion of the population.

Still, we find in our sample that $RTC' = 71\%$, equivalent to a general « yes » when it comes to the alignment to the question of *whether covid-19 may be dangerous to the health of the population*. We also find that $RTC' = 62\%$, regarding the will to be vaccinated against the covid-19; this is a majority of yes, but far from a complete total of the European population. This level of RTC' bodes well with other studies, e.g. in France, roughly 7 out 10 people, have reported accepting vaccination to covid during the first wave (Detoc et al., 2020).¹¹

We finally notice that, for the information gap, this measure varies between 11-19%, or an average of 16%, concerning health hazard statements - otherwise stated, statements have been discounted by 16%, to reflect the uncertainty as measured by response time. This is a

¹¹ Uncorrected RTC is more like 74% in our sample, see below.

rather large factor, as the uncorrected trust statement in healthcare would be $62\% \times (1+21\%) = 75\%$. This discrepancy between declarations and confident answers naturally happens when respondents recognize some external contingencies (e.g. healthcare system, and the quality of a vaccine if found).

Table 2b first looks at expressed worries, as worries are typically seen as a catalyzer of behavioral change. Regarding worries, the largest worry expression concerns health, with an RTC' range between 50-70%, for the susceptible continental European population. This is consistent with other literature findings, e.g. Dryhurst et al. (2020).¹²

What is interesting is that health worries towards third parties are high especially with regards to the close family circle. It concerns not only kids but especially older family members' health, in line with higher mortality for the older population. Dryhurst et al. (2020) have demonstrated that social orientation is the largest contributor to risk perception.

Worries are also by far, not exclusively around health. The second worry is linked to job preservation, and household and country finance. The country's ability to navigate through the crisis is a worry that is as acute as its own health. We hypothesize that this worry emerges from the fact that a large part of the countries we cover has forced full blanket lockdown to re-gain control of the pandemic evolution, with large pressure of economic activity and high volatility of stock market returns (Coibion et al., 2020). Social risks are a majority, especially towards friends and family, while social unrest (such as thefts and breakage) are also made clear. In general, thus, it is rather important to map the type and breadth of risks as possible catalyzers to NPIs.

Table 2b. Worries taxonomy around the covid-19

Worries Type	Statement	RTC'	S.D.	Information GAP
Health	I am worried about my own health	62%	0.33	4%
Job	I am worried about my job situation	49%	0.32	4%
Finance	I am worried that our country will run out of money	63%	0.21	12%

¹² Dryhurst et al. (2020) have assessed in April 2020 health worries around the world to be just below 5 on a Likert scale of 0 (not at all worried) to 7 (extremely worried).

The GAP value associated with the categories of worries is the lowest out of all 4 categories (see Tables 2b, versus 2a, 2c, and 2d), suggesting that in the face of the pandemic people feel rather safe and clear in expressing their worries.

Table 2c looks at the interface of actors and their actions being implemented around the covid-19. Public authorities must be trusted in general and in particular for their way of managing the crisis, so that citizens adopt recommended protective actions (Li et al., 2018). However, governments have built some, but limited legitimacy, in the eyes of European citizens. Those actors have the least support (see the low RTC') among all groups analyzed in the survey. This is also where the statements have the lowest information gap for all categories so that those statements are the closest reflective of the true perception of respondents.

Table 2c. Perceptions around actors and their actions around covid-19

Actors	Statement	RTC'	S.D.	Information GAP
Health carers	I am grateful to healthcare professionals	78%	0.16	18%
Workers	I am grateful to our essential workers	70%	0.18	20%
Media	Media provide reliable information about the pandemic	55%	0.21	8%
Health institutions	I am satisfied with how our healthcare system is handling this crisis	62%	0.22	15%
Governments	I am satisfied with how my government is handling this crisis	55%	0.28	3%
	The government is doing a good job dealing with covid-19	55%	0.22	3%

Table 2d reports on three types of NPI actions. Bo et al. (2020) found that NPIs have been able to contain the covid-19 pandemic in the first wave around the world. Avoidance elements such as social distancing, then quarantines, then preventive hygienic factors are to be adopted as extensively as possible by the population as those measures seem to have the largest impact on reducing the reproduction rate of the covid-19. Especially their combination was large enough to push the reproduction rate below unity and break the build-up of the contagion. As a counterfactual, Cho (2020) shows that had Sweden used stricter lockdown interventions, it could have reduced its fatality rate due to covid-19, by a material amount (up to 75%). Like in other countries where lockdown was rather strict, our data suggest that many people are starting to be complying with avoidance behavior, such as social distancing and

staying at home. They also, and as expected to a lesser extent, practice hygienic factors, such as washing hands. This matches results found in multiple studies, e.g. Zickfeld et al. (2020). Still, the reach of compliance stands in the range of 75%, in our data, leaving a place for still broader adoption of NPIs. This category especially proves the importance of reaching to reaction time measurement when it comes to understanding attitudes and behavior in sensitive categories (such as expressing compliance to socially expected behavior). On the declarative level, 80% to 90% of respondents expressed compliance to staying at home, social distancing, and washing hands. At the same time these are the statements with one of the highest values of information GAP, suggesting that people give socially acceptable answers, but they do not necessarily believe in them (there is still a significant group not fully confident, thus not complying, only declaring).

Table 2d. NPI compliance

Behavior Type	Statement	RTC'	S.D.	Information GAP
Distancing	I comply with the recommendations for physical distancing	76%	0.16	18%
Quarantine	I comply with the restrictions to stay home	76%	0.23	13%
Cleaning	I wash hands for 20 seconds when necessary	74%	0.19	18%
Extra caution	I disinfect groceries before putting them away	48%	0.28	13%
Extra caution	I disinfect mail and deliveries before opening them	44%	0.25	22%

3. Segmentation analysis

We have so far discussed averages of metrics from Tables 2a, b, c, and d. These tables however demonstrate widespread variance in most metrics, with 2 standard deviations being on average, more than 50%, or flipping between a yes and a no. This strongly suggests that attitudes and behaviors during covid-19 are not homogenous.

We can easily hypothesize that behaviors might be clustered. For instance, the old population must be more worried about their own health given the virus incidence and health hazard are increasing exponentially with age. Further health risk should be more prevalent than job loss risk as old-timers may be often, already retired. As another example, healthcare workers are typically more exposed to the viral charge and are often reported to be rather worried about infecting their family, as the family indeed did not necessarily adhere to the same healthcare vocation (see Dai, 2020).

Using segmentation techniques, Bodrud-Doza et al. (2020) find that on top of socio-demographics, risk perceptions are better clustered into four homogenous groups linked to risk attitudes towards covid-19 in Bangladesh - that is, as a mix of mortality risks and food scarcity, socio-economic issues, or mental health problems. In another study, Kamenidou et al. (2020) find cohesive segments in the Greek population in their compliance with NPIs. Here, we use as well clustering techniques, but we include not only diverse forms of risk perception, but also, social orientations, in consistency with the neuroscience literature of people traits (Do et al., 2017, and Howard 2020).

3.1. Method

We resort to *clustering analysis*, in particular, K-means clustering to partition the population into cohesive and stable segments. We base our clustering analysis on all socio-demographic (i.e. gender, age, education, number of children, location density, occupation, incomes, political orientation) and risk perceptions variables less the 6 NPI variables (i.e. the 6 first variables of Table in Appendix 1).

The K-means technique minimizes the sum of square distances within each possible cluster to its centroid. Following the literature, we draw upon the statistical gap technique to infer the appropriate number of clusters before implementing K-means.

From an initial number of random centroids (2500), the final number of segments using the statistical gap, leads to $k = 24$, with convergence achieved after 500 Monte-Carlo bootstrapping iterations, meaning that the partition obtained is stable (see Figure 1). We observe however that additional gains in terms of the total within intra-cluster variation decrease significantly from $k = 11$ onwards. Therefore, we decided to retain a clustering with $k = 10$.¹³

As can be seen from Table 3, segments' size varies from 8.1% of the population for the smallest, to 12.6% for the largest one. The between some of squares/total sum of square achieved by the K-mean clustering is 22.8%, implying that clusters are relatively close to each other, but still, sufficient difference prevails between each other.

¹³ We also tested different values of k ranging from 6 to 12 and the segments obtained bring out the same risk profiles (with more granularity as k increased). We have chosen the value of $k = 10$, which turned out to bring out these different risk profiles the best.

3.2. Clusters discussion

Appendix 2 synthesizes the clustering outcome with the associated RTC', GAP and latency mean values of the key distinctive statements linked to worries, and opinions, as well as key socio-demographics compared to the overall sample mean. Table 4a (sociodemographic features) and Table 4b (RTC' and GAP values) further summarize a high-level archetype of those segments from Appendix 2.

Figure 1. Optimal number of clusters (K = 10) of European citizens' attitudes towards covid-19 pandemic - Gap statistic method

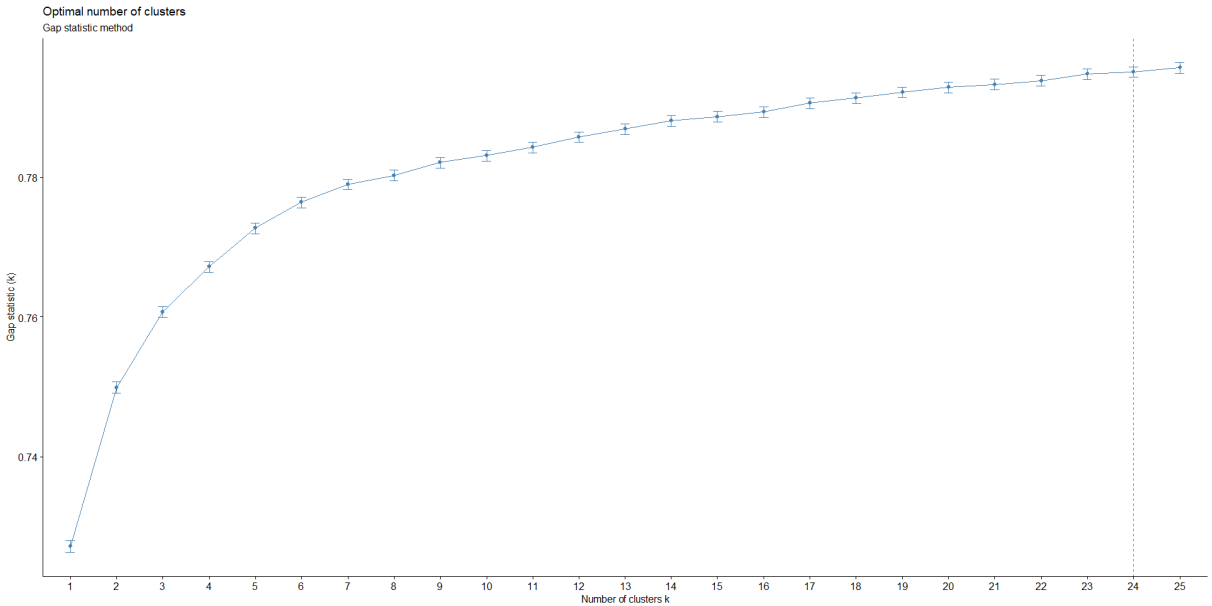


Table 3. K-means (k = 10) clustering of European citizens' attitudes towards covid-19 pandemic

Cluster #	sum of squares by cluster	Cluster size	%
1	17,443.2	577	11.3
2	19,011.6	639	12.6
3	14,477.9	412	8.1
4	15,238.9	449	8.8
5	17,344.2	525	10.3
6	19,093.8	586	11.5
7	14,432.2	428	8.4
8	12,174.0	429	8.4
9	16,816.9	455	8.9
10	18,297.1	587	11.5
Total sample		5,087	100

Tables 4a and 4b provide key statistically relevant factors emerging out of the segment and already helps witness a few important drivers of segmentation. First (Table 4a), work status,

age, income, family status, and education drive part of the segmentation, and still, to a lower extent, gender, political orientation, and location density. While socio-economic drivers are well known to impact attitudes, e.g. Papageorge et al. (2020), Table 4a also shows that differences in sociodemographic factors never explain all 10 segments, but at maximum correlated with segment inclusion for a maximum 4 out of the 10 segments. Work status exhibits the broadest correlations, with 6 segments out of 10. This is to be expected as we also look at risks such as finance and job preservation on top of health. Work status also plays a role in health risk because workers (versus non-workers) face the additional challenge of social interactions at work, at least for essential jobs.

Second (Table 4b), exposure to the disease, in the form of close knowledge of people being infected, or being quarantined, is another driver of behavioral change, as also found in Dryhurst et al. (2020). Third, social orientation and self-risk profile are clearly important in defining segments, with some segments clearly being low risk, low social orientation, like the 3rd or 9th segments, up to high risk, self-centered, like the 4th segment or still high social orientation such as the 10th segment, in line with the social trait theory of Do et al. (2017). Note also how different is the 3rd and 9th segment. The latter is biased towards the older, retired population, that feels safe; the former is more of the type of limited risk perception across all categories and among its family peers.

Finally, it is rather informative to look at the information gap by segment as reported in Table 4b. Among the three less NPI compliant segments, the 6th segment exhibits some latency, when it concerns its compliance to NPI. Further, it is likely not as so sure as stated that covid is dangerous, but it looks like more affecting the older part of the family than themselves.

The 8th segment has significant latency of answers on the moral hazard of the covid-19, as well as their NPI compliance. This segment looks rather unstable.

The claim by the 5th segment that the state does a good job in handling the covid-19 is slightly undermined by a higher latency in the way they answer the question as well as for their will to be vaccinated.

Table 4a. High-level sociodemographic features by segment of European citizens' attitudes towards covid-19 pandemic

Segment	Underestimate the dangers of covid-19	Highly worried (family oriented)	Neglecters	Health worried (self-centered)	Fake worried (Antigovernment)	Carefree (Government supporters)	All others	Social instability (non-self centric)	Remote safe	Health care protected (compliant and grateful)
Cluster	1	2	3	4	5	6	7	8	9	10
% of obs.	11.3	12.6	8.1	8.8	10.3	11.5	8.4	8.4	8.9	11.5
Infected		NO	YES		NO					
Quarantine	YES									
Age					18-25			50-64	>64	26-49
Gender			Female							
Education	High school	Primary school			Bachelor or higher	High school				
Income				High		Low	High			
Political orientation	Right		Left			No right				
Work status				Not employed	Students	unemployed		Not employed	Retired	Employed/ entrepreneur
# of Kids	0			1-3						
Location							Small town			

Table 4b. High-level sociodemographic features and information GAP by segment of European citizens' attitudes towards covid-19 pandemic

Cluster	1	2	3	4	5	6	7	8	9	10
	Underestimate the dangers of covid-19	Highly worried (family oriented)	Neglecters	Health worried (self-centered)	Fake worried	Carefree (Government supporters)	All others	Social instability (non-self centric)	Remote safe	Health care protected (compliant and grateful)
Health hazard perception										
Dangerousness				Y / +					N / -	
Occurrence								Y / =		
Treatment								Y / +	N / -	
Vaccine									N / -	Y / +
Worries taxonomy around the covid-19										
Health			N / -	Y / =						
Job		Y / +	N / -							
Finance		Y / +				N / -				
Social		Y / +	N / -					Y / +		
Perceptions around actors and their actions										
Health carers									N / =	Y / =
Workers					Y / =				N / -	
Media	N / -	Y / +	N / -					Y / +		
Health institutions						Y / +			N / -	
Governments					N / -	Y / +				
NPI compliance										
Distancing								Y / +	N / =	Y / =
Quarantine		Y / =								
Cleaning		Y / +				N / +			N / -	
Extra caution						N / +		Y / +		

Notes:

RTC': Y = High YES; N = high NO; GAP information: + = low confidence and – = high confidence.

Dangerousness: covid-19 is dangerous for my health; Occurrence: My chances are high to get infected; Treatment: If infected, I will have the appropriate health treatment; Vaccine: I will take the opportunity of a vaccine; Health: I am worried about my own health; Job: I am worried about my job situation; Finance: I am worried that our country will run out of money; Social: I am worried about not being able to meet with my family and Living in isolation negatively impacts my wellbeing and I am anxious about not being able to meet with friends; Health carers: grateful to healthcare professionals; Workers: I am grateful to our essential workers; Media: Media provide reliable information about the pandemic; Health institutions: I am satisfied with how our healthcare system is handling this crisis; Governments: I am satisfied with how my government is handling this crisis and The government is doing a good job dealing with covid-19; Distancing: I comply with the recommendations for physical distancing; Quarantine: I comply with the restrictions to stay home; Cleaning: I wash hands for 20 seconds when necessary; Extra caution: I disinfect groceries before putting them away and I disinfect mail and deliveries before opening them.

3.3. Segments as drivers of NPIs

Given the segments found, and the importance of risk and social profiling, we now analyze whether those segments may explain differences in NPIs compliance, extending some of the findings by e.g. Howard (2020).

Table 5 reports the regression results of linking individual RTC' value to the 10 segments for the three most important actions reported to significantly reduce the reproduction rate of the covid-19 pandemics, that is: social distancing, quarantine, and hygiene (see Bo et al., 2020). Regressions also include country effects, to account for differences in the types of measures taken by the various countries during the pandemic. Further, we also have experimented with re-including as control, the socio-demographic features of each citizen, and found the results of Table 5 to hold, with no significant change in the differentiated effect by segment, confirming that key primary drivers of NPI are attitudinal perceptions.

Note first that all regressions have Large F-values, with the Probability > F always below 1%, implying we cannot reject the existence of a systematic relationship between NPI compliance and segments. Second, segments have a large marginal impact on positive compliance to NPIs, e.g., based on Table 5, the average practice of social distancing / stay at home and clean hands for segment 3 are on average practiced by 5 points less than the baseline¹⁴; this is a material difference in compliance of 20% (= 70-50/75-50, where 50% is the split between yes and no).

Third, from the hypothesis that (mostly health) worries should drive more health protection, we should expect that segments with limited health worries - such as segments 3, 6, and 9 should have a much lower propensity to NPI compliance. This is exactly what we find in the three regressions.

Fourth, each of those three lower NPI compliant segments, have *also different* NPI profiles, otherwise stated, attitude segmentation guides NPI segmentation. As an example, the 3rd segment is reluctant to all three NPIs; the 6th segment is more reluctant to homestay and the 9th segment is the least compliant on both keeping social distancing as well as hands cleaning. Segments 4 and 5 have lower NPI compliance across the board, but with higher compliance than the 3rd segment.

¹⁴ RTC' is 76% for social distancing or an RTC value of 1.04. Using Table 5, RTC for segment 3 is $1.04 - 0.1 = 0.94$, or an RTC' of 73%.

Segments 5 and 7 have lower compliance on social distancing, while the 10th segment initiates relatively more social distancing and hygiene behavior, relative to baseline.

All this fits with the results on NPI compliance in a recent study on the Greek population by Kamenidou et al. (2000), which also uncovers segments based on the intensity of NPI used, with roughly 50% of the population close to being following all NPI measures, 35% in between and about 15% rather unconcerned. In our case, segments 1, 2, and 10 combined account for 30% of the total European population and are the most NPI compliant. In contrast, segments 3, 6, and 9 stand for 35% of the European population and are the least compliant, with a performance gap at the margin (see above) of more than 25% compared with the best compliant citizens.

Using as a benchmark the study by Bo et al. (2020), which shows a decline of 45% of the 5 days covid-19 reproduction rate, R_t , by using a combination of quarantines and social distancing (versus non-use), our figures implies a reduction of the 5 days' R_t of about 3.5% for the total population.¹⁵ Using R_t estimates as computed in rteu.live for the countries of our sample, the cumulative effect of infection from May ended to 30th of October (5 months), would amount to be between 20% to 30% of total infections lower by now, as a result of the compound effect. Spain, as one of the most affected countries in our sample, has for example added 1 million infected cases in those 5 months, according to Worldometer. Roughly 250,000 deaths could have been likely avoided if the three segments would have been at the same level of compliance as the rest of the population.

¹⁵ The three segments have on average 26% lower use than the frontier - for 30% of the population - or a 7.8% use gap. At 45% impact of the use, we have a marginal effect on the reproduction rate of 3.5%.

Table 5. Attitude segments as NPI predictor for European citizens, based on RTC value

Segment	Social distancing			Stay at home			Clean hands		
	Coeff.	s.e.	P-val	Coeff.	s.e.	P-val	Coeff.	s.e.	P-val
2	-0.01	0.008	0.270	-0.01	0.010	0.262	0.01	0.009	0.467
3	-0.10	0.012	0.000	-0.18	0.016	0.000	-0.13	0.014	0.000
4	-0.03	0.010	0.002	-0.04	0.013	0.004	-0.03	0.012	0.007
5	-0.03	0.009	0.002	-0.02	0.012	0.042	-0.02	0.010	0.047
6	-0.04	0.009	0.000	-0.09	0.013	0.000	-0.06	0.011	0.000
7	-0.02	0.010	0.014	-0.03	0.013	0.014	-0.02	0.012	0.095
8	-0.04	0.009	0.000	-0.06	0.011	0.000	-0.04	0.010	0.000
9	-0.09	0.011	0.000	-0.13	0.014	0.000	-0.12	0.013	0.000
10	0.00	0.008	0.612	0.00	0.012	0.714	-0.03	0.011	0.006
Country effects									
ES	0.02	0.008	0.062	0.16	0.012	0.000	-0.05	0.009	0.000
FR	-0.06	0.009	0.000	0.13	0.013	0.000	-0.03	0.010	0.001
IT	-0.05	0.008	0.000	0.18	0.012	0.000	-0.05	0.010	0.000
SE	0.01	0.008	0.313	0.11	0.012	0.000	-0.01	0.009	0.410
Constant	0.79	0.058	0.000	0.68	0.059	0.000	-0.05	0.009	0.000
# of observations	5,087			5,087			5,087		
F-stat (45, 5041)	15.87		0.000	17.61		0.000			0.000
R ²	0.1166			0.1647			0.0732		

Notes:

s.e. = robust standard errors; dependent variable is RTC' values;
 Country fixed effects and socio-economic characteristics included;
 Segment 1 and Germany are the reference groups.

4. DISCUSSION AND CONCLUSIONS

This study has demonstrated the prevalence of consistent clusters of risk and social orientation attitudes, which themselves are good predictors of different clusters of NPI compliance among continental European citizens. Further, it clearly shows that three segments, standing for a material portion (30%) of citizens, are less compliant than average regarding key non-pharmaceutical interventions that have been proved to be effective in controlling the covid-19 pandemic.

Those segments have proven to be solid, prevailing in each of the countries we have analyzed, and with the same impact on the way, people perform NPI and their mix.

Given the power-law nature of a pandemic, this non-compliance may quickly build up a large amount of contamination, which calls for identifying those citizens. The exact tactics to communicate, induce or enforce those segments to expand their NPI are beyond the scope of the paper but it is clearly important to have a more targeted approach, exploiting the fact that those segments tend to have different work status profile, different age structure, or political affinity. The common theme is, however, their social orientation profile, requiring trying to stimulate how they relate to family, friends, and colleagues. The fact that they may be more risk-taker may need to build disincentive too, e.g. penalties that are a function of repeated non-compliance, and pandemic development. In all cases, given the compound nature of the pandemic, actions must be taken early.

One final element of our work is that we have adjusted our data to reflect the solidity of answers as measures by reaction time. While this is becoming a natural procedure in neuro-economics, it is especially important to also use such procedures when one looks at critical behaviors – such as in this case, behavioral adjustments like a pandemic. Even if the survey provides the escape route of not answering the question (“hard to tell”), we find that RT is an important metric to compute. In general, we find an information gap of between 4% to 21% depending on questions asked. The information gap naturally evolves based on the respondent’s sense of control to the action asked. Interestingly, people tend to respond fast when it comes to their worries, reflecting that those are real; while there is a tendency of over-estimating compliance, especially for the segments much less inclined to follow them.

As for the next steps, it would be interesting to see how stable these segments are and how they change in time with the development of and waves of the pandemic. Second, strict lockdown, in a situation of the first wave, has possibly made people follow new rules. But there are clearly signs of fatigue by the population in respecting those NPIs. Finally, it would also be beneficial to look at more distant cultures – Asia or Arabic countries. Are the segments culturally universal, or are there differences in the perception, attitudes, and behavior connected with the pandemic.

In general, we believe that in line with Do et al (2017), that segments are likely the result of stable personality traits and will possibly be expressed along the way the pandemic evolves and in reaction to the types of policy made by multiple governments. The fact that NPI compliance may be only a bit weaker for a relatively large group of the population has a large consequence for how the pandemic can be stopped and there is thus a need for deeper analysis within those segments with less compliance, to prevent negative externalities within the covid economy.

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APPENDIX 1 Tested statements

BEHAVIOR
1. I actively encourage others to follow the restrictions and guidelines
2. I comply with the recommendations for physical distancing
3. I comply with the restrictions to stay home
4. I disinfect groceries before putting them away
5. I disinfect mail and deliveries before opening them
6. I wash hands for 20 seconds when necessary
7. I would like to help people who are more vulnerable to COVID-19
8. Since COVID-19 I eat healthier
9. Since COVID-19 I eat unhealthier
10. Since COVID-19 I exercise less
11. Since COVID-19 I exercise at home more
12. When a COVID-19 vaccine is available, I'd like to be vaccinated
EMOTIONS
13. I'm worried about my financial situation
14. I'm worried about my job situation
15. I'm worried that our country will run out of money
16. I'm worried that there will not be enough basic necessities in the stores
17. I am worried about my own health
18. I am worried about the health of my children
19. I am worried about the health of my older family members
20. I am worried about the health of people in my country
21. I worry that there will be an increase in break-ins and thefts
22. I'm worried about my children's education
23. I am anxious about not being able to meet with friends
24. I am worried about not being able to meet with my family
25. I worry how living in isolation will affect me
26. Living in isolation negatively impacts my wellbeing
OPINIONS
27. The COVID-19 outbreak will make society more unequal
28. Being together all the time increases family tensions
29. COVID-19 increases domestic violence
30. COVID-19 will increase divorce rates
31. COVID-19 will bring countries closer
32. I am grateful to our essential workers
33. I am grateful to our healthcare professionals
34. My chance of getting COVID-19 is high
35. Slowing the spread of COVID-19 is more important than the economy
36. Coronavirus is dangerous for my health
37. Media exaggerate the situation with COVID-19
38. Media provide reliable information about the pandemic
39. [The President] is doing a good job dealing with COVID-19
40. I am satisfied with how my government is handling this crisis
41. The government is doing a good job dealing with COVID-19
42. I am satisfied with how our healthcare system is handling this crisis
43. In case of a coronavirus infection, I will get appropriate medical help
44. The government discloses real numbers of coronavirus infections and deaths
45. COVID-19 reveals the best in people
46. COVID-19 reveals the worse in people
47. I believe we will beat COVID-19 soon
48. People will stop following the restrictions soon
49. The restrictions caused by COVID-19 will continue at least until the fall
50. The restrictions caused by COVID-19 will continue for about a month

Appendix 2. Characterization of the K-Mean clustering (k=10)

Cluster 1		577 respondents		cluster	full sample	cluster	full sample	cluster	full sample
				RTC'		LATENCY		GAP	
Quarantine2	Quarantine no	0.81	0.87						
Kids1	0 children	0.56	0.31						
Edu4	High school	0.28	0.37						
Politics2	Right	0.24	0.15						
Politics1	Left	0.24	0.35						
Kids2	1 child	0.21	0.36						
Quarantine1	Quarantine yes	0.09	0.06						
infected3	Infected don't know	0.06	0.05						
Kids4	3 children	0.04	0.07						
RTC.n37	Media exaggerate the situation with COVID-19	0.40	0.30	0.48	0.48	0.85	0.24		

Notes:

maximum and minimum average of variables for each cluster
socio-economic characteristics
risk's perceptions (Yes)
risk's perceptions (I don't know)
risk's perceptions (No)
Latency
averages in red represent values below the sample's average

Appendix 2. Characterization of the K-Mean clustering (k=10)

Cluster 2		639 respondents		cluster	full sample	cluster	full sample	cluster	full sample
				RTC'		LATENCY		GAP	
Age4	36-49	0.27	0.38						
Country	DE	0.20	0.05						
Country	ES	0.20	0.43						
Country	SE	0.20	0.07						
Edu1	Primary schools	0.03	0.02						
infected2	Infected no	0.69	0.61						
Kids3	2 children	0.18	0.26						
Politics4	Don't associate with politics	0.22	0.35						
Quarantine3	Quarantine don't know	0.10	0.13						
RTC.n18	I am worried about the health of my children	0.84	0.58	0.33	0.37	0.11	0.02		
RTC.n12	I am worried about my financial situation	0.83	0.57	0.33	0.36	0.11	0.04		
RTC.n03	I comply with the restrictions to stay home	0.81	0.75	0.34	0.36	0.15	0.13		
RTC.n19	I am worried about the health of my older family members	0.81	0.70	0.37	0.41	0.18	0.16		
RTC.n22	I am worried about my children s education	0.77	0.48	0.36	0.39	0.11	0.09		
RTC.n27	I am worried about not being able to meet with my family	0.77	0.61	0.39	0.43	0.18	0.12		
RTC.n13	I am worried about my job situation	0.76	0.49	0.35	0.37	0.09	0.04		
RTC.n06	I wash hands for 20 seconds when necessary	0.76	0.73	0.39	0.40	0.20	0.18		
RTC.n14	I am worried that our country will run out of money	0.75	0.62	0.41	0.44	0.21	0.13		
RTC.n44	The government discloses real numbers of coronavirus infections and deaths	0.40	0.52	0.48	0.48	0.54	0.05		

Appendix 2. Characterization of the K-Mean clustering (k=10)

Cluster 3		412 respondents		cluster	full sample	cluster	full sample	cluster	full sample
				RTC'		LATENCY		GAP	
infected1	Infected yes			0.24	0.13				
infected2	Infected no			0.69	0.79				
Politics1	Left			0.24	0.12				
Politics3	Other			0.22	0.29				
Sex1	Female			0.50	0.38				
Sex2	Male			0.49	0.60				
RTC.n03	I comply with the restrictions to stay home			0.60	0.75	0.39	0.36	0.05	0.13
RTC.n24	COVID-19 increases domestic violence			0.56	0.63	0.42	0.42	0.09	0.14
RTC.n50	The restrictions caused by COVID-19 will continue for about a month			0.53	0.59	0.53	0.51	0.12	0.19
RTC.n01	I actively encourage others to follow the restrictions and guidelines			0.52	0.64	0.50	0.47	0.03	0.22
RTC.n07	I would like to help people who are more vulnerable to COVID-19			0.51	0.62	0.52	0.48	0.07	0.22
RTC.n19	I am worried about the health of my older family members			0.50	0.70	0.45	0.41	0.02	0.16
RTC.n23	Being together all the time increases family tensions			0.46	0.54	0.49	0.49	0.11	0.06
RTC.n11	Since COVID-19 I exercise at home more			0.42	0.54	0.44	0.43	0.24	0.01
RTC.n45	COVID-19 reveals the best in people			0.42	0.53	0.46	0.45	0.24	0.03
RTC.n38	Media provide reliable information about the pandemic			0.41	0.55	0.46	0.45	0.27	0.08
RTC.n27	I am worried about not being able to meet with my family			0.40	0.61	0.45	0.43	0.27	0.12
RTC.n29	Living in isolation negatively impacts my wellbeing			0.39	0.55	0.47	0.47	0.48	0.06
RTC.n26	I am anxious about not being able to meet with friends			0.38	0.58	0.44	0.44	0.34	0.09
RTC.n08	Since COVID-19 I eat more healthy			0.37	0.52	0.42	0.43	0.35	0.03
RTC.n30	COVID-19 will bring countries closer			0.36	0.48	0.45	0.45	0.62	0.10
RTC.n33	My chance of getting COVID-19 is high			0.36	0.46	0.46	0.46	0.77	0.13
RTC.n28	I worry how living in isolation will affect me			0.35	0.54	0.48	0.47	1.51	0.01
RTC.n10	Since COVID-19 I exercise less			0.35	0.48	0.48	0.43	0.52	0.06
RTC.n22	I am worried about my children's education			0.23	0.48	0.38	0.39	1.67	0.09
RTC.n17	I am worried about my own health			0.23	0.62	0.36	0.35	0.78	0.04
RTC.n13	I am worried about my job situation			0.20	0.49	0.37	0.37	2.38	0.04
nla43	In case of a coronavirus infection I will get appropriate medical help			0.56	0.61	0.52	0.48		

Cluster 4		449 respondents		cluster	full sample	cluster	full sample	cluster	full sample
				RTC'		LATENCY		GAP	
Income2	>20000€			0.54	0.37				
Kids1	0 children			0.56	0.88				
Kids2	1 child			0.21	0.06				
Kids3	2 children			0.18	0.03				
Kids4	3 children			0.04	0.02				
Occ4	Unemployed			0.16	0.25				
Politics5	Don't want to answer			0.08	0.12				
Quarantine2	Quarantine no			0.81	0.77				
RTC.n17	I am worried about my own health			0.85	0.62	0.34	0.35	0.10	0.04
RTC.n36	Coronavirus is dangerous for my health			0.82	0.71	0.35	0.37	0.13	0.12
RTC.n47	I believe we will beat COVID-19 soon			0.42	0.53	0.43	0.42	0.23	0.00

Cluster 5		525 respondents		cluster	full sample	cluster	full sample	cluster	full sample
				RTC'		LATENCY		GAP	
Age2	18-25			0.11	0.04				
Country	FR			0.20	0.43				
Country	IT			0.20	0.11				
Edu2	Middle school			0.11	0.14				
Edu5	Bachelor or higher			0.30	0.22				
Income3	don't want to answer			0.11	0.07				
infected1	Infected yes			0.24	0.33				
Occ1	Student			0.06	0.01				
Quarantine4	Quarantine don't want to answer			0.00	0.00				
Town1	<100000 inhab.			0.59	0.68				
Town2	>100000 inhab.			0.41	0.32				
RTC.n31	I am grateful to our essential workers			0.75	0.70	0.43	0.43	0.20	0.20
RTC.n39	[PRESIDENT] is doing a good job dealing with COVID-19			0.40	0.53	0.45	0.45	0.22	0.05
RTC.n41	The government is doing a good job dealing with COVID-19			0.31	0.55	0.43	0.39	0.61	0.04
RTC.n40	I am satisfied with how my government is handling this crisis			0.31	0.55	0.43	0.39	0.83	0.03
nla35	When a COVID-19 vaccine is available I'd like to be vaccinated			0.62	0.61	0.50	0.47		
nla42	I am satisfied with how our healthcare system is handling this crisis			0.54	0.62	0.49	0.43		

Appendix 2. Characterization of the K-Mean clustering (k=10)

Cluster 6		586 respondents	cluster	full sample	cluster	full sample	cluster	full sample
			RTC'		LATENCY		GAP	
Country	ES		0.20	0.03				
Country	SE		0.20	0.40				
Edu3	Vocational		0.28	0.35				
Edu4	High school		0.28	0.19				
Income1	<20000€		0.35	0.26				
Kids5	>3 children		0.01	0.00				
Occ4	Unemployed		0.16	0.09				
Politics2	Right		0.24	0.31				
Politics5	Don't want to answer		0.08	0.06				
RTC.n40	I am satisfied with how my government is handling this crisis		0.81	0.55	0.38	0.39	0.15	0.03
RTC.n41	The government is doing a good job dealing with COVID-19		0.79	0.55	0.39	0.39	0.16	0.04
RTC.n42	I am satisfied with how our healthcare system is handling this crisis		0.77	0.62	0.42	0.43	0.20	0.15
RTC.n16	The COVID-19 outbreak will make society more unequal		0.56	0.62	0.53	0.48	0.15	0.21
RTC.n48	People will stop following the restrictions soon		0.55	0.61	0.50	0.46	0.10	0.16
RTC.n25	COVID-19 will increase divorce rates		0.53	0.59	0.47	0.44	0.05	0.11
RTC.n46	COVID-19 reveals the worse in people		0.46	0.54	0.47	0.45	0.16	0.01
RTC.n14	I am worried that our country will run out of money		0.43	0.62	0.48	0.44	0.31	0.13
RTC.n21	I worry that there will be an increase in break-ins and thefts		0.37	0.52	0.47	0.45	0.64	0.02
RTC.n15	I am worried that there will not be enough basic necessities in the stores		0.33	0.46	0.48	0.47	3.07	0.23
RTC.n04	I disinfect groceries before putting them away		0.33	0.48	0.44	0.41	0.95	0.13
RTC.n05	I disinfect mail and deliveries before opening them		0.30	0.44	0.45	0.44	1.55	0.22
RTC.n18	I am worried about the health of my children		0.29	0.58	0.41	0.37	0.58	0.02
RTC.n09	Since COVID-19 I eat more unhealthy		0.27	0.37	0.44	0.43	2.13	0.54
RTC.n12	I am worried about my financial situation		0.24	0.57	0.39	0.36	0.68	0.04
nla16	The COVID-19 outbreak will make society more unequal		0.56	0.62	0.53	0.48		
nla01	I actively encourage others to follow the restrictions and guidelines		0.63	0.64	0.51	0.47		
nla19	I am worried about the health of my older family members		0.59	0.70	0.45	0.41		
nla36	Coronavirus is dangerous for my health		0.58	0.71	0.43	0.37		
nla02	I comply with the recommendations for physical distancing		0.76	0.76	0.43	0.40		
nla03	I comply with the restrictions to stay home		0.69	0.75	0.40	0.36		

Cluster 7		428 respondents	cluster	full sample
Age2	18-25		0.11	0.18
Country	FR		0.20	0.11
Country	IT		0.20	0.33
Edu2	Middle school		0.11	0.06
Edu3	Vocational		0.28	0.20
Edu5	Bachelor or higher		0.30	0.44
Income1	<20000€		0.35	0.51
infected3	Infected don't know		0.06	0.08
infected4	Infected don't want to answer		0.01	0.00
Occ1	Student		0.06	0.13
Occ3	Entrepreneur		0.07	0.12
Quarantine4	Quarantine don't want to answer		0.00	0.00
Sex1	Female		0.50	0.58
Sex2	Male		0.49	0.41
Town1	<100000 inhab.		0.59	0.50
Town2	>100000 inhab.		0.41	0.50

Cluster 9		455 respondents	cluster	full sample	cluster	full sample	cluster	full sample
			RTC'		LATENCY		GAP	
Age6	>64		0.12	0.02				
Income3			0.11	0.17				
infected4	Infected don't want to answer		0.01	0.02				
Kids5	>3 children		0.01	0.02				
Occ5	Retired		0.17	0.05				
Quarantine4	Quarantine don't want to answer		0.00	0.02				
RTC.n02	I comply with the recommendations for physical distancing		0.69	0.76	0.38	0.40	0.19	0.19
RTC.n32	I am grateful to our healthcare professionals		0.68	0.78	0.38	0.38	0.17	0.18
RTC.n06	I wash hands for 20 seconds when necessary		0.65	0.73	0.39	0.40	0.14	0.18
RTC.n31	I am grateful to our essential workers		0.63	0.70	0.41	0.43	0.17	0.20
RTC.n43	In case of a coronavirus infection I will get appropriate medical help		0.55	0.61	0.45	0.48	0.15	0.22
RTC.n49	The restrictions caused by COVID-19 will continue at least until the fall		0.52	0.58	0.48	0.51	0.10	0.19
RTC.n34	Slowing the spread of COVID-19 is more important than the economy		0.52	0.59	0.50	0.53	0.05	0.25
RTC.n35	When a COVID-19 vaccine is available I'd like to be vaccinated		0.48	0.61	0.45	0.47	0.02	0.20
RTC.n42	I am satisfied with how our healthcare system is handling this crisis		0.46	0.62	0.40	0.43	0.00	0.15
RTC.n36	Coronavirus is dangerous for my health		0.43	0.71	0.37	0.37	0.04	0.12

Appendix 2. Characterization of the K-Mean clustering (k=10)

Cluster 8	429 respondents	cluster		cluster		cluster	
		RTC'	full sample	LATENCY	full sample	GAP	full sample
Age3	26-35	0.18	0.29				
Age5	50-64	0.32	0.20				
Edu1	Primary schools	0.03	0.05				
Occ2	Employed	0.55	0.71				
Quarantine1	Quarantine yes	0.09	0.13				
Quarantine3	Quarantine don't know	0.10	0.07				
RTC.n47	I believe we will beat COVID-19 soon	0.73	0.53	0.29	0.42	0.15	0.00
RTC.n38	Media provide reliable information about the pandemic	0.71	0.55	0.30	0.45	0.18	0.08
RTC.n28	I worry how living in isolation will affect me	0.71	0.54	0.32	0.47	0.21	0.01
RTC.n45	COVID-19 reveals the best in people	0.71	0.53	0.31	0.45	0.18	0.03
RTC.n50	The restrictions caused by COVID-19 will continue for about a month	0.70	0.59	0.33	0.51	0.22	0.19
RTC.n43	In case of a coronavirus infection I will get appropriate medical help	0.70	0.61	0.33	0.48	0.24	0.22
RTC.n49	The restrictions caused by COVID-19 will continue at least until the fall	0.70	0.58	0.33	0.51	0.20	0.19
RTC.n07	I would like to help people who are more vulnerable to COVID-19	0.70	0.62	0.33	0.48	0.25	0.22
RTC.n26	I am anxious about not being able to meet with friends	0.70	0.58	0.32	0.44	0.20	0.09
RTC.n39	[PRESIDENT] is doing a good job dealing with COVID-19	0.70	0.53	0.31	0.45	0.15	0.05
RTC.n01	I actively encourage others to follow the restrictions and guidelines	0.69	0.64	0.34	0.47	0.26	0.22
RTC.n25	COVID-19 will increase divorce rates	0.69	0.59	0.31	0.44	0.18	0.11
RTC.n46	COVID-19 reveals the worse in people	0.69	0.54	0.31	0.45	0.15	0.01
RTC.n23	Being together all the time increases family tensions	0.68	0.54	0.33	0.49	0.23	0.06
RTC.n21	I worry that there will be an increase in break-ins and thefts	0.68	0.52	0.33	0.45	0.18	0.02
RTC.n44	The government discloses real numbers of coronavirus infections and deaths	0.68	0.52	0.33	0.48	0.20	0.05
RTC.n48	People will stop following the restrictions soon	0.68	0.61	0.32	0.46	0.19	0.16
RTC.n16	The COVID-19 outbreak will make society more unequal	0.68	0.62	0.34	0.48	0.24	0.21
RTC.n24	COVID-19 increases domestic violence	0.67	0.63	0.32	0.42	0.19	0.14
RTC.n08	Since COVID-19 I eat more healthy	0.67	0.52	0.32	0.43	0.17	0.03
RTC.n30	COVID-19 will bring countries closer	0.67	0.48	0.32	0.45	0.17	0.10
RTC.n29	Living in isolation negatively impacts my wellbeing	0.67	0.55	0.34	0.47	0.22	0.06
RTC.n04	I disinfect groceries before putting them away	0.67	0.48	0.32	0.41	0.14	0.13
RTC.n15	I am worried that there will not be enough basic necessities in the stores	0.66	0.46	0.33	0.47	0.19	0.23
RTC.n34	Slowing the spread of COVID-19 is more important than the economy	0.66	0.59	0.38	0.53	0.25	0.25
RTC.n11	Since COVID-19 I exercise at home more	0.66	0.54	0.33	0.43	0.15	0.01
RTC.n37	Media exaggerate the situation with COVID-19	0.65	0.40	0.30	0.41	0.08	0.24
RTC.n33	My chance of getting COVID-19 is high	0.64	0.46	0.35	0.46	0.14	0.13
RTC.n10	Since COVID-19 I exercise less	0.63	0.48	0.33	0.43	0.13	0.06
RTC.n05	I disinfect mail and deliveries before opening them	0.62	0.44	0.34	0.44	0.14	0.22
RTC.n09	Since COVID-19 I eat more unhealthy	0.60	0.37	0.34	0.43	0.06	0.54
nla34	Slowing the spread of COVID-19 is more important than the economy	0.66	0.59	0.38	0.53		
nla35	When a COVID-19 vaccine is available I d like to be vaccinated	0.67	0.61	0.35	0.47		
nla33	My chance of getting COVID-19 is high	0.64	0.46	0.35	0.46		
nla09	Since COVID-19 I eat more unhealthy	0.60	0.37	0.34	0.43		
nla05	I disinfect mail and deliveries before opening them	0.62	0.44	0.34	0.44		
nla01	I actively encourage others to follow the restrictions and guidelines	0.69	0.64	0.34	0.47		
nla16	The COVID-19 outbreak will make society more unequal	0.68	0.62	0.34	0.48		
nla29	Living in isolation negatively impacts my wellbeing	0.67	0.55	0.34	0.47		
nla23	Being together all the time increases family tensions	0.68	0.54	0.33	0.49		
nla43	In case of a coronavirus infection I will get appropriate medical help	0.70	0.61	0.33	0.48		
nla11	Since COVID-19 I exercise at home more	0.66	0.54	0.33	0.43		
nla10	Since COVID-19 I exercise less	0.63	0.48	0.33	0.43		
nla15	I am worried that there will not be enough basic necessities in the stores	0.66	0.46	0.33	0.47		
nla07	I would like to help people who are more vulnerable to COVID-19	0.70	0.62	0.33	0.48		
nla50	The restrictions caused by COVID-19 will continue for about a month	0.70	0.59	0.33	0.51		
nla44	The government discloses real numbers of coronavirus infections and deaths	0.68	0.52	0.33	0.48		
nla49	The restrictions caused by COVID-19 will continue at least until the fall	0.70	0.58	0.33	0.51		
nla21	I worry that there will be an increase in break-ins and thefts	0.68	0.52	0.33	0.45		
nla48	People will stop following the restrictions soon	0.68	0.61	0.32	0.46		
nla30	COVID-19 will bring countries closer	0.67	0.48	0.32	0.45		
nla24	COVID-19 increases domestic violence	0.67	0.63	0.32	0.42		
nla14	I am worried that our country will run out of money	0.69	0.62	0.32	0.44		
nla08	Since COVID-19 I eat more healthy	0.67	0.52	0.32	0.43		
nla26	I am anxious about not being able to meet with friends	0.70	0.58	0.32	0.44		
nla28	I worry how living in isolation will affect me	0.71	0.54	0.32	0.47		
nla04	I disinfect groceries before putting them away	0.67	0.48	0.32	0.41		
nla27	I am worried about not being able to meet with my family	0.70	0.61	0.31	0.43		
nla25	COVID-19 will increase divorce rates	0.69	0.59	0.31	0.44		
nla06	I wash hands for 20 seconds when necessary	0.72	0.73	0.31	0.40		
nla45	COVID-19 reveals the best in people	0.71	0.53	0.31	0.45		
nla39	[PRESIDENT] is doing a good job dealing with COVID-19	0.70	0.53	0.31	0.45		
nla46	COVID-19 reveals the worse in people	0.69	0.54	0.31	0.45		
nla31	I am grateful to our essential workers	0.73	0.70	0.30	0.43		
nla22	I am worried about my children s education	0.70	0.48	0.30	0.39		
nla38	Media provide reliable information about the pandemic	0.71	0.55	0.30	0.45		
nla37	Media exaggerate the situation with COVID-19	0.65	0.40	0.30	0.41		
nla19	I am worried about the health of my older family members	0.74	0.70	0.30	0.41		
nla02	I comply with the recommendations for physical distancing	0.73	0.76	0.29	0.40		
nla03	I comply with the restrictions to stay home	0.74	0.75	0.29	0.36		
nla32	I am grateful to our healthcare professionals	0.74	0.78	0.29	0.38		
nla13	I am worried about my job situation	0.70	0.49	0.29	0.37		
nla41	The government is doing a good job dealing with COVID-19	0.72	0.55	0.29	0.39		
nla18	I am worried about the health of my children	0.73	0.58	0.29	0.37		
nla42	I am satisfied with how our healthcare system is handling this crisis	0.73	0.62	0.29	0.43		
nla47	I believe we will beat COVID-19 soon	0.73	0.53	0.29	0.42		
nla40	I am satisfied with how my government is handling this crisis	0.74	0.55	0.28	0.39		
nla12	I am worried about my financial situation	0.73	0.57	0.27	0.36		
nla36	Coronavirus is dangerous for my health	0.75	0.71	0.27	0.37		
nla17	I am worried about my own health	0.76	0.62	0.26	0.35		

Appendix 2. Characterization of the K-Mean clustering (k=10)

Cluster 10	587 respondents	cluster	full sample	cluster	full sample	cluster	full sample
		RTC'		LATENCY		GAP	
Age3	26-35	0.18	0.09				
Age4	36-49	0.27	0.10				
Age5	50-64	0.32	0.41				
Age6	>64	0.12	0.33				
Country	DE	0.20	0.33				
Income2	>20000€	0.54	0.63				
Occ2	Employed	0.55	0.40				
Occ3	Entrepreneur	0.07	0.02				
Occ5	Retired	0.17	0.43				
Politics3	Other	0.22	0.17				
Politics4	Don't associate with politics	0.22	0.12				
RTC.n32	I am grateful to our healthcare professionals	0.81	0.78	0.41	0.38	0.17	0.18
RTC.n02	I comply with the recommendations for physical distancing	0.81	0.76	0.41	0.40	0.17	0.19
RTC.n35	When a COVID-19 vaccine is available I d like to be vaccinated	0.68	0.61	0.50	0.47	0.24	0.20
n1a34	Slowing the spread of COVID-19 is more important than the economy	0.61	0.59	0.59	0.53		
n1a50	The restrictions caused by COVID-19 will continue for about a month	0.60	0.59	0.55	0.51		
n1a49	The restrictions caused by COVID-19 will continue at least until the fall	0.58	0.58	0.55	0.51		
n1a28	I worry how living in isolation will affect me	0.50	0.54	0.54	0.47		
n1a23	Being together all the time increases family tensions	0.52	0.54	0.54	0.49		
n1a07	I would like to help people who are more vulnerable to COVID-19	0.62	0.62	0.53	0.48		
n1a15	I am worried that there will not be enough basic necessities in the stores	0.40	0.46	0.53	0.47		
n1a44	The government discloses real numbers of coronavirus infections and deaths	0.60	0.52	0.53	0.48		
n1a48	People will stop following the restrictions soon	0.57	0.61	0.52	0.46		
n1a33	My chance of getting COVID-19 is high	0.50	0.46	0.52	0.46		
n1a29	Living in isolation negatively impacts my wellbeing	0.54	0.55	0.51	0.47		
n1a46	COVID-19 reveals the worse in people	0.52	0.54	0.51	0.45		
n1a14	I am worried that our country will run out of money	0.57	0.62	0.51	0.44		
n1a30	COVID-19 will bring countries closer	0.51	0.48	0.50	0.45		
n1a45	COVID-19 reveals the best in people	0.57	0.53	0.50	0.45		
n1a21	I worry that there will be an increase in break-ins and thefts	0.49	0.52	0.50	0.45		
n1a39	[PRESIDENT] is doing a good job dealing with COVID-19	0.64	0.53	0.50	0.45		
n1a38	Media provide reliable information about the pandemic	0.63	0.55	0.50	0.45		
n1a10	Since COVID-19 I exercise less	0.46	0.48	0.49	0.43		
n1a05	I disinfect mail and deliveries before opening them	0.40	0.44	0.49	0.44		
n1a25	COVID-19 will increase divorce rates	0.57	0.59	0.48	0.44		
n1a27	I am worried about not being able to meet with my family	0.65	0.61	0.48	0.43		
n1a31	I am grateful to our essential workers	0.71	0.70	0.48	0.43		
n1a26	I am anxious about not being able to meet with friends	0.64	0.58	0.48	0.44		
n1a11	Since COVID-19 I exercise at home more	0.55	0.54	0.48	0.43		
n1a08	Since COVID-19 I eat more healthy	0.55	0.52	0.47	0.43		
n1a09	Since COVID-19 I eat more unhealthy	0.31	0.37	0.47	0.43		
n1a47	I believe we will beat COVID-19 soon	0.54	0.53	0.47	0.42		
n1a24	COVID-19 increases domestic violence	0.65	0.63	0.46	0.42		
n1a04	I disinfect groceries before putting them away	0.45	0.48	0.46	0.41		
n1a22	I am worried about my children s education	0.40	0.48	0.46	0.39		
n1a37	Media exaggerate the situation with COVID-19	0.31	0.40	0.44	0.41		
n1a41	The government is doing a good job dealing with COVID-19	0.76	0.55	0.43	0.39		
n1a06	I wash hands for 20 seconds when necessary	0.76	0.73	0.43	0.40		
n1a40	I am satisfied with how my government is handling this crisis	0.77	0.55	0.43	0.39		
n1a12	I am worried about my financial situation	0.33	0.57	0.43	0.36		
n1a13	I am worried about my job situation	0.21	0.49	0.42	0.37		
n1a32	I am grateful to our healthcare professionals	0.81	0.78	0.41	0.38		
n1a18	I am worried about the health of my children	0.72	0.58	0.41	0.37		
n1a17	I am worried about my own health	0.77	0.62	0.39	0.35		



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