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Abstract

This paper develops a tractable model of a society hit by a viral pandemic. It is sufficiently rich so as to relate the optimal decisions of the policymaker to the underlying characteristics of this society, in terms of preferences, social mores and economic structures. This allows us to make sense of the diversity of policies adopted worldwide with respect to the Covid-19 pandemic.

JEL-Codes: E580, E620, F450, H760.

Keywords: Covid-19, public policy, trust, compliance, uncertainty.

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1 Introduction.

The Covid-19 pandemic links two crises: a health crisis and an economic crisis. The former causes the latter. But this does not mean that all societies experience the pandemic in the same way. Contamination and mortality rates, to take just the two most obvious indicators, differ markedly across countries[1].

Let us start from the simple idea that the heterogeneity of situations and responses reflects both structural features, of a technological, economic and socio-psychological nature and political decisions made by the governments in charge. The technological structural features are essentially of a health nature and refer to the prophylactic and care capacity of the medical and hospital system: storage of preventive materials and drugs, availability of specialised equipment (in the case of covid-19, ventilators and resuscitation beds). The economic structure refers to the social insurance system and the existing regulatory framework to deal with the economic consequences of the pandemic and its prevention: unemployment insurance, health insurance, subsidies to businesses, etc. Socio-psychological features refer to the commonly shared habits within a given society that make it more or less easy for its members to adopt a particular attitude towards the pandemic: self-discipline, compliance with instructions, demonstration of independence, propensity to free-ride or depend on an informal sector that is poorly controlled by the authorities.

These structural features inform the fundamental dilemma that links the two crises, health and economic: a priori, reducing the loss of human life is paid for by a slowdown in economic activity and even a loss in economic activities which can be huge. The need to slow down or interrupt the chains of contamination requires the urgent implementation of social distancing measures, from the most insignificant (washing hands, using barrier gestures) to the most restrictive (containment or lockout, which itself can take more or less severe forms). These measures, modifying interpersonal relations generally making them less easy and slowing mobility, degrade the productive efficiency of firms and thus the productive efficiency of the economic system as a whole. In addition, collective preferences with regard to economic and health records and social values, including the degree of individual and civic freedom differ across countries.

Moreover the current pandemic is an uncertain nature. It is neither properly known nor anticipated. Precisely because of its absolute novelty: an unknown virus outbreak in a globalized structure of trade in goods, services and people means that all countries are affected almost simultaneously, despite their geographical, sociological or economic differences.

Policy responses which can be seen as solutions to this fundamental dilemma are also quite different. Some countries have played an extreme containment policy (the PRC in Hubei province) while others rely more or less consistently on the strategy of herd immunity (Sweden). Finally, others are internally fragmented (the United States). This raises the issue of making sense of this heterogeneity of policy responses across countries. What are the factors underlying the public policy problem of fighting the Covid-19 pandemic? Why different societies respond differently to a virus that hits them uniformly?[2]

[1]See Siguri, Evans and Tediosi for a survey on the economics of epidemics eradication (2015). See also Barrett (2007).

[2]For a broad presentation of the policy issue after Covid-19, see Tirole (2020). For discussions on policies to be adopted against the Covid-19 pandemics, see Baldwin and de Mauro (2020).

In this paper we provide a simple macro model of an economy, yet rich enough to evaluate analytically the policy response to a viral shock. Two instruments are taken into consideration: a 'social distancing' instrument and a fiscal instrument. Thie model highlights the impact on the optimal decision of structural features and preferences, introduced in the guise of parameters or exogenous variables. The model is static but is nonetheless helpful to characterize many tradeoffs that are underlying the current crisis. This allows to make sense of the very different responses observed in response to the Covid-19 pandemic.

2 The diversity of lockout policies.

2.1 The model.

We consider a society hit by a viral shock denoted by ℓ. The virus affects positively the mortality rate denoted by m. Measures of social distancing, such lockouts, aim at limiting the spread of the virus and thus its impact on public health and aggregate mortality. These measures are decided and enforced by the government. Their impacts depend on various structural parameters used to characterize relevant values and the structure of this society. The first value is compliance, denoted by c. Compliance refers to the capacity of individuals to contribute to the public good and to follow the public prescriptions set by the government. A high value of c corresponds to a strict adherence of the recommendations made by the government and contributes to their collective efficiency. The degree of compliance may be affected by different factors, such as religious faith, customs or ideologies. The second value is (mis)trust, denoted by δt. It refers to the collective capacity to trust or mistrust public announcements and information given by the government. When trust is high, individuals believe in the relevance of the information about the epidemics provided by the government and adhere to these recommenations which makes the policy more efficient. δ is a binary variable that takes the value 1 in the case of trust and -1 in the case of mistrust. The capacity of (mis)trust is linked to an exogenous and positive variable t. The efficiency of public policy depends also on the existing level of hospital infrastructure, denoted by h. Finally, there is an index capturing the main structural characteristics of this society, denoted by s.

The social-sanitary measures such as social distancing decided by the government are captured by an instrument denoted by d[3]. This instrument can vary continuously, from 0 to a maximum which for simplicity we set at ∞. For expository purposes, we first focus on this sole instrument while postponing the introduction of a fiscal instrument to section 3.

To express the links between key variables characterizing the socio-economic environment and the interplay between exogenous variables and the extent of the this viral shock with respect to the number of deaths, we define the mortality function as:

$$m = \mathcal{M}\left(d, \ell \,|h\right)$$

with $\mathcal{M}_d < 0$, $\mathcal{M}_\ell > 0$. We use the following specification:

$$\mathcal{M}\left(d, \ell \,|h\right) = \gamma \cdot h^{\varepsilon} \cdot \frac{\ell^{\varrho}}{f + Ad^{\xi}} \tag{1}$$

[3]The instrument may be a composite index of various instruments.

with $A = (e^c)^\alpha \left(e^{\delta t}\right)^\beta (e^s)^\vartheta$, $\beta > 0$, $f > 0$, $\varepsilon < 0$, $\varrho > 1$ and $\xi \geq 1$. These assumptions capture the non-linearity of the pandemic-induced mortality. The value of ϱ bigger than 1 captures the exponential impact of the virus on the mortality rate. This is due to both the network spread of the contagion and its consequent strains on the health system and network effects of contamination. The larger the shock, it is widely scattered throughout the population and the quicker it is spreading. Conversely, the public instrument d generates economies of scale ($\xi \geq 1$). By reducing the charge of the virus, it reduces its dispersion and thus the mortality level in a more-than-proportional way. Finally ϑ can be positive or negative while f is small.

In the absence of public policy ($d = 0$), the mortality rate reaches its maximum. We define m_ℓ^{max} as:

$$m_\ell^{max} = \mathcal{M}(0, \ell \,|h)$$

which is equal to, using (1):

$$m_\ell^{max} = \gamma \cdot h^\varepsilon \cdot \frac{\ell^\varrho}{f}. \tag{2}$$

As f is small, m_ℓ^{max} is very large for any level of ℓ.

However any policy of social distancing has an economic cost and affects negatively an economic indicator denoted by y which for simplicity can be thought as an aggregate output gap, namely the difference between the policy-triggered output and the no-policy output.[4] The latter output level is used as a benchmark and supposed to be constant. Formally we assume:

$$y = -\mathcal{Y}(d)$$

where $\mathcal{Y}' > 0$ and we define y^{min} as:

$$y^{min} = \mathcal{Y}(0)$$

We use the following specification:

$$\mathcal{Y}(d) = -d^\theta \tag{3}$$

where $1 \geq \theta > 0$ so that:

$$y^{min} = 0; -\mathcal{Y}(\infty) = -\infty.$$

To sum up, the social-sanitary public policy has opposite effects. It aims at reducing the mortality index at the expense of a loss in aggregate output. Thus the goverment confronts a dual crisis, namely a health emergency and an economic recession. Its dilemma comes from the fact that reducing one increases the magnitude of the other. Solving this dilemma and choosing the 'right' or 'optimal' policy amounts to decide on the level of d.

We formalize this optimization problem by endowing the government with a quadratic loss function:

$$\varphi(y, m, d) = \frac{1}{2}\left(y - y^{min}\right)^2 - \frac{\lambda}{2}(m - m_\ell^{max})^2 + \frac{\mu}{2} d^2 \tag{4}$$

[4] Given the static nature of the model, an output gap is sufficient to capture the macroeconomic impact of the pandemic. The currently outstanding unresolved issues in economics, pertaining to the « geometry » of a potential recovery (V-shaped, L-shaped, W-shaped recovery, etc.) require a dynamic analysis, based on a combination of overlapping temporary, highly persistent, or permanent aggregate and/or sectoral productivity shocks as well as 'time-to-build' and 'time-to-harm' factors.

It depends on two squared differences and the magnitude of d. The government suffers from the extent of the loss in output y compared to its no-policy output while also seeking to depress the mortality level compared to its maximum level. Finally social distancing brings its own losses due to the reduction in mobility, the imposition of constraints, etc. We can think of the social-sanitary policy d as generating social and political costs, stemming from resetrictions on the extent of individual and civic liberties. The weight given by the policymaker to these costs μ is positive or null.

The policy choice is expressed through a minimization problem:

$$d^* = \arg\min \ \varphi(y, m, d) \tag{5}$$

subject to (3) and(1).

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2.2 The diversity of societies

The set of parameters and exogenous variables in our model allows us to cover in a synthetic way a diversity of societies currently affected by the Covid-19 virus.

1. A 'libertarian' society can be characterized by any extremely high μ, up to infinity. In this extreme situation, its members collectively find insufferable any coertion measure imposed by the government. In particular they are reluctant to let the government limit their freedom to move and work.

2. A 'minimal-state' society is characterized by a low involvement in the public infrastructure, low trust and compliance with respect to public measures. Formally h, c and t are low.

3. A 'confucean' society is based on high compliance and trust. Formally it is characterized by $\alpha > 0, \quad \delta = 1$. The extent of compliance and trust reinforces the impact of public policy in reducing the dissemination of the virus and thus the mortality record. In such a society, public policy is strongly efficient.

4. A 'cohesive' society is based on trust. It is more individualistic than a confucean society but it shares with the latter a trust in public authorities and the information they provided. Formally it is characterized by $\alpha = 0, \quad \delta = 1$. The efficiency of public policy is supported by trust in the government .

5. The 'individualistic-refractory' society is based on low compliance and defiance. It differs from a cohesive society insofar as its members do not trust public authorities and information. Formally it is characterized by $\alpha < 0, \quad \delta = -1$. The extent of low compliance (captured by c^{α}) and defiance (captured by $-t^{\beta}$) reduce the efficiency of public policy.

6. Dictatorship and autocraties are based on extreme control, negative trust from and undervaluation of the harm suffered by the people and caused by their decisions. Formally, it is characterized by $\alpha > 0, \delta = -1$ and μ small. In the limit μ is equal to 0.

The following table summarizes these cases and suggests a typology of countries.[5]

Society	*Parameters*	*Country*
Ultra-libertarian	$\mu = \infty$	-
Minimal state	h, c, t low	Chile
Confucean	$\alpha > 0, \delta = 1$ $\mu \geq 0$	Taiwan, South Corea
Cohesive	$\alpha = 0, \delta = 1$ $\mu \geq 0$	Germany, Sweden
Individualistic	$\alpha < 0, \delta = -1$ $\mu \geq 0$	France
Dictatorship	$\alpha > 0, \delta = -1$ $\mu \geq 0, \mu$ low	China

Finally an important parameter affecting the efficiency of a given measure d through A is s a synthetic index of other structural characteristics. Its impact on the efficiency of public policy depends on the sign of ϑ. s may be linked to geographical characteristics. For example, islands easy to confine (New Zealand) or low density countries (Australia) are characterized by a positive ϑ, as well as countries with an habit of isolation (Nordic countries). On the other hand, countries with a custom of social gatherings (UK, mediterranean countries) or regions characterized by a high promiscuity (New York city) are characterized by a negative $\vartheta < 0$. In brief, playing with these different parameters allows us to understand the diversity of policies being adopted in different communities even though their public authorities face the same decision problem and respond rationally to the Covid-19 pandemic.

2.3 The optimal policy

The first order condition corresponding to (5) amounts to:

$$\left(\theta d^{2\theta-1} + \mu d\right) \frac{f\left(f + Ad^{\xi}\right)^3}{d^{2\xi-1}} = \lambda\xi \left(A\gamma \cdot h^{\varepsilon}\right)^2 \ell^{2\varrho}. \tag{6}$$

Equivalently, with:

$$H\left(d\,|\mu, \theta, \xi\right) \equiv \left(\theta d^{2\theta-1} + \mu d\right) \frac{f\left(f + Ad^{\xi}\right)^3}{d^{2\xi-1}}$$

[5] This typology and the refering to specific countries as examples is not based on scientific evidence. It is solely suggestive.

$$K(\ell\,|c,t,s,h,\alpha,\beta,\gamma,\varrho) \equiv \lambda\xi\,(A\gamma\cdot h^{\varepsilon})^{2}\,\ell^{2\varrho}$$

(6) can be rewritten:

$$H(d\,|\mu,\theta,\xi) = K(\ell\,|c,t,s,h,\alpha,\beta,\gamma,\varrho,\lambda)\,.$$

$H(d)$ is positive (for f small).

This allows to state the following

Proposition 1 The impacts of the various parameters on the optimal decision d^* are:

$$\frac{\partial d^*}{\partial \ell} > 0 \qquad \frac{\partial d^*}{\partial h} < 0 \qquad \frac{\partial d^*}{\partial \theta} > 0 \qquad \frac{\partial d^*}{\partial \xi} < 0$$

$$\frac{\partial d^*}{\partial c} < 0 \qquad \frac{\partial d^*}{\partial t} < (>)\,0 \Longleftrightarrow \delta = 1\,(-1) \qquad \frac{\partial d^*}{\partial s} > (<)\,0 \Longleftrightarrow \vartheta < (>)\,0$$

$$\frac{\partial d^*}{\partial \alpha} < 0 \qquad \frac{\partial d^*}{\partial \beta} < (>)\,0 \Longleftrightarrow \delta = 1\,(-1) \qquad \frac{\partial d^*}{\partial \gamma} > 0 \qquad \frac{\partial d^*}{\partial \varrho} > 0$$

$$\frac{\partial d^*}{\partial \mu} < 0 \qquad \frac{\partial d^*}{\partial \lambda} > 0.$$

These effects are consistent with intuition. The higher the virus malevolence either through higher γ and ϱ or lower θ, the greater the optimal value of d. The better is the health infrastructure, the less stringent the lockout measures must be. Higher levels of compliance and trust alleviate the need to proceed with the policy instrument. But this depends on the values of α and β. The higher the power of compliance, the lower the need to proceed with d and thus the lower d^*. The higher the power of (mis)trust, the lower (higher) the need to proceed with d and thus the lower (higher) d^*. The more efficient is the instrument d through higher ξ, the lower its optimal level.

The structure indicator s impacts negatively (positively) on d^* if ϑ is positive (negative), that is, when the conditions are (de)favorable to social distancing.

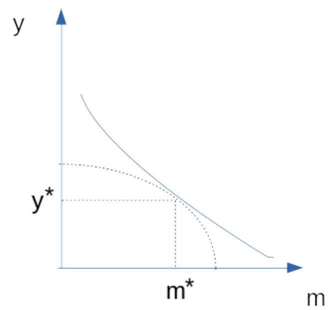
The more welfare weight of health (i.e. a higher λ), the higher d^*. The more (the less) a society cares about health, the more (the less) it intervenes at the cost of higher (lower) loss of output. Lastly the higher the direct welfare costs of d (i.e. a higher μ), the lower d^*. The ultra-libertarian (i.e. $\mu = \infty$) society chooses $d^* = 0$ and thus $m = m_{\ell}^{max}$ for any value of ℓ. On the other hand, a dictatorship does not take much into account the social and political costs of its policy (i.e. μ low) and chooses a high value d^*.

We can provide a simple graphical representation of the policy choice of the public authority in a (m, y) plane while abstracting from the direct welfare effect of d ($\mu = 0$). From eqs. (1) and (3), we get a functional constraint between m and $-y$:

$$m = \gamma\cdot h^{\varepsilon}\cdot\frac{\ell^{\varrho}}{f - Ay^{\theta\xi}} \tag{7}$$

which is a decreasing function, paramerized by ℓ. It crosses the horizontal axis at $m_{\ell}^{max} = \gamma \cdot h^{\varepsilon} \cdot \frac{\ell \varrho}{f}$. It is moved upward when ℓ increases.

The loss function of a given society is represented by indifference curves which are elliptic. The bliss point for any society is $(0, 0)$. The farther the ellipse portion in the first quarter of the graph, the lower is welfare. The optimal decision, given by the point $(m^*, y^*) \equiv (m(d)^*, y(d)^*)$, is determined by the tangency of the boundary of the feasible set and the lowest indifference curve.[6]



Graph 1

3 Extensions

In this section, we discuss the implications of a more general mortality function and the introduction of other variables and links in the model. We then analyze the introduction of randomness on the virus shock and how a duality of government instruments and their interaction impact our analysis.

3.1 Alternative mortality function

The mortality function (1) has two strong implications:

1. m_{ℓ}^{max} is the same for all society. That is, social values and structure have no impact on the mortality rate in the absence of public policy.

2. Based on voluntary collective behaviour, the ultra-libertarian society will have no way to fight the virus.

These implications can be avoided if we slightly modify eq. (1) by assuming that $f = \widetilde{f}A$. In the absence of public policy, a society, and in particular a libertarian one, bases its collective answer solely on voluntary behavior. The pattern of voluntary collective behavior (or voluntary provision of public good) depends on social values such as compliance to the community action and trust. Similarly the efficiency of voluntary behavior depends on the structure parameter s. It may be that

[6]When $\mu > 0$, the indifference curve is parameterized by d and moves with the policy decision.

living on an island is conducive to such a behavior whereas a lowly densified region is detrimental. The assumption that $f = \widetilde{f}A$ is therefore reasonable.

Hence this implies that m_ℓ^{max} depends on c, t and s:

$$\frac{\partial m_\ell^{max}}{\partial c} < 0 \qquad \frac{\partial m_\ell^{max}}{\partial t} < (>)\, 0 \Longleftrightarrow \delta = 1\,(-1) \qquad \frac{\partial m_\ell^{max}}{\partial s} > (<)\, 0 \Longleftrightarrow \vartheta < (>)\, 0.$$

All other results remain valid as long as $\widetilde{f}$ is positive and sufficiently small.

3.2 Experience

One observation often made is that Asian countries were better prepared, both materially and psychologically, to handle the current pandemic than Western countries because they experienced in the last twenty years several pandemics which only marginally affected other countries. Thus the habit of social distancing was better ingrained in individuals and the health infrastructure was upgraded. This effect can be introduced in the model in two ways. First $h \equiv \widetilde{h} - h_0$ may be interpreted as the available 'health space' devoted to the pandemics. $\widetilde{h}$ is the amount of health infrastructure, h_0 is a positive constant if the country has not experienced an epidemic or a pandemic in the (recent) past and is null otherwise. Thus, for the same level of infrastructure, an experienced country disposes of more 'health space' to deal with the pandemic than a non-experienced one and its mortality function is lower, ceteris paribus. Second, the mortality function itself may be directly affected by experience. The levels of compliance and trust are increased with experience and this contributes to a lower mortality function in countries with pandemic experience.

3.3 Uncertain virus

Let us now assume that the viral shock is stochastic with ℓ following a Gaussian distribution law of mean $\overline{\ell}$ and variance σ_ℓ^2. The policy authority only knows that a viral attack is under way and must make a decision not knowing the true value of the shock and attempting to minimize the expected loss triggered by the virus. The optimisation program is:

$$d^* = \arg\min \; E\left(\varphi\left(y, m, d\right)\right) \tag{8}$$

subject to (3) and(1).

The first order condition generates the following constraint:

$$E\left(\left(\theta d^{2\theta-1} + \mu d\right)\frac{f\left(f + Ad^\xi\right)^3}{d^{2\xi-1}} - \lambda\xi\left(A\gamma \cdot h^\varepsilon\right)^2 \ell^{2\varrho}\right) = 0$$

or equivalently,

$$\left(\theta d^{2\theta-1} + \mu d\right)\frac{f\left(f + Ad^\xi\right)^3}{d^{2\xi-1}} = \left(\lambda\xi\left(A\gamma \cdot h^\varepsilon\right)^2\left(\sigma_\ell^2\right)^\varrho\right)$$

which leads to the following proposition:

Proposition 2 When the mortality function is given by eq. (1), the optimal decision does not depend on the mean of the viral shock, while it is increasing in its variance.

$$\frac{\partial d^*}{\partial \overline{\ell}} = 0, \qquad \frac{\partial d^*}{\partial \sigma_\ell^2} > 0$$

This result is surprising and conterintuitive. This pertains to the specification of the mortality function. As the difference $(m - m_\ell^{max})$ is linear in ℓ^ϱ, a variation of $\overline{\ell}$ has no impact on the loss. Instead, if we use the following specification:

$$\mathcal{M}(d, \ell \,| h) = \gamma \cdot h^\varepsilon \cdot \frac{(\ell + \eta\kappa)}{f + Ad^\xi} \tag{9}$$

with $\eta = 0\,(1)$ if $d > 0\,(= 0)$, we overcome this unsatisfactory result. Adding κ means that in the absence of public measure of social distancing, the mortality record jumps discontinuously. The sole fact of adopting such a policy policy reduces the mortality level. It is an extreme form of increasing returns in public policy. The idea that an active policy creates a discontinuity in the transmission channel of the virus is reasonable, and can be justified at least because it modifies the behaviour of agents, both patients and medical staff. This corresponds to the presence of a focal point: as everybody expects everybody else to adopt a protective behavior, everybody adopts such a behavior.

Hence m_ℓ^{max} is equal to:

$$m_\ell^{max} = \gamma \cdot h^\varepsilon \cdot \frac{(\ell + \kappa)}{f}$$

The first order condition is then equivalent to the following constraint:

$$H(d) = \frac{\lambda (\gamma \cdot h^\varepsilon)^2}{f\,(f + Ad^\xi)^3} \left\{ \kappa \left(f + Ad^\xi\right)^2 + \left(Ad^\xi f + A^2 d^{2\xi} + \kappa \left(f + Ad^\xi\right) A\xi d^{\xi-1}\right) \overline{\ell} + A^2 \xi d^{2\xi-1} {\sigma_\ell}^2 \right\}$$

As $H(d)$ is increasing (for f small), we get:

Proposition 3 When the mortality function is given by eq. (9), the optimal decision is increasing in both the mean and the variance of the viral shock.

$$\frac{\partial d^*}{\partial \overline{\ell}} > 0, \qquad \frac{\partial d^*}{\partial \sigma_\ell^2} > 0.$$

This proposition is supported by intuition. A more severe pandemic, both in level and in volatility, is matched by a higher policy response because the stakes of the pandemic are increased when there is implicit risk aversion (as in the case of a quadratic loss function).

3.4 The model with two instruments

For clarity of exposition, we first concentrated our analysis by considering solely an health instrument at the disposal of the government. Now that our formalization has been presented and exploited we can add the plausible configuration of two instruments, as actual policies fighting the covid-19 typically mobilize both a health-related instrument d (such as social distancing) and some fiscal instrument g used to soften the economic impact of the pandemics.

The loss function is given by eq. (4) and we revert to the initial specification of the mortality function given by eq. (1). The fiscal instrument is solely used for economic reasons, namely to reduce the output gap.[7] We use the following specification:

$$y = \mathcal{Y}(d, g\,|c, t) = -d^{\theta} + \varsigma g \tag{10}$$

and therefore:

$$y^{min} = \mathcal{Y}(0, 0\,|c, t) = 0; \mathcal{Y}(\infty, g\,|c, t) = -\infty$$

The two first order conditions lead to the following equations:

$$\left(\theta d^{2\theta-1} + \mu d\right) \frac{f\left(f + Ad^{\xi}\right)^{3}}{d^{2\xi-1}} - \theta d^{\theta-1}\varsigma g = \lambda \xi \left(A\gamma \cdot h^{\varepsilon}\right)^{2} \ell^{2\varrho} \tag{11}$$

and

$$-\varsigma \cdot d^{\theta} + \varsigma^{2} g + \nu g = 0 \tag{12}$$

The solution (d^{**}, g^{**}) satisfies the two following equations:

$$H\left(d^{**}\right) - \theta d^{\theta-1}\varsigma g^{**} = K\left(\ell\,|c, t, s, h, \alpha, \beta, \gamma, \varrho, \lambda\right) \tag{13}$$

and

$$g^{**} = \frac{\varsigma}{\varsigma^{2} + \nu}\left(d^{**}\right)^{\theta}. \tag{14}$$

Given eq. (12), we get:

$$H\left(d^{*}\right) - \theta\left(d^{*}\right)^{\theta-1}\varsigma g\left(d^{*}\right) < K\left(\ell\,|c, t, s, h, \alpha, \beta, \gamma, \varrho, \lambda\right). \tag{15}$$

Thus d^{*} is not the optimal solution. The RHS of eq. (15) is increasing in d as $\theta < 1$ and $\xi > 1$. This leads to

Proposition 4: The optimal level of the social-sanitary instrument is higher when the policy-maker uses an additional fiscal instrument.

$$d^{**} > d^{*}$$

The presence of an additional instrument aiming at reducing the negative economic impact of the virus allows to reduce the dilemma due to the opposite effect of d on y and m. Therefore the public authority prefers a higher the level of social distancing as the use of g will mitigate its impact on output. The more effective is the fiscal instrument (the higher is ν), the higher will be d^{**} and the lower will be the resulting level of mortality.

[7] The fiscal instrument could affect the mortality record as public spending may finance additional health expenditures. For simplicity we abstract from this latter channel.

The fiscal instrument may have more effects than a direct macroeconomic impact on the output gap. The structure of the public budget matters. Within the present model, we can think that g affects the quality of the hospital structure and the amount of health services being provided to fight the pandemic. Formally we can introduce the following features: $h = h(g)$ with $h' > 0$ and $m = \mathcal{M}(d, \mathrm{g}, \ell \,|h)$ with $m = \partial \mathcal{M} / \partial g < 0$. Both effects reinforce the usefulness of the fiscal instrument and Proposition 4 remains valid.

Lastly, if $\mu = 0$, there are two objectives and two instruments. Thus the bliss point is reached as the fiscal instrument is used to nullify the impact of the social-sanitary measures on output and these measures are set at such a high value as to let the mortality level reach 0. Hence, dictatorships are successful in fighting the pandemic insofar as they use a sufficient number of instruments and have no consideration for the social and political costs of their policy.

4 Assessing policy outcomes

The results generated by this analysis shed some light on the diversity of policies being adopted against the Covid-19 pandemic wordlwide. It appears that Asian democracies (Taiwan, South Corea) have been dealing efficiently with the pandemic. Both their mortality and (direct) output decrease seem to be low. This can be understood when considering them as democracies shaped by confucean values. Trust and compliance are high. Moreover they suffered of several epidemics (Sras, H1N1) in the past decades which trained the population and made public authorities sensitive to the risk. Their record is consistent with the model.

On the other hand, dictatorships fight efficiently insofar as they neglect or value much less the social costs of their policy. But we should remember that the loss function of a dictator is not equivalent to a social welfare function based on the individual welfare functions of individuals, either through some utilitarian construction or through the democratic pressure of voters. China for example is likely to boast on its successful fight against the virus. Yet this reflects the sacrifice in terms of individual freedom which is a counterpart of this 'success'. Moreover, we should not forget that a dictatorship cannot totally neglect the social pressure of its population. If it is an inefficient economy, characterized by mistrust and reluctant compliance, it cannot expect much. It is then induced to (grossly) cheat on the reality of the pandemic.

The European countries witness a wide variety of policy answers. It is hard at this stage to find which one is efficient. The pandemic still goes on, countries are differently affected by the virus and we do not dispose of reliable statistical measure of the loss of lifes. Given the differences in social values and political mores this diversity is not surprising. Yet it is interesting to notice that on the whole these countries follow the same pattern of social distancing and lockouts, even if applied with different degrees of severity, with a surprising low level of discontent. This may suggest that a common set of social values is shared.

Finally, the case of a divisive or fragmented society was not discussed. A society can be fragmented because of its size, its sectional and opposite interests, diverging values, political disagreements and lastly, its multijurisdictional nature. The United States are representative of such a society as they are compounding and expressing many of these characteristics in a polarized electoral environment. These differences are likely to contribute to the propagation of the virus and make a common policy unlikely, weak or hesitant.

5 Conclusion

This paper presents a conceptual framework to rationalize and highlight the different responses of government given an exogenous set of instruments.

We set up a model of a pandemic-affected society rich enough to integrate several dimensions which appear to be critical in understanding policies adopted by countries to face the Covid-19 pandemic, yet that remains analytically tractable. Our conclusions are in accordance with observations on both what is done and the current debates on what should be done. The nature of the political system matters a lot. Dictatorships make different decisions than democracies which care more about the social costs of lockouts. The weight given to individual freedom, the trust accorded to a government and the compliance to its decision, the quality of public infrastructure matter and contribute to different decisions in ways consistent with intuition. The nature of the stochastic process generating the virus also matters. Public policy responds positively to higher expected level and variance of the viral charge. Finally the use of an economic instrument to mitigate the economic losses increases the optimal social-sanitary response.

The can be enriched in several dimensions such as: introducing uncertainty on the parameter values; adding more instruments such as information and tracking procedures; being more precise on the nature of other costs and taking into account more costs, including economic ones; considering the international dimension of the pandemic; introducing the quality of governance. Given the macroeconomic nature of this simple model, the heterogeneity within society and between societies is ignored. Yet it is known that the pandemic attacks the weak, the poor and the old disproportionately. Inequality in face of this health hazard is a critical element of its malevolence and social attitudes with respect to inequality. This shapes the pattern of adopted policy measures. To address this issue, a political economy perspective on the pandemic is required. Finally, the dynamics of the pandemic could be studied by means of a dynamic variant of the model. This is left for further research.

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