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iCite Working Paper 2021-044

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Covid-19 endemism and the control skeptics

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This version 26/01/2021

Abstract

This paper analyses the widespread difference in Covid-19 vaccination and Non-Pharmaceutical interventions (NPI) acceptance by the European population and finds that this difference can be clustered in nine archetype clusters. Calibrating a SIR model with control acceptance on Covid-19 pandemics, it is also estimated that three anti-control segments (standing in aggregate for 15% of the population) may be contributing to the entire bulk of the endemism of the Covid-19. While poorly compliant segments have lower risk perception than others, tend to be younger, and less educated, or are more self-centric, trust with respect to media, governmental, and healthcare institutions are significantly shaping control acceptance by the population. In particular, the way to overturn a large set of vaccination "hesitant" (20% of the population), must pass by rebuilding much higher trust in how the current crisis is managed by the government and healthcare system.

Keywords

Covid-19, Pandemic Endemism, vaccine strategy, Non-Pharmaceutical Interventions, SIR

JEL-codes: I12, J22, J23, J33

1.Introduction

Since the WHO has declared the SARS-CoV-2 a pandemic, the virus has reached 200 countries and has officially infected about 5% of the Western Europe population, and a higher percentage of the US citizens.

The good news is that the effective protection of recently discovered vaccines, e.g. above 90% after two doses for Pfizer/BioNTech (Polack et al., 2020), anticipates a way out of the current raging pandemic.

The less good news, besides the associated challenging supply chain, is the relatively high level of skepticism of citizens to take the vaccine massively. anti-vaccine sentiments have been noticeable in recent years, and vaccination worldwide has reached a plateau. Measles is a clear litmus test with reported cases that rose globally by 3-fold in the first three months of 2019 versus 1 year before, and outbreaks emerged in multiple regions (Gellin, 2020; Larson, 2020). For Covid-19, prospective studies suggest a core of anti-vaccine proponents of at least 20% (Detoc et al., 2020 and Bughin et al., 2020a).

With the basic Covid-19 transmission rate recently updated to be $R_0 = 3.8$ (range 2.8 to 5.7) (Flaxman et al., 2020), traditional epidemiologic models imply that herd immunity should only be possible if ¾ of the population becomes resistant to the virus. The recent UK variant of the Covid-19 which is reported to be 70% more contagious than the mainstream virus, would lead to a reproduction rate higher than anticipated [1].

[1] Early evidence suggests that the virus mutant in the UK is 70% more contagious than the original virus; this will put us at the level of $R_0 = 6.5$, see [Covid-19: What have we learnt about the new variant in the UK? | The BMJ]

If thus, we leave in a world when vaccine uptake is left to the discretion of individuals, we are left with complementing vaccination poor uptake, with imposing a set of NPI measures, such as social distancing, or the use of large lockdowns, such as those imposed by many governments around the world to flatten the curve of the Covid-19 pandemics.

At the difference of vaccines that could remain effective for years, the caveat of NPI measures is that they must be followed structurally, as any relaxation may reboot the pandemic. Further, those distancing approaches have large economic and psychological costs (Coibion and Weber, 2020, for the first type of risk, and Dryhurst et al., 2020, for all other risks).[2]

This study aims at profiling European citizens, in terms of both their compliance to vaccination as well as to other social distancing interventions (NPI), that affect the endemic level of the Covid-19 virus. We find nine cohesive segments, with different coverage of control measures, and thus a different contribution to reach the necessary herd immunity level to stop the pandemic.

By adapting a SIR model to account for vaccine and NPI controls, we also estimate the negative externalities spilling over from poor compliant to the most compliant segments. We finally profile segments based on attitudes and socio-demographics as a way to find the "sweet spot" of actions to reduce control hesitancy.

Three findings stand out. Firstly, about 57% are fully compliant with measures, leaving 43% of the European population with some fixes in

[2] Coibion and Weber (2020) estimate that lockdown implies a major drop in economic activities up to 5 to 10% on an annual basis for worldwide GDP.

order to be fully preserved. Differences in type and intensity of coverage feature 9 cohesive segments, of which three, accounting for about 15% of the population, have control acceptance level below what is needed to prevent endemism of the Covid-19.

Lastly, control skeptics can be identified by a key set of markers. Some are socio-demographic related (like lower compliance linked to the male gender or linked to younger age and lower education/income, see e.g. Papageorge et al., 2020). Some others are risk perception of the disease, as well as trust in (the way) institutions are managing and communicating along with the pandemic. In general, we find the trust to be a critical factor to convert the vaccine skeptics (see Schwartz, 2020).

2. Segmentation of pandemic control intent

2.1. Sample and method

The study arises from a multinational Covid-19 Fever project aimed at understanding people's attitudes, emotions, and behaviors connected with the pandemic. The list of the 50 questions and survey methodology is described in Table A.1 in Appendix 1. The list covers risk attitude (such as worries to get infected) (Lee et al., 2020; Mertens et al., 2020) and behavioral change (such as practicing social distancing, and will to be vaccinated) (Asmundson and Taylor, 2020; Banerjee et al., 2020; Harper et al., 2020; Lunn et al., 2020; Oostertoff, 2020; Wise et al., 2020).

Data covers five countries: France, Germany, Italy, Spain, and Sweden and are representative of different socio-economic models (Esping-Andersen, 1999). The data collection was performed online, based on country representative samples for age (above 18 years old) and gender, and recruited via a panel agency in April 2020. The total sample amounts to about 5,000 answers or a minimum of 1,000 per country.[3]

Besides data on socio-demographics (e.g., gender, occupation, income) and Covid-19 exposure, the responses regarding the 50 statements were structured on a 3 point scale (yes (Y), hard to tell, no (N)). Here, we adjust responses further in function of response time (RT) collected through an iCode Smart test (Ohme et al., 2020). In practice, hard to tell is coded as 0; reaction time data are rescaled by the z-score, z, of log(RT), with mean = 0 and two standard deviations = 1, with a positive answer Yes is z(Y) = 1 – z and a positive No becomes z(No) = z – 1. In effect, this procedure amounts to re-center all data in (-1 , 1), but with reversion to zero in function of response time, to account for the fact that large uncertainty in the answer should be rather considered as noise.

Covid 19 attitudes: high-level statistics

Table 1 computes "Agree" (0 < Agree= 0.5+ ((z(Y) - z(N))/4 < 1), as a measure of the balance between the adjusted Yes and No (RTC = 0 implies 100% No (Agree) versus Y, and vice versa), including the standard deviation and the underlying z-score, as a measure of "noise", for a few key statements collected for this study.

We first notice that Agree = 71%, when it comes to the alignment to the question of *whether Covid-19 may be dangerous to health, but Agree = 46% for* probability to be infected (46%). There is thus a positive cognitive bias, as the basic reproduction rate should imply a probability of at least 70%

[3] See Table A.2. in Appendix 1. Full descriptive statistics on the data are available here.

of being infected without control, before reaching the threshold of herd immunity.

Worries are typically a catalyst of behavioral change. For health, we find that Agree = 62%, which is a portion compatible with other literature findings, e.g. Dryhurst et al. (2020).[4] Still, the standard deviation also implies that a fringe of the population is not worried at all.

Table 1. How European citizens perceive the Covid-19 crisis, April 2020 (% of strong opinions)

Features / Statements	Agree	standard deviation	Z
Health hazard			
Covid-19 is dangerous for my health	71%	0.25	11%
My chances are high to get infected	46%	0.20	14%
Worries			
I am worried about my health	62%	0.33	4%
I am worried about my job situation	49%	0.32	4%
Trust			
Media provide reliable information about the pandemic	55%	0.21	8%
I am satisfied with how our healthcare system is handling this crisis	62%	0.22	15%
I am satisfied with how my government is handling this crisis	55%	0.28	3%
Control			
I comply with the recommendations for physical distancing	76%	0.16	18%
I comply with the restrictions to stay home	76%	0.23	13%
I wash hands for 20 seconds when necessary	74%	0.19	18%
I will take the opportunity of a vaccine	65%	0.14	19%

Notes:
$0 < \text{Agree} = 0.5 + (z(Y) - z(N)/4 < 1$. Agree = 50% means a balance between the z-score adjusted Y and N, outside of "I do not know".
$0 < z < 1$ is a measure of uncertainty in the data based on response time.

[4] 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 second worry about job preservation is lower than 50% but with a portion of people with high worry about their job. This has been noticed by other studies, e.g., Coibion et al. (2020).

Regarding institutional actors, the degree of perceived transparency and good policy are just above 50%, but low, with again sufficiently large standard deviation that implies that a large core of citizens *maybe not trusting* (the current Covid-19) play by institutions. Trust is however particularly critical for citizens to adopt NPI and get vaccinated (Li et al., 2018; Larson, 2020; Bughin et al., 2020a and 2020b).

Covid-19 control coverage: high-level statistics

Regarding control actions, Bo et al. (2021), or Haug et al. (2020), find that avoidance elements such as social distancing, then quarantines, followed by preventive hygienic factors have the largest impact on flattening the Covid-19 pandemic curve.

The NPI compliance coverage is strong, at about 74% in the data. Still, despite imposed lockdown, e.g. in most of the countries in our sample, the percentage is less than 80%. Otherwise said, a core of anti-control prevails of more than 20% of the population, a figure observed in the case of the portion of anti-vaccines.

Concerning the vaccine intent, it has the lowest "agree" value among all the controls assessed (Agree = 65%). This low level is driven among others, by the large size of hesitant (see later in Table 4), roughly 22% out of 35%, and 13% that is refusing to get vaccinated.[5]

[5] Those figures are slightly lower than other recent studies on Covid-19 intent to get vaccinated. Neumann-Bohme et al. (2020) estimate an intent at 74% for Europe, while in

Note finally that the z value is relatively large for answers regarding control coverage (NPI compliance and vaccine). It shows how people may indeed give socially acceptable answers, without necessarily believing in them, or reflecting the truth given social norms, or penalties. Hence, the reason we have adjusted the data to better reflect on answers certainty.

Table 2 presents how control measures are interrelated. In particular, the more people are compliant with NPI, the more they will be willing to be vaccinated, as the probability of vaccination increases from 25%, if no NPI compliance to about 75%, if compliant. If someone refuses to be vaccinated, it has close to 5 chances more to be also reluctant to NPI compliance than to be NPI compliant.[6]

Given 74% NPI compliance in our sample, a probability of 75% to accept the vaccine, means that 55% of people may be compliant on both dimensions, in contrast with 5% which does not comply with any of the measures, and a 15% that is either not complying or is hesitant to be. The first 55% *may* stop the pandemic, at the assumed effectiveness of measures. The 15% group (or about 1/3 of the other group) is definitely not to be stopping the endemic nature of Covid-19. Key there will be especially to make the "hesitant" change their minds, as any move to acceptance, significantly increases the chance of more accepting the other control measure.

Lazarus et al. (2020), 80% would accept the Covid-19 vaccine. One reason is the correction for uncertainty of answers, i.e. not corrected, the percentage would be 68% of acceptance, versus 65%.

[6] That is, 39%/8% = 4.9.

Table 2. Measure acceptance complementary regarding Covid-19, Europe

		conditional probability of vaccine acceptance		
Vaccine	Yes	25%	39%	75%
	Hesitant	18%	47%	18%
	no	39%	14%	8%
		No (13%)	Hesitant (13%)	Yes (74%)
		NPI		

Source: directly calculated from sample split, as P(vaccine/NPI coverage)

This contrasting picture anticipates the prevalence of different segments. We are now proceeding to a more granular segmentation, based on the full extent of control measures.

2.2. Control intent profiling

Kamenidou et al. (2020) are one of the first to use cluster analyses to profile the Greek population in their compliance with NPIs and found nine clusters especially in function of the intensity of use of NPI tools. Our study extends the work to 5 other European countries but importantly includes vaccine intent. As one important question regarding control is the level of hesitancy (especially when it comes to a new vaccine), on top of refusal, we split control preferences in terms of support, hesitancy, and no intent to comply.

Methodology

K-means clustering was used to partition the population into 9 cohesive and stable segments (see Table 3).

Table 3. Covid 19 control compliance clusters, Europe, April 2020

Segment	size	Within cluster sum of squares (SS)
Anti NPI and vaccine skeptics	2%	8186
Control but hygiene skeptics	4%	5187
Anti-control	5%	2387
Minimal control	5%	7223
Control but no hygiene	5%	6273
Control but not to be confined	6%	1199
NPI compliant only	7%	972
NPI compliant but vaccine-hesitant	17%	3263
Control lovers	48%	490
betweenSS / totalSS = 71.5%		

From an initial number of random centroids (2500), the final number of segments using the statistical gap leads to nine segments, with convergence achieved after 500 Monte-Carlo bootstrapping iterations, meaning that the partition obtained is stable. The between sum of squares/total sum of squares achieved is 71.5%, meaning that segments are rather informative.

We notice a quite compact segment, labeled as the “control lovers”, composed of 48% of the population, which is complying with NPI and willing to get vaccinated. This matches Table 2 findings that roughly half of the population is well compliant with all measures

The second-largest segment, composed of 17% of the population, is hesitant to get vaccinated, even if it generally complies with NPI. The rest of the seven other segments are rather a niche (each less than 10%) and are differentiated by the mix of control acceptance.

Table 4 shows that vaccination hesitancy is apparent in 6 out of the 9 segments, and dominates two segments that combined, stand for 19% of the population. NPI hesitancy is less frequent than vaccination hesitancy. NPI hesitancy dominates in 2 segments, while those two segments only stand for 7% of the population.

2.3. Impact of segmented compliance on pandemic

Impact of population control on herd immunity

An important metric of epidemiology is the reproduction rate, R. For a population growing at a rate ξ, R_o is defined as the ratio of secondary contaminations β to recovery rate ψ, within the susceptibles, $\beta /(\psi+ \xi)$. S, at the start of the viral take-off, that is, when the share of susceptible S = 100%. From R_o, the herd immunity, H, is achieved at:

(1) $1 – H = (1/R_o)$.

Table 4. Clusters (k = 9) of European citizens' control attitudes, April 2020

Segment	Size	Vaccination : Yes	Hesitates	No	NPI : Yes	Hesitates	No
Anti NPI and vaccine skeptics	2%	29%	66%	5%	17%	67%	16%
Control but hygiene skeptic	4%	49%	38%	13%	70%	28%	1%
Control but no hygiene	5%	71%	27%	2%	66%	5%	29%
Neutral	5%	56%	30%	14%	44%	55%	2%
NPI compliant only	5%	0%	0%	100%	97%	2%	1%
Control but not to be confined	6%	98%	0%	2%	67%	10%	22%
Anti -control	8%	0%	2%	98%	48%	8%	44%
NPI compliant but vaccine hesitant	17%	0%	100%	0%	95%	2%	3%
Control lovers	48%	98%	0%	2%	100%	0%	0%

Note: Figures adjusted for Z-score.

In Appendix 2, we present a simple extension of an epidemiology model with control measures. Suppose now a model where there is no vaccine, but NPI measures are in place, then the control effective herd immunity H_c shrinks to :

(2) $1 - H_c = 1/(1-\alpha)*Ro$

where α is the percentage of effective reduction in viral contacts.

If the pandemic can be further controlled by a vaccine, we note V = $\varepsilon.c$ as the vaccination effective coverage. Assuming an effective daily vaccination rate, $\varepsilon.\omega$, then, the new effective herd immunity H_{cv} is:

(3) $1 - H_{cv} = (\xi + \varepsilon.\omega/\xi)/(1 - \alpha)^{*}Ro$ if $w<c$

(4) $1 - \varepsilon.c - H_{cv} = (1/(1 - \alpha)^{*}Ro$ if $w>c$

Where a negative H_{cv} means that control acceptance is sufficient to reach herd immunity, H.

Assuming sufficient pace ω, we now calibrate equation (4), based on Ro = 3.8 (range, 2.7 – 5.8) from the most recent estimates (Bughin, 2020; Flaxman et al., 2020).

At this level, the herd immunity threshold without control is 74% (range: 63% - 83%). We further take the Covid-19 vaccine effectiveness ε , at one dose at 55% and 90% if a second dose is taken (range 85% - 95%) (see Polack et al., 2020, for the Pfizer-BioNtech vaccine), while the effectiveness of NPI coverage α = 80% (range, 70% - 90%).[7] We simplify such that $\xi = 0$, as typically $\xi << \beta$.

Table 5 illustrates the derived effective herd immunity for the total population. It is clear that NPI and vaccination have both a strong effect on reducing herd immunity, but that each measure taken *separately* is not enough to stop the Covid-19 endemism, with close to 20% of individuals being infected, before herd immunity is achieved. Clearly, the picture

[7] The later effectiveness is among others derived from Lasso estimates (Haug et al., 2020) of NPI measures implementation on effective reproduction rates.

changes if one combines both measures, as the herd immunity becomes lower than zero.

Table 5. The impact of control compliance on herd immunity, Europe, total population

	Herd immunity threshold (no control = 74%)		
	NPI only	Vaccine	vaccine and NPI
Average case	17%	18%	-39%
Reproduction			
$R_0 = 2.8$	-13%	9%	-69%
$R_0 = 5.7$	45%	27%	-10%
vaccine effectiveness			
$\varepsilon = 0.55$	17%	40%	-17%
$\varepsilon = 0.85$	17%	21%	-36%
$\varepsilon = 0.95$	17%	15%	-42%
NPI effectiveness			
$\alpha = 0.7$	34%	18%	-21%
$\alpha = 0.9$	-14%	18%	-70%
weighted average simulation	16%	19%	-38%
Stand dev simulation	6%	4%	11%

Average case: Ro = 3.8; $\varepsilon = 0.9$; $\alpha = 0.8$; $\xi = 0$.

Note critically that herd immunity achievement is rather sensitive to parameters. If poor effectiveness in control measures prevail, e.g. if say only one dose of vaccine is taken with $\varepsilon = 0.55$, while the reproduction rate is on the high end as it becomes apparent in the case of new variant which has recently emerged in the UK and individuals slightly relax NPI compliance as a result of hope of vaccinations, or simply because of fatigue ($\alpha = 0.7$), then herd immunity threshold with current control appetite is only achieved when 22% of the population is infected. We are thus to be rather cautious in relaxing pressure on control compliance, without certainty that the disease spread is under control.

Impact of segmented control on herd immunity

One way of getting the disease under control is to look deeper at the behaviors of the different control attitudes segments. Table 6 shows the contribution to herd immunity for each of the nine segments. Here as well, we consider the average case, but we also look at the worst case, where the vaccine is only applied at one dose, control effectiveness is low, and Covid-19 virus mutant is more contagious than average, with $R_0 = 5.7$.

Note as well that in the exercise shown in Table 6 and subsequent, the only sensitivity is the differential impact of measures compliance, while everything else is constant. In particular, we assume that the underlying contact intensity (driving β), converges per segment. While this hypothesis may be heroic, we do not have a measure of contact intensity in our sample to measure the impact. As an alternative, we use recent research on contact rate difference by socio-demographics, in particular, we rely on Leung et al. (2017).

We then parametrize an estimated contact rate based especially on the difference in physical contacts per age (25% higher for 30 years old, and 25% lower for 60 years old, and older), per education background (low-high skill/education is -10% to 15% versus the mean) and per occupation (front office employees and entrepreneurs have 50% more contact than others). Using those estimates, and simulating the distribution of the contaminate rate at the segment level, based on the difference in socio-demographics, the effect is a possible underlying change in the result of (-13%,+13%) at 95%. Further, the segments that are more control measures compliant, tend to be slightly older, and thus the assumption of constant contamination in fact may limit the true underlying difference in segments.

Based on this sensitivity, we feel safe to keep the constant hypothesis across-segment in what follows.

Table 6. Effect of control compliance on herd immunity, European segments

Average case	NPI only	vaccine	vaccine and NPI
Anti NPI and vaccine skeptics	70%	48%	43%
Control but hygiene skeptic	40%	30%	-4%
Control but no hygiene	44%	10%	-20%
Neutral	59%	23%	9%
NPI compliant only	-17%	74%	-17%
Control but not to be confined	43%	-15%	-45%
Anti -control	57%	74%	57%
NPI compliant but vaccine hesitant	-10%	74%	-10%
Control lover	-32%	-15%	-120%
Case: $R_0 = 3.8$, $\alpha = 0.8$; $\varepsilon = 0.9$; $\xi = 0$			
Worse case	**NPI only**	**vaccine**	**vaccine and NPI**
Anti NPI and vaccine skeptic	80%	67%	64%
Control but hygiene skeptic	61%	56%	39%
Control but no hygiene	63%	44%	29%
Neutral	73%	52%	44%
NPI compliant only	23%	83%	46%
Control but not to be confined	63%	29%	14%
Anti -control	72%	83%	74%
NPI compliant but vaccine-hesitant	28%	83%	49%
Control lover	14%	29%	-11%
case: $R_0 = 5.7$; $\alpha = 0.7$; $\varepsilon = 0.55$; $\xi = 0$			

Table 6, average case, shows that *three* segments are contributing to the *endemic nature of the Covid-19 crisis.* Further, the effect is not small for the anti-control crowd (both anti-vaccine and vaccine skeptics). The herd immunity is only achieved when the level of contamination is getting close to 50% of their population segments. The good news is that they stand for about 10% of the total European population. Table 6, worse case, further highlights that it all depends on the severity of contagion, and effectiveness of control. When those assumptions are not met, only the control lover segment is sufficiently protective to stop the pandemic.

Table 7 further highlights the importance of *converting hesitant* in both NPI (hesitancy amounts to 2% reduction in herd immunity threshold) as well as taking vaccine (hesitancy here would lead to a 28% reduction). Naturally, the three segments that are the most skeptical (standing for about 25% of the population, and being part of "anti-NPI and vaccine skeptics", "NPI compliant but vaccine-hesitant", and "neutral"), would no longer be contributing to endemism, if we convert their hesitancy.

Table 7. Herd immunity reduction if hesitant fully converted

Average case	NPI only	Vaccine	vaccine and NPI
Anti NPI and vaccine skeptic	42%	81%	122%
Control but hygiene skeptic	11%	47%	57%
Control but no hygiene	2%	33%	35%
Neutral	28%	37%	65%
NPI compliant only	1%	0%	1%
Control but not to be confined	4%	0%	4%
Anti-control	3%	3%	5%
NPI compliant but vaccine-hesitant	1%	122%	123%
Control lovers	0%	0%	0%

Ro = 3.8 ; $\varepsilon = 0.9$; $\alpha = 0.8$; hesitant converted at 100%; reduction versus herd immunity at 74% when no control.

The segment "NPI compliant but vaccine-hesitant" is the largest of the three segments, standing for 17% of the population. This segment could end the pandemic by only being NPI compliant and for the portion of its segment accepting already to be vaccinated (see Table 6) in the average case scenario but would contribute to the disease endemism in the worst-case scenario. Thus, converting the hesitant is a hedge against possible adverse effects during the process of control compliance. Note finally that the niche segment of the anti-control may remain an endemic segment, as the segment is rather sure of its anti-posture.

Externalities induced from low control compliance

A feature of the pandemic is the extra infections incurred to other individuals, from people resisting protection measures. Suppose two segments, a and b = (1-a), and from classical epidemiology, the equilibrium of infected, I* plus recovered R* = T* = 1 - (S*+V*).

We then can compute the *negative* externality as the increase in total infected, T*, from the decrease in control, e.g :

(5) $\delta dT_a^*/-\delta c_b = (1 - b).b.(1 - \varepsilon.c - H_{cv}) > 0$

(6) $\delta dT_a^*/-\delta \alpha_b = (1 - b).b.((1 - \varepsilon.c - H_{cv}).(1 - \alpha)/\beta > 0$

The derivative values are such that (5) > (6), as (1 - α) < β, and from the feature of the classical SIR model, both derivatives (5) and (6) are increasing with the relative size, b, of segment (up to segment reaching 50%), e.g.

$\delta(\delta dT_a^*/\delta c_b)/ \delta b = (2b-1).(1-\varepsilon.c- H_{cv})$

Table 8 computes the externalities arising from others, at the average level of vaccination intent and of NPI compliance, and for the base case.

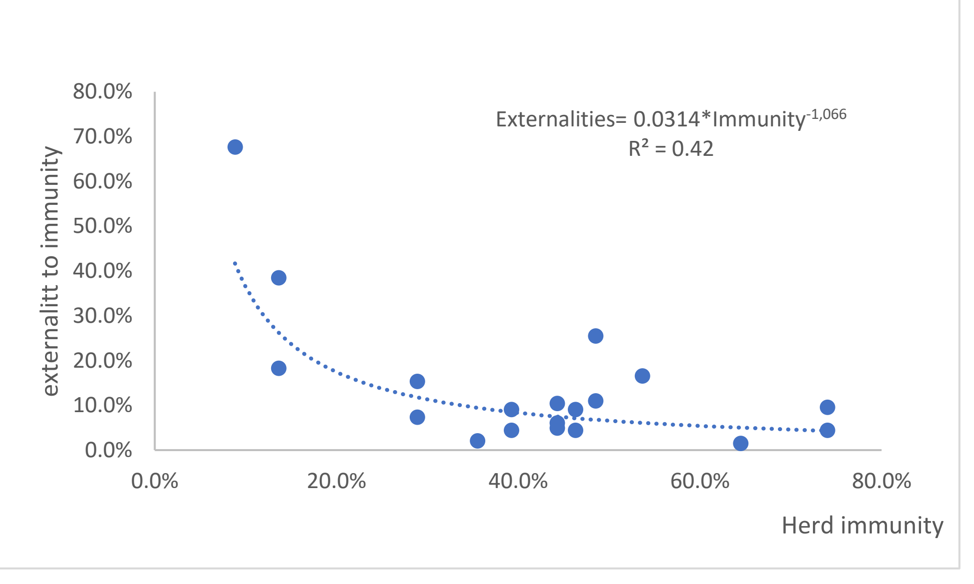
In this base case, the most protected segments achieve their own immunity, so that the externality risk is hedged. Still, we notice that externalities account for one third, of equilibrium infections. Summing the externality impact of not complying with both NPI and vaccine, the percentage of infections amounts to 3.3 - 4.1 points of a percentage of the population, among a total of 8.7 to 10 points of population.

Table 8. Externalities linked to poor vaccination, Europe

	Average case		Externality	Worse case		Externality
Segments	infection externality	infected and recovered	Ratio	infection externality	infected and recovered	Ratio
Case: vaccination						
Anti NPI and vaccine skeptics	1.6%	61.6%	2.6%	0.8%	77%	1.1%
Control but hygiene skeptic	3.1%	13.8%	22.2%	1.6%	56%	2.8%
Control but no hygiene	3.8%	8.6%	43.6%	1.9%	55%	3.5%
Neutral	3.8%	38.9%	9.7%	1.9%	67%	2.9%
NPI compliant only				1.9%	45%	4.3%
Control but not to be confined				2.3%	49%	4.6%
Anti -control	5.6%	57.3%	9.8%	2.9%	74%	4.0%
NPI compliant but vaccine-hesitant				5.0%	48%	10.6%
Control lovers				5.6%	10%	55.7%
Average	3.30%	8.70%	37.9%	3%	10.1%	29.8%
Case: NPI						
Anti NPI and vaccine skeptics	0.4%	61.6%	0.6%	0.1%	77%	0.2%
Control but hygiene skeptic	0.4%	13.8%	2.6%	0.1%	56%	0.2%
Control but no hygiene	0.5%	8.6%	5.4%	0.2%	55%	0.3%
Neutral	0.6%	38.9%	1.6%	0.2%	67%	0.3%
NPI compliant only				0.1%	45%	0.2%
Control but not to be confined				0.2%	49%	0.4%
Anti -control	0.9%	57.3%	1.6%	0.3%	74%	0.5%
NPI compliant but vaccine-hesitant				0.3%	48%	0.6%
Control lovers				0.3%	10%	2.9%
Average	0.80%	8.70%	9.2%	0.3%	10.1%	3.0%

The segment most affected by the externality risk depends on its own effort to control the endemism of the virus and its segment size. In our case, the largest segment (“control lovers”), is also the one with the largest effort to comply to control measures. Simulating the link between control effort (as measured by herd immunity threshold), and size of externalities, for different sets of control effectiveness and contamination rate, we empirically find a negative relationship that scales with the use of control measures. This demonstrates the effect of "free-riding" from poorly compliant segments to others (see Figure 2).[8,9]

Figure 2. Simulated negative infection externalities and herd immunity per segment, Europe



Note: each dot stands for a segment; includes both average, weighted average, and worst scenario as part of simulation; only segments with positive Rc are plotted, as others are de facto immune.

[8] The exponent coefficient is -1, but not statistically different from 1 between externality risk.
[9] Of course, this externality risk may not have to materialize if control is sufficiently large that the segment may become immune to the spread of the Covid-19. This is what we find in Table 8 for the average scenario. However, this externality risk expands to virtually all segments, under the worse scenario, when the contagion level is much higher than average (reaching close to the case of the UK covid 19 variant) and effectiveness of vaccine is low (matching the one dose vaccination).

3. Profiling the segments

As low control segments may boost infection risks for themselves but also at the detriment to other segments, it is critical to converting those segments to comply with more extensive and effective control. In this last section, we leverage the data collected on socio-economic drivers and Covid-19 attitudes to un-cover possible control boosters. In particular, we focus on variables that significantly shift citizens to be part of less than more compliant segments.

3.a. Univariate correlations with herd immunity level control intent

As an illustration, Figures 3a and 3b already report the univariate cross-segments correlation, between herd immunity level and, as one example socio-economics (Figure 3a) and for the second, covid attitudes (Figure 3b). Only statistically significant correlations are reported, and herd immunity is here computed at the average scenario.

The data confirm what is already known regarding socio-demographics and control reliance but here in the blended context of either NPI and compliance or vaccination. Regarding socio-demographics, older, (evidently more retired than active) individuals tend to comply to operate more control measures, as are citizens or people with a larger income. On the opposite, younger people, entrepreneurs, and larger families tend to be less compliant. Older versus young difference is evidently linked to a large difference in occurrence, as well as in attitude, there is a clear sign that "worries", be them health risk of infection oriented, but also psychological, or financial, lead to more protection. Institutional trust has a contrasting view, where media reliability is associated with herd immunity.

Still, other social effects are not easily closely tied to health matters and imply that other factors may play an important role, but the government role to control segments is rather different if one talks leadership (president) or government in general.

Figure 3a. How socio-economics correlate with herd immunity

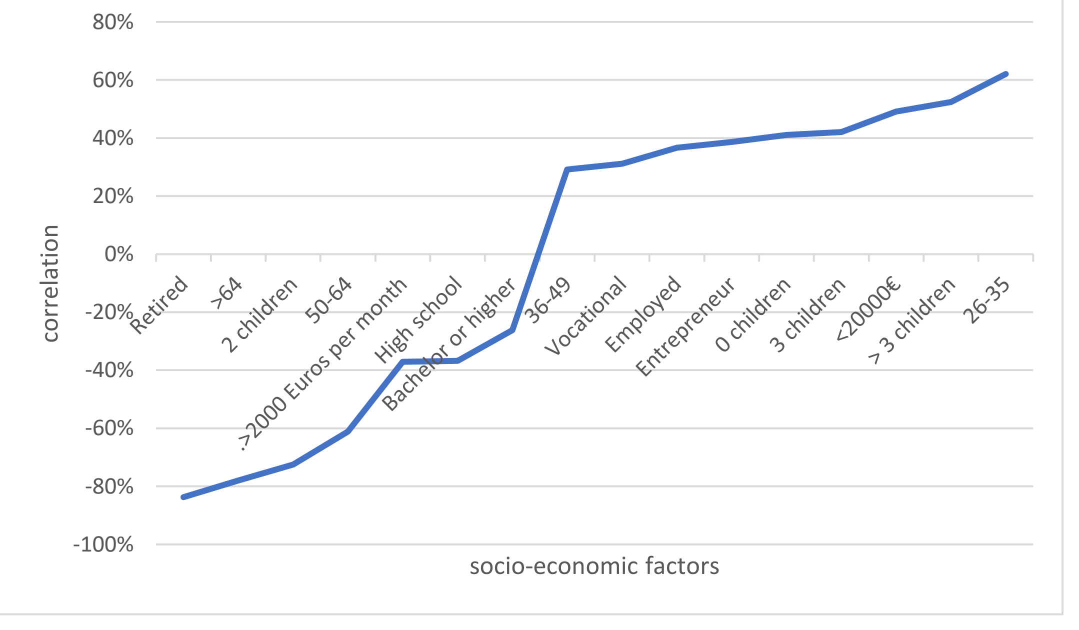
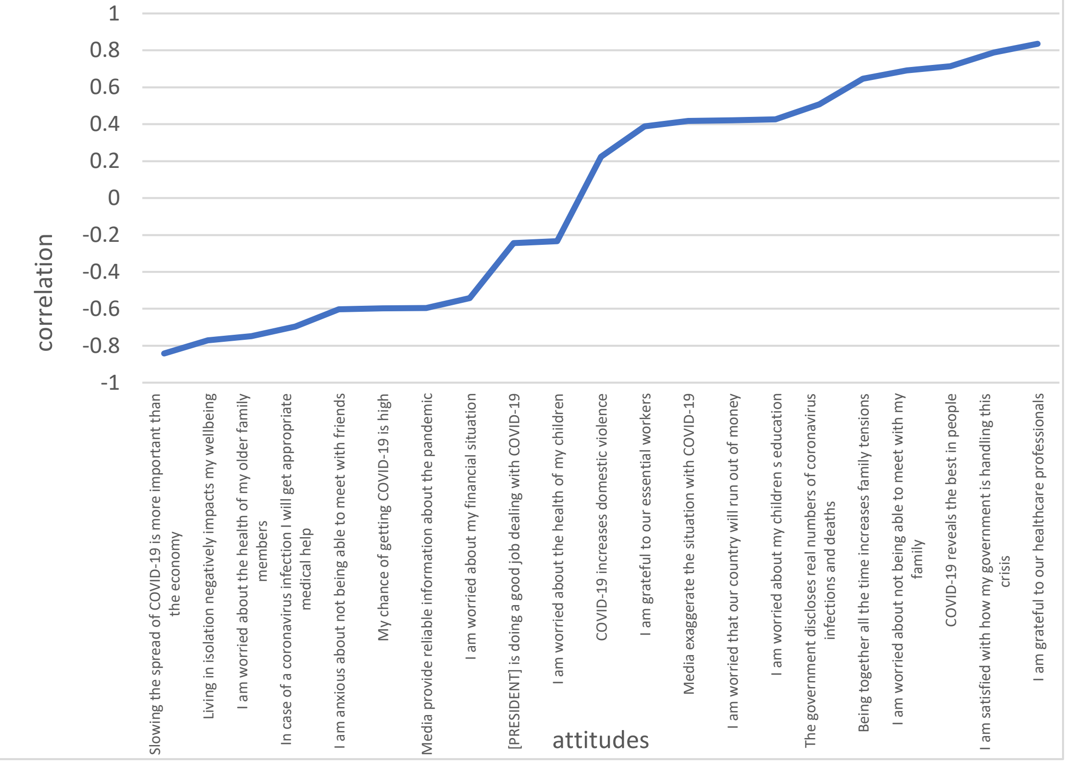


Figure 3b. How Covid-19 attitudes correlate with herd immunity



3.b. Multi-logit model of control segments

Table 9 provides the multivariate analysis of drivers of segments. For readability, segments are reorganized from the smallest to the largest segment. A few things appear clear.

Across segments

Both socio-demographics and attitudes contribute to differences in control compliance. Regarding socio-demographics, *age and income are the most often significant drivers*, with age and income *increasing* compliance. On top of being an *employee (in contrast to being an entrepreneur or being retired)* reduces the will either to be confined or to be vaccinated.

Health risk perception matters (both occurrence and risk associated with infection), especially for high compliance. The difference among lower compliant groups is however driven *by other risk perception types*, e.g. financial, psychological, and social.

Trust level in institutions, e.g. in government, media and healthcare system drive a major part of control compliance. *One mistrust is enough not to be extensively compliant* to control.

Appetence to help others affected by Covid-19 is also a clear marker of control compliance.

Within Segment

Let us contrast the most "pro" against the most "anti-control".

Let us remind that the "control lovers" segment is the most control-compliant and accounts for close to 50% of the population. The segment is the most suffering from health risk, is older, approves the institutional actions made to control the Covid-19 crisis, while are also willing others that could be handicapped by the crisis.

In contrast, the segment of the "anticontrol" is much smaller than the control lovers (e.g., a core of 8% refusing vaccination as well as NPI altogether). This core is young (26-35), more male, earns less than average, is more worried about education, and that the state will run out of money. Their members are more self-centric, and, even if they recognize the risk of Covid-19, they are less worried about their health than by how the healthcare system itself is handling the crisis, a fortiori for them.

Table 9. Drivers of control segment, logit estimates

Segments:	anti NPI and vaccine skeptics	control but hygiene skeptic	anti-control	neutral	control but no hygiene	control but not to be confined	NPI Compliant Only	NPI compliant vaccine-hesitant	Control lovers
Dimensions :									
Female			-1.245**			13.53***			
Male			-1.062**			13.77***			
18-25				1.626*	0.462*				
26-35			0.775**		0.481**	-0.583**			-0.382**
36-49					0.691***	-0.581**		0.484*	-0.364**
50-64					0.589***	-0.387*			
Primary schools		-0.941*							
Bachelor or higher							0.511**		
1 child						-0.791**	0,168	0,2	
Employed				1.583**		0.682**			
Entrepreneur				1.603**			-0.725*		
less 2000 euro per month		-0.457*	0.956***	-0.589**					
more 2000 Euro per month		-0.504*	0.727**	-0.742**	-0.347**				0.201*
infected			-0.550*		-0.370**	-0.423*		0.674**	0.295**
non infected	0.615*		-0.484*			-0.458*	-0.486*	0.721***	
like to help people vulnerable to COVID-19	-1.290***		-0.900*	-1.144*					0.856***
worried about my financial situation					0.402**				
worried country will run out of money				-1.521***					
worried about my own health	-0.543**		-0.720**			-0.380*		-0.615***	0.670***
worried about the health of my children	-0.540*								
worried about older family members health	0.653*		-1.680***						0.458**
worried about my children s education			0.824**			-0.604**			
Being together increases family tensions					-0.968***				

Notes : + significant at 10% ; ++ at 5%, +++ at 1%.

Table 9. Drivers of control segment, logit estimates (continued)

Segments:	**anti NPI and vaccine skeptics**	**control but hygiene skeptic**	**anti-control**	**neutral**	**control but no hygiene**	**control but not to be confined**	**NPI Compliant Only**	**NPI compliant vaccine-hesitant**	**Control lovers**
Dimensions:									
COVID-19 increases domestic violence				1.210**	0.530**				
COVID-19 will increase divorce rates							0.788*		
worried not to meet with family	-0.606*								
worried how isolation will affect me					-0.552**	1.013***	0.879**		
Isolation negatively impacts wellbeing					-0.549**				
grateful to essential workers			-1.900***	-1.966***	0.543*			0.737**	0.636***
grateful to healthcare professionals			-2.121***		0.803**				1.330***
Getting COVID-19 is high		0.808**	1.115***					-0.818**	
Coronavirus dangerous for health	0.667**		0.714**				-0.679**	0.986***	-0.699***
Media exaggerate COVID-19								-0.691**	0.371**
Media provide reliable information					-0.383*				
[PRESIDENT] is doing a good job						0.605*			
I am satisfied with how government handling this crisis		-1.111**							
I am satisfied with how healthcare is handling this crisis	-1.004**		-1.029**		-0.736**			-0.750*	1.161***
If infection I will get appropriate medical help								-1.311***	
The government discloses real infections and deaths		-0.797**						-0.748**	0.603***
COVID-19 makes society more unequal			-1.221**	-1.049*	0.546*		-1.013**	1.071***	

Notes : + significant at 10% ; ++ at 5%, +++ at 1%.

Vaccine-hesitancy

Last, but not least, we have a confirmation that vaccine hesitancy is a problem on its own, as the segment of NPI compliant/vaccine hesitant is four times larger than the NPI compliant and vaccine-hesitant. Except that both segments are less worried about health and have been less exposed to infections in their close circle, their commonality stop there.

For the largest segment, it is slightly more visible in the midlife of citizens (36-45 years old), they are grateful to essential workers, but in general, *they are not aligned with how the healthcare and the government are handling the crisis alike*. Institutions clearly have a major role to play here.

4. Conclusions

This study has studied the joint determinants of vaccine and NPI control compliance in the face of the Covid-19 pandemic for 5 European countries.

While current vaccination intent does not seem to be broad enough to guarantee to stop the pandemic in Europe, the conjunction of vaccine uptake with NPI may be needed to stop the disease. In this respect, the research demonstrates that NPI and vaccination control differences can be synthesized in nine cohesive control clusters, which furthermore are driven by specific attitudinal drivers.

One-third of the segments, standing for about 25% of the population, have not complied extensively with control measures, notably exhibiting low appetite for vaccination, and are the most contributing to the current endemic nature of Covid-19. Vaccine hesitancy is also large, for 20% of the European population.

A few themes emerge that explain and anticipate actions to boost, control appetite. The first is the importance of making citizens aware of the true health danger of the virus. Nobody is immune from a complication from the virus. The second is the notion of better institutional trust. This institutional trust must be reinforced not only in terms of the current government actions but also from the media and from how the healthcare system is handling the crisis. Bureaucracy, the bottleneck in the supply chain, inconsistency in actions have been argued to be a clear issue recently. While we do not measure this in this paper, our research fuels the idea that government actions must be trusted to increase adhesion by citizens of important measures such as vaccination and social distancing.

The above conclusions must be understood with three caveats. The first is that data have been collected in April 2020 and should be updated to confirm the above. The second caveat is that for the least compliant segments we do not control fully for segment susceptibility and contact frequency. Still, age difference (possibly, the largest driver of susceptibility) does not seem large enough to revert our findings.

Last but not least, the will to get vaccinated is purely probed as yes, no, or I hesitate, but it is not discussed in the context of important trade-offs, e.g. vaccination versus being confined for longer, etc. This type of conjoint analysis is the aim of further research and is badly needed given the importance of creating the right incentives to limit the continued propagation of a virus that has already taken away more than 2 million lives in one year.

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APPENDIX 1.

Table A.1. List of 50 statements evaluated, Yes, No, I do not know

Variable code	Behaviors
rtcn01	I actively encourage others to follow the restrictions and guidelines
rtcn02	I comply with the recommendations for physical distancing
rtcn03	I comply with the restrictions to stay home
rtcn04	I disinfect groceries before putting them away
rtcn05	I disinfect mail and deliveries before opening them
rtcn06	I wash hands for 20 seconds when necessary
rtcn07	I would like to help people who are more vulnerable to COVID-19
rtcn08	Since COVID-19 I eat healthier
rtcn09	Since COVID-19 I eat unhealthier
rtcn10	Since COVID-19 I exercise less
rtcn11	Since COVID-19 I exercise at home more
rtcn35	When a COVID-19 vaccine is available, I'd like to be vaccinated
	EMOTIONS
rtcn12	I'm worried about my financial situation
rtcn13	I'm worried about my job situation
rtcn14	I'm worried that our country will run out of money
rtcn15	I'm worried that there will not be enough basic necessities in the stores
rtcn17	I am worried about my health
rtcn18	I am worried about the health of my children
rtcn19	I am worried about the health of my older family members
rtcn20	I am worried about the health of people in my country
rtcn21	I worry that there will be an increase in break-ins and thefts
rtcn22	I'm worried about my children's education
rtcn26	I am anxious about not being able to meet with friends
rtcn27	I am worried about not being able to meet with my family
rtcn28	I worry how living in isolation will affect me
rtcn29	Living in isolation negatively impacts my wellbeing
	OPINIONS
rtcn16	The COVID-19 outbreak will make society more unequal
rtcn23	Being together all the time increases family tensions
rtcn24	COVID-19 increases domestic violence
rtcn25	COVID-19 will increase divorce rates
rtcn30	COVID-19 will bring countries closer
rtcn31	I am grateful to our essential workers
rtcn32	I am grateful to our healthcare professionals
rtcn33	My chance of getting COVID-19 is high
rtcn34	Slowing the spread of COVID-19 is more important than the economy
rtcn36	Coronavirus is dangerous for my health
rtcn37	Media exaggerate the situation with COVID-19
rtcn38	Media provide reliable information about the pandemic
rtcn39	[The President] is doing a good job dealing with COVID-19
rtcn40	I am satisfied with how my government is handling this crisis
rtcn41	The government is doing a good job dealing with COVID-19
rtcn42	I am satisfied with how our healthcare system is handling this crisis
rtcn43	In the case of coronavirus infection, I will get appropriate medical help
rtcn44	The government discloses real numbers of coronavirus infections and deaths
rtcn45	COVID-19 reveals the best in people
rtcn46	COVID-19 reveals the worse in people
rtcn47	I believe we will beat COVID-19 soon
rtcn48	People will stop following the restrictions soon

Table A.2. 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%

Appendix 2. The effects of different control acceptance levels on pandemics

Suppose a covid-prone population N, with N large enough, with death rate, δ, and composed of four archetypes of citizens: the susceptible, S (standing for those not yet been infected by SARS-CoV-2 and not vaccinated); the infected I, the vaccinated V and R, the recovered (who have been infected but have since recovered).

Disease-free citizens enter the S class, through birth or immigration at a constant rate ξ. The vaccine coverage is c in period t, and ω is the vaccine flow rate, with $\Sigma_1^t\omega<c$. Further, the vaccine is effective at a rate ε, $0 < \varepsilon < 1$, so that $(\varepsilon.\omega)$ reduces the susceptible class at each period, t. The susceptibles can be infected, at the rate β. The infection rate is driven by $(1-\tau.\alpha').b.I$ where $\tau.\alpha'$ is the decrease in contact intensity from the portion α' of the people claiming NPI compliance, and τ is the share of contacts reduction, or the effectiveness of α' ; we note: $\tau.\alpha' = \alpha$. Infected individuals recover at ψ the constant recovery rate .

For simplicity, the population is constant and $\delta = \xi$. Dividing by N, we have that for each time (t), s'= -(i+r+v) and we can derive the SIR dynamics (eg v'=dV/dt) as follows:

(1) $v' = \varepsilon.\omega.S - \xi.V$

(2) $i' = \beta.I.S.(1-\alpha)-(\psi+\xi).I$

(3) $r' = \psi.i-\xi.R$

Besides the disease-free equilibrium (0,0,0,0), the endemic steady state happens when:

(4) $v^* = {}^* = (\psi+\xi)\ \varepsilon.\omega/(\ \beta.(1-\alpha).\xi.\ /\beta.(1-\alpha).\xi.$

(5) $s^* = (\psi+\xi)\ /\beta.(1-\alpha)$

So that total infected, $t^*=(i^*+r^*)=1-(s^*+v^*)$ is

(6) $t^* = 1-\ ((\psi+\xi).(\varepsilon.\omega+\xi)/\xi\ )/\beta.(1-\alpha))$ if $\omega<c$

(7) $t^* = 1-\varepsilon.c-\ (1/\beta.(1-\alpha))$ if $\omega>c$

And from (6): $\delta t^*/\delta\ \varepsilon<0$; $\delta t^*/\delta\omega<0$; from (7): $\delta t^*/\delta\ c<0$; from (6-7): $\delta t^*/\delta\ \alpha<0$

It is also easy to extend the model to multiple segments. Suppose that we have a covid prone economy with two segments, $a + b = 1$, the first composed of control-compliant, with proportion "a", and one opposite segment, 1-a, composed of anti-control individuals. We note that $1> \omega_a- \omega_b=y>0$ and $1>\alpha_a-\alpha_b=z>0$; $\omega\text{^}=a.y +\omega_b$; $\alpha\text{^}=a.z + \alpha_b$. Then, consider the case v<c (the case v>c is straightforward), then (6) applies, and :

$$(8)\ \ t_a^*= 1-\{a.((\psi+\xi).(\varepsilon.\omega\text{^}+\xi))/\beta.(1-\alpha\text{^}).\xi)$$

Using (7), it is easy to derive the following sensitivities:

$$(9)\ \ \delta dt_a^*/- \delta\omega_b= (1-b).b.(\psi+\xi)/(\beta.(1-\alpha\text{^})) >0$$

$$(10)\ \delta dt_a^*/-\delta\alpha_b= (1-b).b.\ ((\psi+\xi).(\varepsilon.\omega\text{^}+\xi))/(\beta.(\xi)^2\ \ >0$$

which demonstrates that more control resistance by the segment b ($-\delta\omega_b<0$, $-\delta\alpha_b<0$) *increases* the level of contamination of the most control-compliant segment, a. In other words, (8)-(9) measure the negative externalities imposed by the least to the most compliant segment of the economy.

Appendix 3. Logistic regressions for the nine segments

	(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)		(9)	
Spain	0.710**	(0.323)	0.520	(0.472)	-1.497***	(0.268)	-0.733**	(0.358)	-2.485***	(0.411)	0.606**	(0.304)	0.648***	(0.139)	0.362*	(0.205)	0.219	(0.263)
France	1.270***	(0.286)	1.688***	(0.400)	-1.028***	(0.213)	-0.220	(0.282)	-0.765***	(0.261)	0.435	(0.285)	-0.210*	(0.126)	0.728***	(0.186)	0.574**	(0.234)
Italy	1.024***	(0.305)	0.947**	(0.423)	-1.196***	(0.230)	-1.182***	(0.361)	-1.710***	(0.311)	1.112***	(0.261)	0.515***	(0.133)	0.166	(0.196)	0.387	(0.262)
Sweden	-0.123	(0.342)	0.284	(0.444)	-1.057***	(0.211)	-0.299	(0.283)	-0.446*	(0.234)	-0.228	(0.302)	0.0327	(0.130)	1.015***	(0.188)	0.790***	(0.224)
Female	-0.670	(0.855)	-0.806	(0.859)	13.53***	(0.677)	-1.245**	(0.494)	-0.607	(0.587)	13.56		0.253	(0.483)	0.674	(0.617)	1.025	(0.983)
Male	-0.450	(0.850)	-1.120	(0.860)	13.77***	(0.664)	-1.062**	(0.499)	-0.755	(0.591)	13.65		0.414	(0.484)	0.327	(0.615)	0.899	(0.980)
18-25 old	0.297	(0.369)	1.626*	(0.935)	-0.326	(0.313)	0.118	(0.430)	-0.456	(0.407)	0.190	(0.379)	-0.204	(0.188)	0.462*	(0.268)	-0.0350	(0.347)
26-35 old	-0.0762	(0.348)	1.175	(0.929)	-0.583**	(0.270)	0.775**	(0.371)	0.0641	(0.349)	0.0459	(0.336)	-0.382**	(0.162)	0.481**	(0.237)	0.428	(0.292)
36-49 old	0.0985	(0.324)	1.101	(0.916)	-0.581**	(0.246)	0.359	(0.373)	-0.176	(0.341)	-0.202	(0.325)	-0.364**	(0.153)	0.691***	(0.221)	0.484*	(0.278)
50-64 old	-0.415	(0.297)	0.561	(0.895)	-0.387*	(0.214)	0.188	(0.337)	0.0206	(0.312)	-0.305	(0.284)	-0.156	(0.136)	0.589***	(0.204)	0.326	(0.247)
Primary schools	-0.941*	(0.567)	-0.226	(0.689)	-0.171	(0.396)	-0.191	(0.458)	0.450	(0.401)	0.369	(0.437)	0.112	(0.200)	-0.0846	(0.256)	-0.123	(0.331)
Vocational	-0.401	(0.256)	0.270	(0.389)	-0.0462	(0.206)	-0.0412	(0.263)	0.259	(0.254)	0.174	(0.266)	0.00709	(0.116)	-0.197	(0.165)	0.0441	(0.191)
High school	-0.337	(0.247)	0.263	(0.377)	0.109	(0.216)	-0.397	(0.276)	0.283	(0.265)	0.243	(0.262)	-0.0854	(0.117)	0.222	(0.162)	-0.172	(0.197)
Bachelor or higher	-0.228	(0.254)	0.323	(0.395)	0.0217	(0.215)	-0.0819	(0.270)	-0.180	(0.275)	0.511**	(0.254)	-0.0253	(0.119)	0.0753	(0.169)	-0.225	(0.205)
0 children	-0.167	(0.598)	0.0975	(0.805)	-0.791**	(0.386)	-0.280	(0.423)	-0.111	(0.447)	0.168	(0.774)	0.157	(0.287)	0.404	(0.424)	0.200	(0.505)
1 child	0.289	(0.607)	0.340	(0.822)	-0.589	(0.393)	-0.180	(0.436)	-0.133	(0.460)	0.292	(0.769)	0.0306	(0.290)	0.248	(0.429)	0.0139	(0.507)
2 children	0.149	(0.610)	-0.178	(0.841)	-0.286	(0.388)	-0.702	(0.464)	-0.159	(0.464)	0.190	(0.772)	-0.0217	(0.291)	0.486	(0.430)	0.179	(0.507)
3 children	-0.206	(0.689)	-0.562	(0.940)	-0.548	(0.456)	-0.470	(0.529)	-0.312	(0.539)	0.592	(0.815)	0.0231	(0.318)	0.145	(0.467)	0.602	(0.538)
Employed	-0.123	(0.376)	1.583**	(0.671)	0.682**	(0.339)	-0.166	(0.366)	0.555	(0.354)	-0.494	(0.315)	-0.190	(0.171)	0.0488	(0.222)	-0.328	(0.293)
Entrepreneur	-0.0678	(0.463)	1.603**	(0.759)	0.587	(0.406)	-0.0993	(0.450)	0.366	(0.439)	-0.725*	(0.417)	-0.254	(0.208)	0.179	(0.266)	-0.328	(0.346)
Unemployed	0.124	(0.379)	1.039	(0.653)	0.146	(0.366)	-0.265	(0.393)	0.370	(0.369)	-0.483	(0.330)	-0.0473	(0.179)	0.0825	(0.229)	-0.166	(0.302)
Retired	0.292	(0.444)	-0.124	(0.977)	0.214	(0.396)	-0.487	(0.430)	-0.0644	(0.427)	-0.0239	(0.405)	0.165	(0.205)	-0.0346	(0.273)	-0.197	(0.357)
twon size: <100000 inhab.	0.128	(0.164)	0.136	(0.206)	-0.0845	(0.117)	0.00144	(0.165)	-0.171	(0.147)	0.156	(0.146)	-0.0764	(0.0686)	0.148	(0.0949)	-0.112	(0.118)
income: <20000€	-0.457*	(0.262)	-0.589**	(0.289)	-0.211	(0.212)	0.956***	(0.320)	-0.00890	(0.217)	0.124	(0.245)	0.124	(0.116)	-0.121	(0.144)	-0.227	(0.189)
income: >20000€	-0.504*	(0.273)	-0.742**	(0.304)	-0.0770	(0.203)	0.727**	(0.322)	0.0104	(0.218)	0.173	(0.254)	0.201*	(0.116)	-0.347**	(0.146)	-0.223	(0.187)
Infected to c19 yes	0.0610	(0.366)	-0.454	(0.388)	-0.423*	(0.255)	-0.550*	(0.295)	0.524	(0.382)	-0.378	(0.295)	0.295**	(0.144)	-0.370**	(0.174)	0.674**	(0.290)
Infected don't know	-0.0707	(0.350)	-0.318	(0.335)	-0.458*	(0.239)	-0.484*	(0.252)	0.615*	(0.349)	-0.486*	(0.276)	0.206	(0.135)	-0.232	(0.157)	0.721***	(0.275)
Infected don't want to answer	-0.428	(0.817)			-0.0290	(0.822)	0.198	(0.638)	1.651***	(0.617)	0.852	(0.583)	-0.160	(0.364)	-0.489	(0.527)	0.619	(0.653)
Left	0.595*	(0.306)	-0.422	(0.401)	0.149	(0.257)	-0.0576	(0.325)	0.296	(0.316)	-0.0299	(0.285)	0.0238	(0.138)	-0.494***	(0.177)	0.142	(0.263)
Right	0.465	(0.314)	-0.257	(0.374)	0.178	(0.256)	0.113	(0.314)	-0.178	(0.313)	-0.0142	(0.302)	0.109	(0.140)	-0.394**	(0.179)	0.206	(0.264)
Other	0.346	(0.312)	0.360	(0.342)	-0.149	(0.257)	-0.137	(0.324)	0.322	(0.307)	-0.00494	(0.286)	-0.127	(0.138)	-0.0661	(0.176)	0.361	(0.253)
Don't associate with politics	0.0127	(0.310)	0.188	(0.350)	-0.232	(0.289)	0.169	(0.321)	0.390	(0.324)	0.0462	(0.288)	-0.214	(0.137)	0.0323	(0.165)	0.297	(0.250)

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

	(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)		(9)	(18)
rtcn07	-0.525	(0.478)	-1.144*	(0.657)	0.653	(0.419)	-0.900*	(0.498)	-1.290***	(0.483)	-0.322	(0.452)	0.856***	(0.221)	-0.105	(0.274)	0.280	(0.364)
rtcn08	0.466	(0.327)	-0.802**	(0.396)	-0.499**	(0.241)	-0.497	(0.340)	0.120	(0.274)	-0.0194	(0.290)	0.305**	(0.136)	-0.304*	(0.180)	0.327	(0.228)
rtcn09	0.779**	(0.342)	-0.233	(0.422)	-0.260	(0.312)	-0.0167	(0.369)	0.0144	(0.330)	0.195	(0.339)	0.124	(0.162)	-0.101	(0.214)	-0.0522	(0.280)
rtcn10	0.0500	(0.314)	0.548	(0.391)	-0.826***	(0.263)	0.727**	(0.307)	-0.270	(0.303)	-0.350	(0.294)	0.315**	(0.135)	-0.0995	(0.178)	0.0742	(0.232)
rtcn11	0.0820	(0.293)	-0.374	(0.379)	-0.916***	(0.242)	-0.678**	(0.313)	-0.630**	(0.291)	-0.203	(0.279)	0.528***	(0.135)	0.274	(0.178)	-0.151	(0.225)
rtcn12	-0.187	(0.292)	-0.195	(0.418)	-0.191	(0.244)	-0.0897	(0.294)	-0.334	(0.289)	-0.263	(0.285)	0.000971	(0.134)	0.402**	(0.170)	0.0812	(0.229)
rtcn13	0.397	(0.306)	-0.0310	(0.414)	0.0604	(0.259)	-0.494	(0.335)	-0.139	(0.301)	0.219	(0.295)	-0.0775	(0.136)	-0.0106	(0.181)	0.376	(0.234)
rtcn14	-0.476	(0.431)	-1.521***	(0.545)	0.192	(0.330)	0.0631	(0.443)	-0.461	(0.357)	-0.216	(0.393)	0.119	(0.188)	-0.138	(0.249)	0.505	(0.335)
rtcn15	0.347	(0.357)	-0.485	(0.525)	-0.00569	(0.321)	-0.286	(0.446)	-0.125	(0.408)	0.606*	(0.359)	0.121	(0.174)	-0.363	(0.238)	-0.261	(0.298)
rtcn16	0.0872	(0.457)	-1.049*	(0.614)	0.0818	(0.407)	-1.221**	(0.509)	-0.00600	(0.474)	-1.013**	(0.429)	0.0347	(0.215)	0.546*	(0.296)	1.071***	(0.374)
rtcn17	0.319	(0.279)	-0.512	(0.384)	-0.380*	(0.228)	-0.720**	(0.297)	-0.543**	(0.258)	-0.0975	(0.273)	0.670***	(0.123)	-0.132	(0.164)	-0.615***	(0.216)
rtcn18	-0.126	(0.319)	0.0472	(0.417)	-0.0734	(0.248)	-0.271	(0.324)	-0.540*	(0.283)	-0.231	(0.298)	0.176	(0.137)	0.205	(0.181)	0.0445	(0.239)
rtcn19	0.148	(0.391)	-0.377	(0.531)	0.0376	(0.328)	-1.680***	(0.338)	0.653*	(0.335)	0.131	(0.363)	0.458**	(0.186)	0.199	(0.256)	-0.0165	(0.297)
rtcn21	0.117	(0.366)	-0.183	(0.464)	0.0405	(0.286)	0.0576	(0.382)	-0.00438	(0.320)	-0.548	(0.357)	-0.144	(0.165)	0.247	(0.215)	0.0579	(0.274)
rtcn22	-0.226	(0.325)	-0.0169	(0.402)	-0.604**	(0.262)	0.824**	(0.365)	0.480	(0.322)	-0.446	(0.328)	0.118	(0.144)	-0.0201	(0.184)	-0.0758	(0.244)
rtcn23	0.259	(0.439)	0.540	(0.561)	0.103	(0.319)	-0.0728	(0.431)	0.345	(0.390)	0.461	(0.395)	0.182	(0.186)	-0.968***	(0.247)	0.294	(0.324)
rtcn24	-0.373	(0.379)	1.210**	(0.530)	0.247	(0.304)	-0.198	(0.371)	-0.221	(0.332)	-0.159	(0.339)	-0.0133	(0.171)	0.530**	(0.225)	-0.370	(0.290)
rtcn25	-0.0462	(0.435)	0.133	(0.537)	-0.326	(0.327)	0.331	(0.410)	-0.367	(0.372)	0.788*	(0.414)	0.127	(0.186)	-0.308	(0.238)	0.0269	(0.320)
rtcn26	0.437	(0.396)	-0.635	(0.428)	-0.0686	(0.287)	-0.0694	(0.361)	-0.131	(0.309)	-0.164	(0.347)	0.238	(0.162)	0.0293	(0.205)	-0.0970	(0.270)
rtcn27	-0.459	(0.372)	0.681	(0.505)	-0.0976	(0.308)	0.620	(0.379)	-0.606*	(0.336)	-0.167	(0.355)	0.00200	(0.167)	0.342	(0.220)	-0.412	(0.282)
rtcn28	-0.778	(0.479)	0.0403	(0.654)	1.013***	(0.356)	0.411	(0.473)	-0.130	(0.407)	0.879**	(0.441)	0.0114	(0.199)	-0.552**	(0.253)	-0.534	(0.338)
rtcn29	0.186	(0.437)	0.701	(0.508)	0.305	(0.301)	0.152	(0.374)	0.314	(0.344)	-0.426	(0.386)	-0.0867	(0.177)	-0.549**	(0.232)	0.0977	(0.300)
rtcn30	0.419	(0.362)	0.282	(0.510)	0.113	(0.307)	-0.384	(0.413)	-0.211	(0.407)	-0.551	(0.391)	0.185	(0.170)	0.0996	(0.217)	-0.475	(0.315)
rtcn31	-0.563	(0.495)	-1.966***	(0.598)	-0.346	(0.385)	-1.900***	(0.475)	0.240	(0.479)	-0.395	(0.435)	0.636***	(0.218)	0.543*	(0.291)	0.737**	(0.368)
rtcn32	-0.770	(0.479)	-0.955	(0.590)	0.0869	(0.399)	-2.121***	(0.401)	-0.368	(0.407)	-0.508	(0.470)	1.330***	(0.246)	0.803**	(0.335)	0.187	(0.365)
rtcn33	0.808**	(0.404)	0.200	(0.515)	0.199	(0.327)	1.115***	(0.413)	-0.586	(0.414)	0.513	(0.408)	0.0250	(0.182)	-0.264	(0.231)	-0.818**	(0.347)
rtcn34	-0.700	(0.534)	-1.993***	(0.718)	0.437	(0.451)	-0.374	(0.589)	-1.449***	(0.509)	0.656	(0.565)	1.003***	(0.253)	-0.475	(0.336)	0.0226	(0.441)
rtcn36	-0.314	(0.353)	0.320	(0.465)	0.343	(0.285)	-1.398***	(0.316)	-1.207***	(0.284)	-0.179	(0.327)	1.024***	(0.160)	-0.00966	(0.207)	-0.248	(0.251)
rtcn37	-0.207	(0.322)	0.366	(0.377)	-0.0338	(0.249)	0.714**	(0.333)	0.667**	(0.271)	-0.679**	(0.324)	-0.699***	(0.148)	-0.0634	(0.197)	0.986***	(0.259)
rtcn38	0.330	(0.430)	0.0172	(0.542)	0.296	(0.353)	0.166	(0.429)	-0.641	(0.395)	0.280	(0.402)	0.371**	(0.187)	-0.271	(0.238)	-0.691**	(0.307)
rtcn39	0.220	(0.409)	-0.337	(0.494)	0.0960	(0.321)	0.271	(0.408)	0.340	(0.365)	0.558	(0.387)	0.140	(0.175)	-0.383*	(0.225)	-0.0670	(0.287)
rtcn40	0.655	(0.473)	-0.604	(0.580)	0.605*	(0.363)	0.138	(0.501)	-0.576	(0.454)	-0.522	(0.445)	0.0106	(0.207)	0.0561	(0.271)	-0.210	(0.340)
rtcn41	-1.111**	(0.508)	-0.0205	(0.568)	-0.277	(0.357)	-0.665	(0.482)	-0.0245	(0.424)	0.625	(0.441)	0.297	(0.206)	-0.228	(0.262)	0.349	(0.369)
rtcn42	0.0623	(0.403)	-0.0768	(0.521)	0.00820	(0.353)	0.0783	(0.471)	-0.357	(0.430)	-0.0632	(0.393)	0.0359	(0.183)	0.308	(0.241)	-0.460	(0.309)
rtcn43	-0.500	(0.488)	-0.375	(0.650)	0.119	(0.431)	-1.029**	(0.518)	-1.004**	(0.505)	0.255	(0.530)	1.161***	(0.237)	-0.736**	(0.297)	-0.750*	(0.410)
rtcn44	0.174	(0.471)	0.268	(0.641)	0.0764	(0.423)	0.0860	(0.488)	0.0595	(0.478)	0.330	(0.482)	0.300	(0.222)	0.0336	(0.294)	-1.311***	(0.377)
rtcn45	-0.797**	(0.401)	0.633	(0.518)	-0.133	(0.314)	-0.134	(0.406)	0.285	(0.384)	-0.215	(0.380)	0.603***	(0.174)	-0.349	(0.230)	-0.748**	(0.332)
rtcn46	-0.532	(0.376)	0.782*	(0.474)	-0.0597	(0.280)	-0.186	(0.373)	0.502	(0.344)	0.224	(0.335)	0.0717	(0.167)	-0.380*	(0.210)	-0.0201	(0.300)
rtcn47	-0.0352	(0.354)	-0.222	(0.464)	0.177	(0.270)	0.0604	(0.341)	0.0885	(0.326)	-0.112	(0.326)	-0.201	(0.153)	-0.0555	(0.202)	0.360	(0.256)
rtcn48	0.518	(0.423)	-0.0989	(0.639)	-0.184	(0.330)	-0.501	(0.437)	0.948**	(0.417)	0.106	(0.410)	-0.198	(0.197)	-0.00921	(0.257)	0.373	(0.334)
rtcn49	-1.501***	(0.529)	0.267	(0.702)	0.221	(0.371)	-1.068**	(0.502)	-0.612	(0.462)	0.205	(0.533)	0.636***	(0.232)	-0.215	(0.318)	0.187	(0.398)
rtcn50	1.312**	(0.551)	0.123	(0.728)	0.290	(0.434)	-0.557	(0.532)	0.212	(0.533)	-0.0738	(0.525)	0.224	(0.254)	-0.167	(0.337)	-0.560	(0.423)
Constant	-1.279	(1.222)	-0.984	(1.762)	-14.94***	(0.986)	5.935***	(1.129)	1.866*	(0.993)	-16.28***	(0.928)	-7.600***	(0.702)	-2.304***	(0.867)	-3.542**	(1.521)
Observations	5,087		5,046		5,087		5,087		5,087		5,087		5,087		5,087		5,087	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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