The Political Economy of Pandemics

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Abstract

The COVID-19 policy responses represent an unprecedented challenge. Policymakers worldwide, have to react fast to a totally new type of crisis under enhanced public scrutiny, as their policies are immediately compared across countries. We show how relative comparisons induce herding when policymakers are concerned by their popularity, and we discuss its extent under different scenarios. This *policy contagion* induce some countries to choose less efficient policies than they would in isolation or when facing a less correlated shock. Further, when shocks arrive sequentially, first movers prompt coordination on their policies of later movers, albeit inducing less distortions than when shocks are simultaneous. On average, however, the policy coordination triggered by a common pandemic shock improves welfare by disciplining biased policy agendas.

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1 Introduction

The recent COVID-19 pandemic represents an unprecedented challenge for policymakers that have to react to a highly infectious virus with scarce information about symptoms, fatality and spread speed and characteristics. Perhaps even more challenging, however, is the fact that the same virus affects population in all countries with high similarity. In the first four months of 2020, COVID-19 has spread to more than 200 countries. In all this countries, the rate of contagion is similar and the fatalities were concentrated among the eldest, regardless of gender, race of nationality. Several policies attacking the same shock provide useful reference points to constituents. This is challenging for policymakers because the public can use these references points to infer the effectiveness of the domestic policies which will in turn affect the policymaker's popularity. How efficient can policies be in an environment with scarce information, high commonality of the shock and easy comparison of policies across countries?

In this paper we construct a model in which policymakers in different countries, while holding possibly biased agendas, are also interested in how they are perceived by their public. When a common shock hits, we show that cross-comparisons induce excess herding/coordination on policies, namely policies become more similar than they would be just based on their informative value. However, at the same time this herding improves welfare as it induces more discipline in their actions of policymakers who have to put less weight on their personal agendas/bias.

If policymakers face idiosyncratic shocks (a financial crisis, a natural disaster, civil unrest, etc), they may justify their current policy stance only referring to counterfactuals that are not readily available and can never be evaluated, or in comparison to other situations (other countries or the past) that are only distant parallels. With scarce information about the shock, the public usually lacks clear elements to assess the abilities and the private interests behind the implemented policies in the short run. Public scrutiny is loose at best and will only become tighter in the longer when it is not as important, thus possibly lacking its disciplining role through elections.

If, in contrast, policymakers actions can be compared across countries, the commonality of a shock could be in principle a blessing, as then policymakers would put more efforts and would shy away from following their personal agendas. This is particularly relevant as in the case of pandemics the final outcome would be only observed in the long run once long-term health and economic factors can be factored in, thus for the relatively short time-frame that policymakers care about (until reelection, for instance), their policies would be assessed only based on the policy choices of other, possibly similar countries, without knowing the final effects.

We show that when cross country comparisons are readily available, however, policymakers may have to put excessive weight on what other countries are doing not to tarnish their popularity, and this *policy herding* can be damaging for welfare. Indeed, this contagion is apparent during the COVID-19 pandemic: in almost all these countries, policymakers have gone through initial phases of total lock down, strengthening the health infrastructure, joint with fiscal and monetary policies to compensate for the economic loses. These policies are, besides small idiosyncratic differences, almost a copy of the first policies implemented in China, the first country suffering the pandemics. The same holds true within a country. In the U.S., even though states face very different challenges at very different times, the type and timing of policies were very similar, as recently documented by **?**).

Not only the health responses (lock down, testing, tracking, etc) have been correlated across countries, but also their monetary and fiscal responses. The IMF, for instance, report that most countries have expanded liquidity support and swap lines to the financial sector, increased capital and liquidity buffers to banks and offer credit guarantees and moratorium of payments to the real economy.[1] Central banks have also cut interest rates in similar magnitudes (Turkey, U.S., Canada, Norway, Mexico, Brazil and Hong Kong cut their rates between 1% and 2%, more than ten other countries cut them between 0.5% and 1%).

Herding is generated by policymakers wary of the popularity implication of following an idiosyncratic and perhaps preferred, path. We explore theoretically under what conditions this commonality of the shock introduces discipline even though inducing herding and contagion over policies. Our first key result is that when the shocks affecting several countries are very similar, policymakers will react to each other's policies, forcing them to act following less their own agendas and more a common agenda. Under these conditions, herding induces discipline from an ex-ante perspective, but ex-post may bias the reaction of countries that could have acted better if they did not need to pander to their own public.

Even though correlated, our model points at possible reasons of heterogenous responses as well. Different policymakers may put different weights on their popularity, depending on the proximity of elections, the general state of the economy, the precision and generality of the data, etc. Also policymakers may put more weight to policies of

[1] See details of these policies at https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19

countries that are closer in terms of the similarity of the pandemics effects (countries in the same region or development stage). Our model also provides hints on the types of politicians who will be more likely to depart from the "common policy" (such as Brazil or Sweden).[2]

Besides the uncertainty, breath and commonality of pandemics, another characteristic is that, even though widely spread, it affects countries at different times and to a different extent. The COVID-19 pandemics affected China first, followed by Asian countries, Australia and Canada in January. In February it spread to Italy and several European countries, followed in March heavy contagion in the United States and Latin American countries. How does the sequentiality in the need to adopt policies to fight against pandemics affect our results in terms of the effectiveness of policies?

The second main result is that, when the shock does not happen simultaneously to all countries, but appears sequentially and force politicians to react at different times, leading policymakers are worried about future policies enacted in other countries and then act more conservative in following their own agendas, being even more disciplined. Furthermore, policymakers who follow know they will be evaluated against past conservative leading policymakers, and then also become more disciplined but will have to herd on the first mover's policies more than they would based on pure information.

Related Literature: Our modelling strategy relates to the beauty contest literature, motivated by Keynes and pioneered by **?**). We however take a different route. Instead of assuming that policymakers explicitly weigh in their preferences the average policy taken by other countries, we derive this weight *endogenously* from popularity concerns. In our setting a politician is interested on his/her's constituents' beliefs about his agenda: the public is more likely to vote for a politician that is more likely to be aligned with its public in his agenda. When constituents can use the policy of other countries to infer the alignment of their own government, the policymaker will endogenously have to weigh in the average policy of other countries.[3]

Applying beauty contests to pandemics, **?**) have recently contributed by assuming that agents explicitly weigh *conformity to other countries policies* in their preferences.

[2] Women leaders (Germany, New Zealand, Finland, Taiwan) have done an outstanding job in terms of reducing death implications according to https://www.nytimes.com/2020/05/15/world/coronavirus-women-leaders.html

[3] **?**) endogenizes beauty contests in asset prices with overlapping generations. **?**) develop a macroeconomic model in which information spillovers induce investors to behave as holding beauty contests preferences.

They focus on the inertia and information loss that come from those policies, while we derive coordination and inertia from popularity concerns of policymakers and focus more on the disciplining effect of such inertia.

Our work is also related to the literature on herding, surveyed by **?**), which focuses on investment cascading in capital markets. We contribute to this literature by deriving herding among policymakers facing a relatively common shock and obtaining herding behavior endogenously from popularity concerns. In contrast to most of the literature on cascading in capital markets, which focused on the lost information that arise from herding, we highlight the positive effects of herding in terms of providing incentives and relaxing moral hazard considerations.[4]

As most of the previous literature on beauty contests, cascading and herding has focused on the role of correlating actions on information aggregation of dispersed signals. This is a natural application for capital markets, for which dispersed information is ubiquitous . Pandemics, even though introducing the possibility to compare across policymakers, is informationally different. Even though information a bout the characteristics of the virus is quite disperse, the prior about its features is more diffuse. Also in contrast to capital markets, in which the objectives of firms and investors are more aligned, policymakers' objectives tend to be more heterogeneous as possibly contaminated by their own idiosyncratic agendas.

As for our focus on the moral hazard effect of relative comparisons, perhaps the closest literature in terms of is the literature on career concerns, pioneered by **?**) and relative comparisons, such as in **?**). This literature does not focus on the application to policymaking and popularity concerns, but shows how comparisons bring positive effects in terms of disciplining behavior of agents. They focus on *performance comparisons* while we focus on *policy comparisons*, namely on comparing actions not the outcome of those actions. Still we find that these sorts of comparison improve welfare and discipline from an ex-ante perspective, but not necessarily from an ex-post perspective.

Within political economy, our work extends to a cross-country arena ideas of *yardstick competition* that have been applied to local public finance. Information about public service provision in one neighborhood is both prone of comparison (neighboring jurisdictions face a similar socioeconomic environment and are likely to experience similar shocks) and easily available (it naturally tends to spill over into adjacent jurisdictions), thus forces political incumbents to care also about what other incumbents are doing. **?**) and **?**) explore this effect in the context of tax policy within US states, **?**)

[4]**?**) show a herding model in which cascading improves efficiency by affecting endogenous information acquisition.

in the context of UK local public service provision.[5]

Our continuum-type/action model, while also applicable to local public finance, allows us to quantify the extent of policy contagion and is malleable to incorporate features which are key in the Covid pandemic. Namely, we can analyze the effects of having: (1) several countries with possibly different correlation of their fundamentals, (2) different timing of responses (first and second movers), (3) different levels/precisions of both public and private (leader's) information, (4) different popularity concerns of leaders (a proxy for the proximity of elections). Politicians that differ in their motivations are central to political agency models (see **?**), **?**) and **?**), among many others), so that policy choices also act as signaling devices as different types of politicians try to differentiate themselves from one another.

Finally, our work is related to the literature that studies how a principal can provide incentives to a biased agent with superior information, either with coordinated rules (such as **?**)) or costly state verification (such as **?**)). While most of this literature considers situations without relative comparisons, in our setting we explore the role of non-coordinated policies under popularity concerns and comparisons across policies.

The next section presents the model and shows that, in spite of popularity concerns, policymakers do not discipline their policies from their agendas when there is no learning involved, either because of perfect information about the policymakers' types or because of lack of references to compare their policies. Section 3 introduces two countries and show that the relative comparison of policies discipline the behavior of policymakers, with this discipline being stronger when policies are implemented sequentially. We end with some final remarks.

2 General Setup

Assume there are N countries, $i \in \{1, 2, .., N\}$, that face potentially different shocks, θ_i. Policymakers in all countries have to enact a policy to face their own shock, that is an action, a_i. The country i's public ex-post utility (conditional on the realization of θ) is given by

$$W_i = -(a_i - \theta_i)^2.$$

[5]**?**) also introduce a simple theoretical model to explain their empirical results. **?**) replicate their model and show that "yardstick competition may induce either more pooling or more separating behaviour among different types of government, depending on the model parameters"

This implies that the public in country i would like the policymaker to take an action $a_i = \theta_i$. This reduced-form utility captures the idea that for each shock there is an optimal policy that maximizes the utility of agents in the economy.

Policymakers, however, may have their own individual agendas, which misalign their objectives with those of the public. In particular, we assume that if the shock is θ_i the policymaker would like to target $\theta_i + b_i$, where b_i is the policymaker i's bias. We call θ_i *the public welfare concern* and b_i *the extra bias or private agenda*.

Policymakers, however, have also a *popularity concern*. This concerns arises because a policymaker's chances to be reelected decrease with the perception of the public about the policymaker's departure from the optimal policy. The policymaker is more "popular" the more unbiased he's believed to be.

We assume the policymakers weigh by ω their welfare and office concerns, and by $1 - \omega$ his popularity concern (for now we assume popularity concerns are the same for policymakers in all countries). To be more precise, the policymaker's ex-post utility (again, conditional on the realization of θ_i) is

$$U_i = -\omega(a_i - \theta_i - b_i)^2 - (1 - \omega)\mathbb{E}\left((a_i - \theta_i)^2\right),$$

where $\mathbb{E}$ represents the *expectation of the public* about policymaker i's agenda.

The policymaker has two generic differences with respect to the public, he is biased and he is more informed. The part of his objective proportional to $(1 - \omega)$ is indeed his *popularity concern* which crucially differs from his best assessment of the public's welfare: the leader is interested not on the public's welfare per se, but rather on *the public's assessment of welfare*, which the superiorly informed policymaker knows is (in part) wrong.

We assume that both the public and the policymaker face imperfect information, and will focus on the role of such information friction on policymakers' behavior. On the one hand, the public does not know the shock θ_i and only knows that the policymaker's bias is drawn from a distribution

$$b_i \sim \mathcal{N}\left(0, \beta^2\right). \tag{1}$$

On the other hand, the policymaker knows his own bias and obtains a noisy signal x_i about the shock, such that

$$x_i \sim \mathcal{N}\left(\theta_i, \eta^2\right). \tag{2}$$

Notice that the public has a diffuse prior about the shock θ_i. This is relevant because then the public does not have any initial belief about the shock other than the policymakers' actions. This assumption, which is quite unique for pandemics, is less applicable to other shocks. We will discuss its importance, and extend the case in which the public has a prior about the shock for a single country in the Appendix.

Assuming that all countries' actions are observable simultaneously, a policymaker in country i tries to infer θ observing his own signal and the action of the policymakers in all other countries, knowing that his constituents will try to infer the office concern by observing the actions taken by policymakers in all countries. This implies that the policymaker i tries to maximize the following expected utility,

$$\min_{a_i} \mathbb{U}_i = \quad \omega \mathbb{E}_i \left[(a_i - \theta_i - b_i)^2 | a_1, ...a_N, x_i \right] + (1-\omega) \mathbb{E}_i \left[\mathbb{E}(a_i - \theta_i)^2 | a_1, ...a_N \right].$$

where $\mathbb{E}_i$ denotes the expectation of policymaker in country i, both about the shock and about the expectation of the public about his bias. Notice that the policymaker understand that he may change the public perception about his bias by changing the implemented policy.

Then, the policymaker's chosen policy, given the signal, is

$$\rightarrow \quad a_i = \omega \left(b_i + \mathbb{E}_i \left(\theta_i | a_1, ...a_N, x_i \right) \right) + (1-\omega) \left(\mathbb{E}(\theta_i | a_1, ...a_N \right) \tag{3}$$

where the first expectation is the policymaker's best guess of the shock and the second is the public perception about the policymaker's bias.

Notice that the *ex-ante welfare loss* of the public is given by

$$\mathbb{W}_i = \mathbb{E}(a_i - \theta_i)^2,$$

which will be our criterion to assess the welfare implications of the policy. Notice that in the perfect situation in which the policymaker knows the shock and is unbiased, $a_i = \theta_i$ and the ex-ante welfare loss is zero.

2.1 Known-Bias Benchmark

In this section and the next we characterize the solution for two key benchmarks. In one case the public knows the government's agenda, in the other case the public does not know this agenda but also cannot learn anything about it as the shock is idiosyncratic to the country so no cross-country comparisons help. We show that in both cases, policymakers lean towards their individuals agendas or office goals. Policymakers are not disciplined by their reelection concerns (*popularity concerns,* henceforth).

Assume the public knows the policymaker's bias, b_i. For simplicity also assume the policymaker observes θ_i perfectly. In this case the policymaker just chooses a_i to minimize U_i, and then

$$a_i^* = \theta_i + b_i.$$

Intuitively, the policymaker cannot use his own action to change the perception of individuals about his agenda, b_i. Then, as the policymaker cannot steer the reelection probability by "behaving", he chooses the action that best caters to his interests. In this benchmark, the ex-post public welfare loss is b_i^2, and the ex-ante welfare loss can be defined as,

$$\mathbb{W} = \mathbb{E}(\theta_i + b_i - \theta_i)^2 = \mathbb{E}(b_i^2) = V(b_i) = \beta^2$$

In the case the shock is perfectly observed by the policymaker and there is no uncertainty about the bias, the policymaker will follow his bias. As there is no bias in expectation, the public has an expected loss equal to the variance of such bias.

2.2 Single-Country Benchmark

Assume now a country that suffers a shock in isolation, or a situation in which the shock the country faces is uncorrelated to the shocks in all other countries. This closed-economy environment is the setting that most of the literature on political agency considers. This is one of the reasons the benchmark is relevant, as it shows that popularity concerns are useless in inducing discipline when relative comparisons are not available to the public, and when the outcome of the policies do not appear evident in the time frame that is relevant for reelection concerns and that characterizes electoral cycles.

In this situation, with perfect information of the policymaker about the shock, the public (not having any signal about the shock, does not have any element to assess the action and to update beliefs about the bias of the government, Then, the optimal policymaker's action from equation (3) is,

$$a_i^* = \omega\left(\theta_i + b_i\right) + (1-\omega)\mathbb{E}\left(\theta_i | a_i\right),$$

The public's expectation of the shock is $\mathbb{E}\left(\theta_i | a_i\right) = a_i$. Then,

$$a_i^* = \theta_i + b_i.$$

Intuitively, the public just observes the action of the government, a single signal to infer both the shock and the bias. This lack of reference for the public allows policymakers to follow their bias unpunished. Even though they are concerned by their popularity, their popularity is not at risk when the public cannot assess the efficiency of policies.

Also in this case, the ex-ante welfare loss for the public is $\mathbb{W} = \beta^2$. as in the previous benchmark, policymakers will not be disciplined by popularity concerns, follow their biases and generate a loss given by the variance of those biases.

3 Popularity Concerns Coordinate Policies

In this section, to highlight the coordination effects of popularity concerns, we assume two extremes that we will relax later. First, we assume a single shock to all countries (all countries get a shock θ). This assumption is motivated by the property of pandemics, which affects very similarly the population in all countries. Our insights can also be applied to shocks that are less correlated across countries (global financial crises, commodity crashes, etc.), in which case the setting with imperfectly correlated shocks is more applicable. This benchmark also allows us to focus on the disciplining effect of herding caused by popularity concerns, as it avoids information aggregation problems that typically appear in herding in capital markets. We relax this assumption in the Appendix.

Second, we assume just two countries. This simpler case captures the disciplining effect of coordination and then we show that extending the analysis to $N > 2$ countries strengthen our results, as more countries facing the shock induce even more discipline. This last extension is also more prevalent to the application to understanding pandemics.

First we assume that countries suffer the shock simultaneously. Then we show that, if shocks are sequential, as was the case in the recent pandemics evolution, there is a cascading of policies but the disciplining impact of popularity concerns strengthens.

3.1 Simultaneous Shocks and Policies

We assume that both countries suffer the same shock simultaneously, and that each policymaker knows the own bias and the bias of the other country's policymaker. By observing the action of the other country, a policymaker can infer the signal the other policymaker obtains, improving the belief about the shock. Further, the policymaker knows that the public will also observe the other country's policy, helping them infer both the shock and the bias of the own policymaker.

We focus on a linear equilibrium, so strategies have the form

$$a_1 = Ax_1 + Bb_1 + (1 - A)\, a_2, \qquad\qquad a_2 = Ax_2 + Bb_2 + (1 - A)\, a_1 \tag{4}$$

which yields

$$a_1 = \frac{x_1 + \frac{B}{A} b_1 + (1 - A)\, a_2'}{(2 - A)}, \quad a_2 = \frac{x_2 + \frac{B}{A} b_2 + (1 - A)\, a_1'}{(2 - A)}.$$

where:

$$\begin{aligned} a_1' &:= \frac{a_1 - (1 - A)\, a_2}{A} = x_1 + \frac{B}{A} b_1 = \theta + \varepsilon_1 + \frac{B}{A} b_1 \\ a_2' &:= \frac{a_2 - (1 - A)\, a_1}{A} = x_2 + \frac{B}{A} b_2 = \theta + \varepsilon_2 + \frac{B}{A} b_2. \end{aligned}$$

represent information that is observable by all in equilibrium (i.e., given A and B).

As policymakers observe their own signals and also the simultaneous move of the other government, each policymaker has the following expectation of the common shock

$$\begin{aligned} \mathbb{E}_1 (\theta | x_1, a_2) &= \mathbb{E} (\theta | x_1, a_2') = \frac{\frac{x_1}{\eta^2} + \frac{a_2'}{\eta^2 + (B/A)^2 \beta^2}}{\frac{1}{\eta^2} + \frac{1}{\eta^2 + (B/A)^2 \beta^2}} = \frac{\frac{x_1}{\eta^2} + \frac{x_2 + \frac{B}{A} b_2}{\eta^2 + (B/A)^2 \beta^2}}{\frac{1}{\eta^2} + \frac{1}{\eta^2 + (B/A)^2 \beta^2}} \\ \mathbb{E}_2 (\theta | x_2, a_1) &= \mathbb{E} (\theta | x_2, a_1') = \frac{\frac{x_2}{\eta^2} + \frac{a_1'}{\eta^2 + (B/A)^2 \beta^2}}{\frac{1}{\eta^2} + \frac{1}{\eta^2 + (B/A)^2 \beta^2}} = \frac{\frac{x_2}{\eta^2} + \frac{x_1 + \frac{B}{A} b_1}{\eta^2 + (B/A)^2 \beta^2}}{\frac{1}{\eta^2} + \frac{1}{\eta^2 + (B/A)^2 \beta^2}}. \end{aligned}$$

The public's expectation of the shock, as they have a diffuse prior but can observe the policies in both countries, is

$$\mathbb{E} (\theta) := \mathbb{E}((\theta | a_1, a_2) = \mathbb{E}((\theta | a_1', a_2') = \frac{\frac{a_1'}{\eta^2 + (B/A)^2 \beta^2} + \frac{a_2'}{\eta^2 + (B/A)^2 \beta^2}}{\frac{2}{\eta^2 + (B/A)^2 \beta^2}} = \frac{a_1 + a_2}{2}.$$

Notice that, critically different than in the single country benchmark in which the best inference about θ was the own policymaker's action, here the public learns from the own policymaker's action and from the action of the other country's policymaker. The use of several actions to calibrate the learning about the shock will be the main force introducing discipline for policymakers.

Combining conjectured linear strategies and optimal actions from equation (3), which we report only for country 1 (2 is symmetric):

$$a_1 = Ax_1 + Bb_1 + (1-A)\,a_2 = \omega\left(b_1 + \frac{\frac{x_1}{\eta^2} + \frac{\frac{a_2-(1-A)a_1}{A}}{\eta^2+(B/A)^2\beta^2}}{\frac{1}{\eta^2} + \frac{1}{\eta^2+(B/A)^2\beta^2}}\right) + (1-\omega)\frac{a_1+a_2}{2}$$

We can write each action just as a function of signals and biases:

$$a_1 = \frac{x_1 + \frac{B}{A}b_1 + (1-A)\,a_2'}{(2-A)} = \omega b_1 + \omega\frac{\frac{x_1}{\eta^2} + \frac{a_2'}{\eta^2+(B/A)^2\beta^2}}{\frac{1}{\eta^2} + \frac{1}{\eta^2+(B/A)^2\beta^2}} + (1-\omega)\frac{x_1 + \frac{B}{A}b_1 + a_2'}{2}$$

If the linear specification is true, the parameters A and B that determine the weight that policymakers assign to signals, biases, and other's actions, have to hold for all possible combinations of signals and biases. Grouping proportional terms we can obtain the values for A and B, which are characterized in the following proposition,

Proposition 1 *Policies in both countries are given by equation (4), with*

$$A = \frac{2\omega r}{(1+\omega r)} \qquad\qquad B = \frac{2}{(1+r)}A \tag{5}$$

where r is the real root of the following cubic equation

$$\frac{1}{2}\left(\frac{\eta}{\beta}\right)^2 r(r+1)^2 + (r-1) = 0$$

Then, actions as functions of signals and biases are,

$$a_i = \frac{1+\omega r}{2}\left(x_i + \frac{2}{1+r}b_i\right) + \frac{1-\omega r}{2}\left(x_{-i} + \frac{2}{1+r}b_{-i}\right) \tag{6}$$

Proof. From the equations of the two actions as functions of signals and biases, we have the following three independent relations between B and A,

$$\frac{1-A}{2-A} \;=\; \frac{\omega\frac{1}{\eta^2+(B/A)^2\beta^2}}{\frac{1}{\eta^2} + \frac{1}{\eta^2+(B/A)^2\beta^2}} + \frac{1-\omega}{2}, \qquad \frac{1}{2-A} = \frac{\omega\frac{1}{\eta^2}}{\frac{1}{\eta^2} + \frac{1}{\eta^2+(B/A)^2\beta^2}} + \frac{1-\omega}{2}$$

$$\text{and} \qquad \frac{1}{2-A}\frac{B}{A} = \omega + \frac{B}{A}\frac{1-\omega}{2}$$

From the third relation, we can write B/A as a function of ω

$$B/A = \frac{\omega}{\frac{1}{2-A} - \frac{1-\omega}{2}} \tag{7}$$

Combining the first two relations we can write A as a function of parameters,

$$z = \omega \frac{\eta^2 + \left(\frac{\omega}{z-\frac{1-\omega}{2}}\beta\right)^2}{2\eta^2 + \left(\frac{\omega}{z-\frac{1-\omega}{2}}\beta\right)^2} + \frac{1-\omega}{2}, \qquad z := \frac{1}{2-A}$$

Rewriting

$$\left(z - \frac{1+\omega}{2}\right)\left(\frac{\omega}{z-\frac{1-\omega}{2}}\right)^2 = \frac{\eta^2}{\beta^2}(1-2z)$$

and defining

$$s := 2z - 1 = \frac{A}{2-A}, \tag{8}$$

we have a cubic equation of the form

$$\left(\frac{s}{\omega} - 1\right) + \frac{1}{2}\frac{\eta^2}{\beta^2}\frac{s}{\omega}\left(\frac{s}{\omega}+1\right)^2 = 0$$

Defining $r = \frac{s}{\omega}$ we have the cubic equation in the proposition, which is only a function of the ratio of precisions $\frac{\eta}{\beta}$, this is,

$$\frac{s}{\omega} = r\left(\frac{\eta}{\beta}\right) \in [0,1] \tag{9}$$

Replacing these roots in equation (8) we obtain the solution for A, which then replaced into equation (7) provides B in the proposition. Finally, replacing these weights on equation (4), we obtain the action of a policymaker directly as a function of all signals and biases. ■

As is clear from the proposition, the weights that policymakers assign to their own signal and their own bias depend on the strength of popularity concerns (negatively related to ω) and on the root r, which is only determined by the ratio of variances $\frac{\eta}{\beta} \in [0, \infty)$. When this ratio is 0 (this is when signals are precise about the shock), then $r = 1$. When this ratio is ∞ (this is when there are no biases), then $r = 0$. We focus on this stable root, which smoothly decreases with $\frac{\eta}{\beta}$.

The next proposition summarizes how the weight that policymakers put on their information about the shock and on their own agenda depend on popularity concerns and on the variance of signals and biases.

Proposition 2 *As the ratio of variances η/β increases, policymakers assign relatively more* *weight to their bias (relative to the own signal) and more weight to the other policymaker's action (herding).*

Proof. The derivative of the weight to the signal, A, with respect to the ratio η/β is

$$\frac{\partial A}{\partial \frac{\eta}{\beta}} = \underbrace{\frac{A}{r(1+\omega r)}}_{>0} \underbrace{\frac{\partial r}{\partial \frac{\eta}{\beta}}}_{<0} < 0$$

The derivative of the weight to the own bias, B, with respect to the ratio η/β is

$$\frac{\partial B}{\partial \frac{\eta}{\beta}} = \underbrace{\frac{1-\omega r^2}{r(1+r)(1+\omega r)}}_{>0} \underbrace{\frac{2A}{(1+r)}}_{>0} \underbrace{\frac{\partial r}{\partial \frac{\eta}{\beta}}}_{<0} < 0$$

and, as the ratio of weights is $\frac{B}{A} = \frac{2}{(1+r)}$, its derivative with respect to η/β is

$$\frac{\partial B/A}{\partial \frac{\eta}{\beta}} = \underbrace{-\frac{2}{(1+r)^2}}_{<0} \underbrace{\frac{\partial r}{\partial \frac{\eta}{\beta}}}_{<0} > 0$$

■

Intuitively, when signals about fundamentals are very imprecise with respect to the variance of biases, the public infers from the actions more about the bias than about the shocks. Then policymakers are more concerned of responding to shocks because they may be misunderstood as following their own biases. This is the reason policymakers put relatively larger weights to other countries' actions, increasing the coordination of actions and herding among countries.

This result is relevant to understand initial reactions to the recent COVID-19 crisis. At the initial phases, when the information about the extent and implications of the pandemic was imprecise at best (high η), there was a larger coordination of actions, more herding and commonality of actions. As such information becomes more precise, each policymaker puts more weight to the own signal and to the own bias, and less weight to the rest of policies.

The next proposition compares weights policymakers put to their bias and to others' actions, for different levels of popularity concerns.

Proposition 3 *As popularity concerns increase (ω declines) policymakers assign more weight to other countries' actions, but do not change the relative weight to the own bias relative to the own signal.*

Proof. The derivative of the weight to the signal, A, with respect to ω is

$$\frac{\partial A}{\partial \omega} = \frac{A}{\omega(1+\omega r)} > 0$$

The derivative of the weight to the own bias, B, with respect to ω is

$$\frac{\partial B}{\partial \omega} = \frac{2}{(1+r)}\frac{\partial A}{\partial \omega} > 0$$

and, as the ratio of weights is $\frac{B}{A} = \frac{2}{(1+r)}$, its derivative with respect to ω is 0. ■

This proposition shows that, while popularity concerns mostly determine the extent of herding and coordination of actions to respond to shocks, the ratio of variances determine both herding and the relative weight to the own bias.

Figure 1 illustrates how the weight on the own bias relative to the own signal B/A and the weight on the other country's policy $1-A$ as a function of η/β and the popularity concern $1-\omega$. Notice that the weight to the other country's policy, which determines herding, increases with the variance of the shock and the popularity concern.

Figure 1: Determinants of weights

Graphs/WeightsSimEta.pdf Graphs/WeightsSimOmega.pdf

These considerations are relevant insofar allow us to identify effects on the ex-ante welfare loss, which is

$$\mathbb{W}_i = \mathbb{E}\left[(a_i - \theta)^2\right]$$

Since

$$a_i - \theta = \frac{1}{2}\left[(x_i - \theta) + (x_{-i} - \theta)\right] + \frac{\omega r}{2}\left[(x_i - x_{-i}\right] + \frac{1}{(1+r)}\left[b_i + b_{-i} + \omega r(b_i - b_{-i})\right]$$

Notice that this is the sum of normal distributions with mean 0. Then

$$(a_i - \theta) \sim \mathcal{N}\left(0, 2(1+(\omega r)^2)\left[\frac{\eta^2}{4} + \frac{\beta^2}{(1+r)^2}\right]\right)$$

This implies that the welfare loss is

$$\mathbb{W}_i = \frac{1+(\omega r)^2}{2}\left[\left(\frac{2\beta}{1+r}\right)^2 + \eta^2\right] \tag{10}$$

Proposition 4 *The ex-ante welfare loss increases in both variances η^2 and β^2 when maintaining the ratio η/β constant and decreases with popularity concerns (increase in ω).*

Proof. The proof is straightforward from taking derivatives of equation (10) with respect to η^2, β^2 (maintaining r fixed) and ω. ■

We next discuss the extreme case in which policymakers have perfect information about the shock, and then there are no concerns of putting too little weight to other's signals. This case is useful to focus on the main source of discipline.

Remark on Ex-Ante vs. Ex-Post Welfare: The previous result on the positive effect of popularity concerns reducing ex-ante welfare losses, does not extend to all ex-post realizations. To see this, consider a realization in which the own policymaker happens to have no bias (this is, $b_1 = 0$), while the other country's policymaker is heavily biased (this is, $b_2 > 0$ large). In the case the shock were idiosyncratic, without comparisons, in country 1, the policymaker's action would be $a_1 = \theta$, generating ex-post welfare loss equal to 0. In case country 2 gets the same common shock, from equation (6) the action of country 1's policymaker would be $a_1 = \theta + \frac{1-\omega r}{1+r} b_2$. In case $\eta = 0$, $r = 1$ and of the policymaker in country 1 is unbiased but has large popularity concerns (this is, $\omega = 0$), it would weight by $1/2$ the bias of the other country, reducing the ex-post welfare of his own constituents.

3.1.1 Perfect Information about the Shock

In the special case in which signals are infinitely precise, $\eta = 0$, $r = 1$ and then $B = A = \frac{2\omega}{(1+\omega)}$. The ex-ante welfare loss for the public, from replacing $\eta = 0$, $r = 1$ in equation (10) is,

$$\mathbb{W}|_{\eta=0} = \left[\frac{1+\omega^2}{2}\right]\beta^2 \leq \beta^2$$

Without popularity concerns (that is, $\omega = 1$), then $B = A = 1$ and policymakers would implement a policy $a_i = \theta + b_i$. In this case, the ex-ante welfare loss of the public is $\mathbb{W} = \beta^2$, the same as in the benchmarks with popularity concern but perfect knowledge about the bias, or no learning at all about the bias. In the other extreme, if there were only popularity concerns (this is, $\omega = 0$), then $B = A = 0$ and, according to equation (6), $a_i = \theta + \frac{b_i + b_{-i}}{2}$. In this case, the ex-ante welfare loss of the public would be $\mathbb{W} = \frac{\beta^2}{2}$.

These extremes show the importance of cross-country comparisons, and the interaction with popularity concerns, to induce discipline of policymakers and to reduce ex-ante welfare losses for the public.

3.2 Sequential Shocks and Policies

Now we assume that a country faces a shock θ and is forced to enact a policy without knowing the bias of the next country that will face the same shock. Without loss of generality we will assume that the "leader" (the first country facing the shock) is country 1 and the "follower" (the second country facing the shock) is country 2. This timing is motivated by the evolution of the COVID-19 outbreak, a same shock affecting different countries at sequential times.

The leader only knows his signal and bias at the time of enacting the policy. Then, we assume the leader follows a linear strategy of the form,

$$a_1 = x_1 + \widehat{B} b_1 = \theta + \varepsilon_1 + \widehat{B} b_1$$

where the hats on the parameters are introduced to differentiate from the simultaneous move case above.

In contrast, the follower enacts policies observing his own signal and bias, but also the leader's action. The follower follows a linear strategy of the form,

$$a_2 = \widehat{A} x_2 + \widehat{C} b_2 + \left(1 - \widehat{A}\right) a_1 = \widehat{A} x_2 + \widehat{C} b_2 + \left(1 - \widehat{A}\right)\left(x_1 + \widehat{B} b_1\right)$$

We redefine the strategy of the follower only in terms of his own signal and bias as follows,

$$a_2' := \frac{a_2 - \left(1 - \widehat{A}\right) a_1}{\widehat{A}} = x_2 + \frac{\widehat{C}}{\widehat{A}} b_2 = \theta + \varepsilon_2 + \frac{\widehat{C}}{\widehat{A}} b_2$$

The policymakers' forecasts of the shock are

$$\begin{aligned} \mathbb{E}_1\left(\theta | x_1\right) &= x_1 \\ \mathbb{E}_2\left(\theta | x_2, a_1\right) &= \frac{\frac{x_2}{\eta^2} + \frac{a_1}{\eta^2 + \widehat{B}^2 \beta^2}}{\frac{1}{\eta^2} + \frac{1}{\eta^2 + \widehat{B}^2 \beta^2}} = \frac{\frac{x_2}{\eta^2} + \frac{x_1 + \widehat{B} b_1}{\eta^2 + \widehat{B}^2 \beta^2}}{\frac{1}{\eta^2} + \frac{1}{\eta^2 + \widehat{B}^2 \beta^2}} \end{aligned}$$

We assume that elections happen in both countries after both countries have acted, and then the public forecasts the shock based on the actions of both the leader and the follower. Formally,

$$\mathbb{E}\left(\theta|a_1,a_2\right)=\mathbb{E}\left(\theta|a_1,a_2'\right)=\frac{\frac{a_1}{\eta^2+\widehat{B}^2\beta^2}+\frac{a_2'}{\eta^2+\left(\widehat{C}/\widehat{A}\right)^2\beta^2}}{\frac{1}{\eta^2+\widehat{B}^2\beta^2}+\frac{1}{\eta^2+\left(\widehat{C}/\widehat{A}\right)^2\beta^2}}=\frac{\frac{x_1+\widehat{B}b_1}{\eta^2+\widehat{B}^2\beta^2}+\frac{x_2+\frac{\widehat{C}}{\widehat{A}}b_2}{\eta^2+\left(\widehat{C}/\widehat{A}\right)^2\beta^2}}{\frac{1}{\eta^2+\widehat{B}^2\beta^2}+\frac{1}{\eta^2+\left(\widehat{C}/\widehat{A}\right)^2\beta^2}}$$

Combining optimal actions from equation (3) and the conjectured linear strategies for each country,

$$a_1 = x_1+\widehat{B}b_1=\omega\left(b_1+x_1\right)+(1-\omega)\frac{\frac{x_1+\widehat{B}b_1}{\eta^2+\widehat{B}^2\beta^2}+\frac{x_1}{\eta^2+\left(\widehat{C}/\widehat{A}\right)^2\beta^2}}{\frac{1}{\eta^2+\widehat{B}^2\beta^2}+\frac{1}{\eta^2+\left(\widehat{C}/\widehat{A}\right)^2\beta^2}} \tag{11}$$

$$\begin{aligned} a_2 &= \widehat{A}x_2+\widehat{C}b_2+\left(1-\widehat{A}\right)a_1 \qquad (12)\\ &= \omega\left(b_2+\frac{\frac{x_2}{\eta^2}+\frac{a_1}{\eta^2+\widehat{B}^2\beta^2}}{\frac{1}{\eta^2}+\frac{1}{\eta^2+\widehat{B}^2\beta^2}}\right)+(1-\omega)\frac{\frac{a_1}{\eta^2+\widehat{B}^2\beta^2}+\frac{x_2+\frac{\widehat{C}}{\widehat{A}}b_2}{\eta^2+\left(\widehat{C}/\widehat{A}\right)^2\beta^2}}{\frac{1}{\eta^2+\widehat{B}^2\beta^2}+\frac{1}{\eta^2+\left(\widehat{C}/\widehat{A}\right)^2\beta^2}}\end{aligned}$$

Notice that optimal strategies are characterized by the parameters $\widehat{B}$, $\widehat{A}$ and $\widehat{C}$, which are characterized in the next proposition,

Proposition 5 *Policies for the leader and the follower are given by equations (11) and (12), respectively, with $\widehat{B}$ being the solution to*

$$\frac{\omega}{\widehat{B}}+\frac{(1-\omega)}{1+\frac{\tau+\widehat{B}^2}{\tau+\left[1+\frac{\tau}{\tau+\widehat{B}^2}\right]^2}}-1=0 \tag{13}$$

with $\tau=(\eta/\beta)^2$, and

$$\widehat{A}=\omega\left[\frac{1}{1+\frac{\tau}{\tau+\widehat{B}^2}}+\frac{1}{\widehat{B}}-1\right] \tag{14}$$

$$\widehat{C}=\widehat{A}\left[1+\frac{\tau}{\tau+\widehat{B}^2}\right] \tag{15}$$

Proof. Notice that optimal strategies are characterized by the parameters $\widehat{B}$, $\widehat{A}$ and $\widehat{C}$ in the strategies for the leader and the follower, and for all combinations of signals and biases in both countries. The proportional terms can be collected into three independent conditions,

$$\widehat{B} = \omega + \frac{(1-\omega)\frac{\widehat{B}}{\eta^2+\widehat{B}^2\beta^2}}{\frac{1}{\eta^2+\widehat{B}^2\beta^2}+\frac{1}{\eta^2+\left(\widehat{C}/\widehat{A}\right)^2\beta^2}}, \qquad \widehat{A} = \frac{\omega\frac{1}{\eta^2}}{\frac{1}{\eta^2}+\frac{1}{\eta^2+\widehat{B}^2\beta^2}} + \frac{(1-\omega)\frac{1}{\eta^2+\left(\widehat{C}/\widehat{A}\right)^2\beta^2}}{\frac{1}{\eta^2+\widehat{B}^2\beta^2}+\frac{1}{\eta^2+\left(\widehat{C}/\widehat{A}\right)^2\beta^2}},$$

$$\widehat{A} = \frac{\omega}{\left(\widehat{C}/\widehat{A}\right)} + (1-\omega)\frac{\frac{1}{\eta^2+\left(\widehat{C}/\widehat{A}\right)^2\beta^2}}{\frac{1}{\eta^2+\widehat{B}^2\beta^2}+\frac{1}{\eta^2+\left(\widehat{C}/\widehat{A}\right)^2\beta^2}}$$

Summing the first and the third and equating the last two, we have:

$$\widehat{A} = \omega\left(\frac{1}{\widehat{C}/\widehat{A}}+\frac{1}{\widehat{B}}-1\right), \qquad \left(\widehat{C}/\widehat{A}\right) = 1 + \frac{(\eta/\beta)^2}{(\eta/\beta)^2+\widehat{B}^2}$$

The first expression for $\widehat{B}$ is what we need to solve the whole model:

$$1 = \frac{\omega}{\widehat{B}} + \frac{(1-\omega)}{1+\frac{(\eta/\beta)^2+\widehat{B}^2}{(\eta/\beta)^2+\left(\widehat{C}/\widehat{A}\right)^2}} \quad \rightarrow \quad \omega = \frac{\left((\eta/\beta)^2+\widehat{B}^2\right)\widehat{B}}{(\eta/\beta)^2+\widehat{B}^2+\left((\eta/\beta)^2+\left(\widehat{C}/\widehat{A}\right)^2\right)\left(1-\widehat{B}\right)}$$

which is a high-order polynomial in $\widehat{B}$ and can be rewritten as in the proposition by defining the ratio of variances as $\tau = (\eta/\beta)^2$. ∎

3.2.1 Perfect Information about the Shock

In order to isolate the incentives coming from policymakers' popularity concerns, we focus again on the special case in which both the leader and the follower have perfect information about the shock (this is, $\eta = 0$).

For this particular case the solution of the optimal strategy becomes particularly tractable. From Proposition 5, as $\tau = 0$ the weight $\widehat{B}$ that the leader puts into his own bias is given by the solution to the cubic equation

$$\widehat{B}^3 - \omega(\widehat{B}^2 - \widehat{B} + 1) = 0 \tag{16}$$

and the weights the follower assigns to the own signal and bias are

$$\widehat{A} = \widehat{C} = \frac{\omega}{\widehat{B}} \tag{17}$$

The next proposition characterizes how popularity concerns affect these weights.

Proposition 6 *As popularity concerns increase (ω declines), the leader's weight to his own bias relative to his signal, $\widehat{B}$, decreases and the followers' weight to the leader's action (cascading) increases.*

Proof. From the cubic equation on $\widehat{B}$, we obtain

$$\frac{\partial \widehat{B}}{\partial \omega} = -\frac{-(\widehat{B}^2 - \widehat{B} + 1)}{3\widehat{B}^2 - \omega(2\widehat{B} - 1)} > 0$$

and then

$$\frac{\partial \widehat{A}^{-1}}{\partial \omega} = \frac{\partial \widehat{C}^{-1}}{\partial \omega} = \frac{\partial \widehat{B}/\omega}{\partial \omega} = \frac{\frac{\partial \widehat{B}}{\partial \omega}\omega - \widehat{B}}{\omega^2}$$

Then $\frac{\partial \widehat{A}}{\partial \omega} = \frac{\partial \widehat{C}}{\partial \omega} > 0$ if and only if

$$\frac{\partial \widehat{B}}{\partial \omega} < \frac{\widehat{B}}{\omega}$$

which is the case, because the condition can be rewritten as

$$\widehat{B}^2 > \omega \left(\widehat{B} - \frac{1}{2} \right)$$

which is always true. ■

This characterization heavily relies on the solution of $\widehat{B}$, which comes from equation (16). At the one extreme, if $\omega = 0$, then $\widehat{B} = 0$. At the other extreme, if $\widehat{B} = 1$, then $\omega = 1$. Further, $\widehat{B} = 1$ is monotonically increasing on ω.

In terms of the follower's actions, as popularity concerns increase (ω declines) there are two forces that affect the weights in equation (17). On the one hand it tends to reduce the weights directly because the follower is more worried about the comparison with the leader. On the other hand, as we discussed above, it increases the weight the leader has assigned to the signal (reduces $\widehat{B}$). The first force, however dominates and the follower puts more weight on the action of the leader, increasing cascading but also discipline and welfare.

The next proposition shows the welfare loss in both countries in this case of perfect information about the shock.

Proposition 7 *When there is perfect information about the shock ($\eta = 0$), the welfare loss in the leading country is*

$$\mathbb{W}_1|_{\eta=0} = \widehat{B}^2 \beta^2$$

The welfare loss in the follower country is

$$\mathbb{W}_2|_{\eta=0} = \widehat{B}^2\chi\beta^2.$$

where $\chi = \frac{\widehat{B}^2+(1-\widehat{B})^2}{(\widehat{B}^2+(1-\widehat{B}))^2} < 1$. *As popularity concerns increase (ω declines), welfare losses decline in both countries.*

Proof. For the leader country, the action is $a_1 = \theta + \widehat{B}b_1$. Then welfare is

$$\mathbb{W}_1 = \mathbb{E}\widehat{B}b_1 = \widehat{B}^2\beta^2.$$

For the follower country, the action is

$$a_2 = \frac{\omega}{\widehat{B}}\theta + \frac{\omega}{\widehat{B}}b_2 + \left(1 - \frac{\omega}{\widehat{B}}\right)a_1$$

Replacing a_1,

$$a_2 = \theta + \frac{\omega}{\widehat{B}}b_2 + (\widehat{B} - \omega)b_1$$

Then welfare is

$$\mathbb{W}_2 = \mathbb{E}\left[\frac{\omega}{\widehat{B}}b_2 + (\widehat{B} - \omega)b_1\right]$$

Since $\frac{\omega}{\widehat{B}} = \frac{\widehat{B}^2}{\widehat{B}^2+(1-\widehat{B})}$ and $\widehat{B} - \omega = \frac{\omega}{\widehat{B}}\frac{1-\widehat{B}}{\widehat{B}}$, from equation (16),

$$\mathbb{W}_2 = \left[\frac{\omega}{\widehat{B}}\right]^2\left[1 + \left(\frac{1-\widehat{B}}{\widehat{B}}\right)^2\right]\beta^2 = \widehat{B}^2\underbrace{\left[\frac{\widehat{B}^2 + (1-\widehat{B})^2}{(\widehat{B}^2 + (1-\widehat{B}))^2}\right]}_{\equiv\chi}\beta^2$$

where $(\widehat{B}^2 + (1-\widehat{B}))^2 = \widehat{B}^2\left(1 + (\widehat{B}-1)^2\right) + (1-\widehat{B}))^2$, and then $\chi < 1$. The last sentence in the proposition follows from the fact that $\widehat{B}$ increases monotonically with ω. ■

Besides the result that, even when information is perfect, popularity concerns induce coordination and introduce discipline, this is true both when countries experience the shock simultaneously and sequentially. However, we show next that, when policymakers have to move sequentially, they both have more discipline (put less weight on their own bias) than when acting simultaneously.

Proposition 8 *Both the leader and the follower puts less weight on their own biases when acting sequentially than simultaneously. As a consequence welfare losses are lower when shocks arrive sequentially than when arriving simultaneously.*

Proof. When $\tau = 0$, a policymaker playing simultaneously puts a total weight of 1 to θ and $\frac{1+\omega}{2}$ to his own bias. In the case of acting sequentially and being a leader, the policymaker puts a weight $\widehat{B}$ on his bias, where $\widehat{B}$ solves equation (16). Then,

$$\frac{1+\omega}{2} = \frac{1}{2} + \frac{1}{2}\frac{\widehat{B}^3}{(\widehat{B}^2 - \widehat{B} + 1)} \geq \widehat{B},$$

which is always the case, as $\widehat{B}^3 - 3\widehat{B}(\widehat{B} - 1) - 1 = \widehat{B}(\widehat{B} - 1)(\widehat{B} - 2) - 1 \leq 0$.

The follower also puts a weight 1 on θ and B on the bias when playing simultaneously and a weight of $\widehat{A} + (1 - \widehat{A}) = 1$ on θ and a weight $\widehat{C}$ on the bias when being a follower. The follower is also more disciplined when

$$\frac{1+\omega}{2} \geq \widehat{C} = \frac{\omega}{\widehat{B}}$$

which is the case, as $\widehat{B} \geq \frac{2}{1+\omega}\omega$ for all ω (strictly for $\omega \in (0, 1)$). ■

Finally, we also show that, in comparison to the case in which the follower plays sequentially, he also puts less weight on the bias of the leader, as opposed to when playing simultaneously. This is important because the policy on the follower's country depends less on the own bias on the leader's bias when forced to act sequentially.

Proposition 9 *The follower puts less weight on the leader's bias when acting sequentially than simultaneously.*

Proof. When $\tau = 0$, a policymaker playing simultaneously puts a total weight of $\frac{1-\omega}{2}$ to the other country's bias. When being a follower, the policymaker puts weight $(1 - \widehat{A})\widehat{B}$ on the leader's bias. Then latter is lower than the former when

$$\frac{1-\omega}{2} \geq (1 - \widehat{A})\widehat{B} = \widehat{B} - \omega$$

which implies $\widehat{B} \leq \frac{1+\omega}{2}$, proved in the previous proposition. ■

This result is relevant for comparing the effect on ex-ante welfare and ex-post welfare. Not only sequential actions reduce ex-ante welfare loss, but also reducing the weight on the other country's bias implies a decline in ex-post welfare loss.

4 Conclusions

The recent COVID-19 pandemics constitutes a shock with unique properties, challenging policymakers worldwide. These properties include the totally unknown characteristics and effects of the virus, its commonality and spread to all countries and the sequentiality of this spread. In this paper we study how a policymaker who is concerned about how his constituents perceive him may want to coordinate policies with those in other countries, and what the welfare implications of such herding in policymaking are.

We show that, when facing such an event which allows the public to contrast and compare the policy responses across countries, policymakers tend to coordinate policies beyond what pure information aggregation would prescribe. This coordination, however, increases discipline and expected welfare by taming personal agendas on average, but evidently in certain cases can perniciously distort the behavior of unbiased governments, that thus would act better without these cross country comparisons. This effect is larger when governments have larger popularity concerns and when the public distrusts more their politicians to begin with. Sequentiality in the shock incidence thus in the reaction times indeed enhances herding on policies and strengthens discipline further.

While our model applies well to pandemics which represent a particular shock (unknown, spreading sequentially and commonly across many countries), still our model parameters are general and can describe also other shocks that are either better known by the public (such as financial crises) or that are less correlated across countries or affect few countries (such as natural disasters), or that spread almost instantaneously (like financial panics). These different characteristic of shocks affect how comparable they are, how they induce coordination of policies, and how welfare and policymakers' effectiveness are affected.

Appendix

A Imperfectly Correlated Shocks

In this extension we assume perfect information, $\eta = 0$ to highlight the effect of shock correlation. As we discussed in the text, the more correlated the shocks of countries are, the more the experience of leaders in other countries informs voters about the performance of their leader, namely how competent or unbiased he is. How herding and discipline depend n the correlation of shocks, this is how unique or common a shock is?

Two countries have correlated shocks, such as

$$\theta_2 = \theta_1 + \varepsilon \quad \Longleftrightarrow \quad \theta_1 = \theta_2 - \varepsilon, \qquad \varepsilon \sim \mathcal{N}\left(0, \sigma^2\right)$$

Notice that common shocks, as assumed in the main manuscript, is the case $\sigma^2 = 0$.

The observability/relevance of the counterfactual may be heterogenous: some countries have very similar countries preceding them in the pandemic hit-line (e.g. France and Spain after Italy), some others not, either because they were hit first or because other countries preceding them may be perceived as different (US is different from Italy or China?), so their experience does not apply as much.

A.1 Simultaneous Shocks and Actions

We start with the case in which two countries are hit by two simultaneous correlated shocks.

$$\theta_2 = \theta_1 + \varepsilon \quad \Longleftrightarrow \quad \theta_1 = \theta_2 - \varepsilon, \qquad \varepsilon \sim \mathcal{N}\left(0, \sigma^2\right)$$

From the result of optimal actions in the text,

$$\begin{aligned} a_1 &= \omega\left(b_1 + \theta_1\right) + (1-\omega)\mathbb{E}((\theta_1 | a_1, a_2) \\ a_2 &= \omega\left(b_2 + \theta_2\right) + (1-\omega)\mathbb{E}((\theta_2 | a_1, a_2) \end{aligned}$$

Assuming linear strategies,

$$a_1 := B\left(\theta_1 + b_1\right) + (1-B)\, a_2, \quad a_2 := B\left(\theta_2 + b_2\right) + (1-B)\, a_1$$

In this case we just assume one parameters, exploiting the result that in the case of

$\eta = 0$ the weights to the signal and the bias are the same.

This implies

$$a_1 = \frac{(\theta_1 + b_1) + (1 - B)\, a_2'}{2 - B}, \quad a_2 = \frac{(\theta_2 + b_2) + (1 - B)\, a_1'}{2 - B}$$

where we isolated the information relevant part of the actions:

$$\begin{aligned} a_1' &: = \frac{a_1 - (1 - B)\, a_2}{B} = \theta_1 + b_1 = \theta_2 - \varepsilon + b_1 \\ a_2' &: = \frac{a_2 - (1 - B)\, a_1}{B} = \theta_2 + b_2 = \theta_1 + \varepsilon + b_2 \end{aligned}$$

From the public's perspectives the strategies (a_1, a_2) are signals about θ_1 by public 1 (and θ_2 by public 2), that is for given B and A :

$$\begin{aligned} a_1' &\sim \mathcal{N}(\theta_1, 1), \qquad a_2' \sim \mathcal{N}\left(\theta_1, \sigma^2 + 1\right) \\ a_1' &\sim \mathcal{N}\left(\theta_2, \sigma^2 + 1\right), \quad a_2' \sim \mathcal{N}(\theta_2, 1) \end{aligned}$$

Hence, updated about the shocks are,

$$\mathbb{E}((\theta_1 | a_1, a_2) = \frac{\frac{a_1'}{1} + \frac{a_2'}{\sigma^2+1}}{1 + \frac{1}{\sigma^2+1}}, \qquad \mathbb{E}((\theta_2 | a_1, a_2) = \frac{\frac{a_2'}{1} + \frac{a_1'}{\sigma^2+1}}{\frac{1}{1} + \frac{1}{\sigma^2+1}}$$

Then (omitting a_2 as it is symmetric):

$$a_1 = \frac{(\theta_1 + b_1) + (1 - B)\, a_2'}{2 - B} = \omega\,(b_1 + \theta_1) + (1 - \omega)\frac{\frac{\theta_1 + b_1}{1} + \frac{a_2'}{\sigma^2+1}}{1 + \frac{1}{\sigma^2+1}}$$

Equating all similar terms we have one condition on the weight B,

$$B = \frac{\sigma^2 + 2\omega}{\sigma^2 + \omega + 1}$$

Then

$$a_i = \theta + \frac{1 + \omega + \sigma^2}{2 + \sigma^2} b_i + \frac{1 - \omega}{2 + \sigma^2} b_{-i}$$

Notice that in the case of common shocks, $\sigma = 0$ and we go back to the main text benchmark. As σ increases (this is the commonality of the shock declines), the weight on the own bias decline and the weight on the other country declines.

This is an important results, as highlights how shocks that are less common to other countries, are less relevant in inducing herding, but also discipline.

The ex-ante welfare loss is

$$W_i = \left[\frac{(1+\omega+\sigma^2)^2 + (1-\omega)^2}{(2+\sigma^2)^2}\right]\beta^2$$

which also coincides with the main text for $\sigma^2 = 0$ and is increasing in σ^2.

A.2 Sequential Shocks and Actions

As in the main text, correlated shocks (and then actions) are sequential. The leader does not know the bias of the follower, but the follower knows the bias of the leader. The public in both countries can observe both actions before voting for the new government.

Maximization implies the equilibrium actions are,

$$\begin{aligned} a_1 &= \omega\,(b_1+\theta_1) + (1-\omega)\mathbb{E}_1((\theta_1|a_1,a_2) \\ a_2 &= \omega\,(b_2+\theta_2) + (1-\omega)\mathbb{E}_2((\theta_2|a_1,a_2) \end{aligned}$$

Assuming linear strategies,

$$a_1 = \theta_1 + Bb_1 = \theta_2 + Bb_1 - \varepsilon, \qquad a_2 = C\,(\theta_2+b_2) + (1-C)\,a_1$$

Redefining the action as

$$a_2' = \frac{a_2 - (1-C)\,a_1}{C} = \theta_2 + b_2$$

These strategies (a_1, a_2') are taken as independent signals about θ_1 by public 1 (and θ_2 by public 2),

$$\begin{aligned} a_1 &\sim \mathcal{N}\left(\theta_1, B^2\right), \qquad a_2' \sim \mathcal{N}\left(\theta_1, \sigma^2+1\right) \\ a_1 &\sim \mathcal{N}\left(\theta_2, \sigma^2+B^2\right), \quad a_2' \sim \mathcal{N}\left(\theta_2, 1\right) \end{aligned}$$

Hence the public 's expectations ex-post are:

$$\mathbb{E}((\theta_1|a_1,a_2') = \frac{\frac{a_1}{B^2} + \frac{a_2'}{\sigma^2+1}}{\frac{1}{B^2} + \frac{1}{\sigma^2+1}}, \qquad \mathbb{E}\left(\theta_2|a_1,a_2\right) = \frac{\frac{a_2'}{1} + \frac{a_1}{\sigma^2+B^2}}{1 + \frac{1}{\sigma^2+B^2}}$$

The leader's expectation of the update of the public is

$$\mathbb{E}_1((\theta_1|a_1) = \mathbb{E}\left(\frac{\frac{a_1}{B^2}+\frac{a_2'}{\sigma^2+1}}{\frac{1}{B^2}+\frac{1}{\sigma^2+1}}\right) = \frac{\frac{a_1}{B^2}+\frac{\mathbb{E}_1(\theta_2+Cb_2)}{\sigma^2+1}}{\frac{1}{B^2}+\frac{1}{\sigma^2+1}} = \frac{\frac{a_1}{B^2}+\frac{\theta_1}{\sigma^2+1}}{\frac{1}{B^2}+\frac{1}{\sigma^2+1}}$$

Then,

$$\begin{aligned} a_1 &= \theta_1 + Bb_1 = \omega\left(b_1+\theta_1\right) + (1-\omega)\frac{\frac{\theta_1+Bb_1}{B^2}+\frac{\theta_1}{\sigma^2+1}}{\frac{1}{B^2}+\frac{1}{\sigma^2+1}} \\ a_2 &= C\left(\theta_2+b_2\right) + (1-C)\,a_1 = \omega\left(b_2+\theta_2\right) + (1-\omega)\frac{\frac{\theta_2+b_2}{1}+\frac{a_1}{\sigma^2+B^2}}{1+\frac{1}{\sigma^2+B^2}} \end{aligned}$$

We obtain,

$$B = \omega + (1-\omega)\frac{\frac{B}{B^2}}{\frac{1}{B^2}+\frac{1}{\sigma^2+1}}, \qquad C = \omega + \frac{(1-\omega)}{1+\frac{1}{\sigma^2+B^2}}$$

Thus the (implicit) solution is:

$$\omega = \frac{B^3}{B^2+(1-B)\left(\sigma^2+1\right)}, \qquad C = \frac{B^2+\sigma^2\left(1-B\right)}{B^2+(1-B)\left(\sigma^2+1\right)}$$

In sum the solution is,

$$\begin{aligned} a_1 &= \theta_1 + Bb_1 \\ a_2 &= C\left(\theta_2+b_2\right) + (1-C)\,a_1 \end{aligned}$$

$B\left(\omega,\sigma\right) \in [0,1]$ is increasing in both arguments.
$C\left(\omega,\sigma\right) \in [0,1]$ is increasing in both arguments.

B Non-Degenerate Prior

Suppose the public has a prior on the state

$$\theta \sim \mathcal{N}\left(v, \rho^2\right)$$

or which is equivalent, has a diffuse prior to begin with and then receives a public signal

$$v = \theta + \xi, \quad \xi \sim \mathcal{N}\left(0, \rho^2\right)$$

Now v and ρ will be a key additional parameters of the model.

Suppose leaders know θ perfectly for now ($\eta = 0$) so per se they do not care about v (other than for their reputation motive: what the public might think of them).

B.1 Single Country - Perfect Information

Optimal solution is:

$$a_1 = \omega\left(b_1 + \theta\right) + (1-\omega)\mathbb{E}((\theta|v, a_1)$$

More formally, assume linear strategies of the form:

$$a_1 = A\theta + Bb_1 + Cv \tag{18}$$

the public takes as independent signal the quantity (where a_1 and v are observed, and A, B, C are observed in equilibrium):

$$a_1' = \frac{a_1 - Cv}{A} = \theta + \frac{B}{A}b_1$$

Thus:

$$\mathbb{E}((\theta|v, a_1) = \mathbb{E}((\theta|v, a_1') = \frac{\frac{v}{\rho^2} + \frac{a_1'}{(B/A)^2\beta^2}}{\frac{1}{\rho^2} + \frac{1}{(B/A)^2\beta^2}}$$

We have:

$$A\theta + Bb_1 + Cv = \omega\left(b_1 + \theta\right) + (1-\omega)\frac{\frac{v}{\rho^2} + \frac{\theta + \frac{B}{A}b_1}{(B/A)^2\beta^2}}{\frac{1}{\rho^2} + \frac{1}{(B/A)^2\beta^2}}$$

Thus:

$$A = B = \omega + (1-\omega)\frac{\frac{1}{\beta^2}}{\frac{1}{\rho^2} + \frac{1}{\beta^2}}, \quad C = (1-\omega)\frac{\frac{1}{\rho^2}}{\frac{1}{\rho^2} + \frac{1}{\beta^2}} \quad \to \quad C = 1 - A$$

Thus:

$$a_1 = (1-C)\left(\theta + b_1\right) + Cv, \qquad C = \frac{1-\omega}{1 + \left(\rho/\beta\right)^2}$$

Special cases:

$$\begin{aligned}
\omega &= 1 \quad \to \quad a_1 = \theta + b_1 \\
\omega &\to 0 \quad \to \quad a_1 = \frac{\left(\rho/\beta\right)^2}{1 + \left(\rho/\beta\right)^2}\left(\theta + b_1\right) + \frac{1}{1 + \left(\rho/\beta\right)^2}v
\end{aligned}$$

See how the optimal policy always depends on v even though the leader knows the true state.

Welfare loss

$$\begin{aligned} W &= \mathbb{E}\left(\left(1-C\right)b_1 + C\left(v-\theta\right)\right)^2 = \left(1-C\right)^2\beta^2 + C^2\rho^2 = \\ &= \left(\omega + (1-\omega)\frac{\rho^2}{\beta^2+\rho^2}\right)^2\beta^2 + \left(\left(1-\omega\right)\frac{\beta^2}{\beta^2+\rho^2}\right)^2\rho^2 \\ &= \frac{\beta^2\left(\beta^2\omega^2+\rho^2\right)}{\beta^2+\rho^2} \end{aligned}$$

This welfare loss is always increasing in all three of its parameters, in particular:

$$\frac{dW}{d\rho} = \frac{2\beta^4\rho}{\left(\beta^2+\rho^2\right)^2}\left(1-\omega^2\right) > 0$$

B.2 Single Country - Imperfect Information

Optimal solution is:

$$a_1 = \omega\left(b_1 + \mathbb{E}((\theta|v,x_1)\right) + (1-\omega)\mathbb{E}((\theta|v,a_1)$$

More formally, assume linear strategies of the form:

$$a_1 = Ax_1 + Bb_1 + Cv \tag{19}$$

the public takes as independent signal the quantity (where a_1 and v are observed, and B, A, C are observed in equilibrium):

$$a_1' = \frac{a_1 - Cv}{A} = x_1 + \frac{B}{A}b_1 = \theta + \varepsilon_1 + \frac{B}{A}b_1$$

Thus:

$$\begin{aligned} \mathbb{E}((\theta|v,x_1) &= \mathbb{E}((\theta|v,x_1) = \frac{\frac{v}{\rho^2}+\frac{x_1}{\eta^2}}{\frac{1}{\rho^2}+\frac{1}{\eta^2}} \\ \mathbb{E}((\theta|v,a_1) &= \mathbb{E}((\theta|v,a_1') = \frac{\frac{v}{\rho^2}+\frac{a_1'}{(B/A)^2\beta^2+\eta^2}}{\frac{1}{\rho^2}+\frac{1}{(B/A)^2\beta^2+\eta^2}} \end{aligned}$$

We have:

$$a_1 = Ax_1 + Bb_1 + Cv = \omega\left(b_1 + \frac{\frac{v}{\rho^2} + \frac{x_1}{\eta^2}}{\frac{1}{\rho^2} + \frac{1}{\eta^2}}\right) + (1-\omega)\frac{\frac{v}{\rho^2} + \frac{x_1 + \frac{B}{A}b_1}{(B/A)^2\beta^2+\eta^2}}{\frac{1}{\rho^2} + \frac{1}{(B/A)^2\beta^2+\eta^2}}$$

Thus:

$$A = \frac{\omega\frac{1}{\eta^2}}{\frac{1}{\rho^2} + \frac{1}{\eta^2}} + \frac{(1-\omega)\frac{1}{(B/A)^2\beta^2+\eta^2}}{\frac{1}{\rho^2} + \frac{1}{(B/A)^2\beta^2+\eta^2}}, \quad A = \frac{\omega}{B/A} + \frac{(1-\omega)\frac{1}{(B/A)^2\beta^2+\eta^2}}{\frac{1}{\rho^2} + \frac{1}{(B/A)^2\beta^2+\eta^2}}, \quad C = \frac{\omega\frac{1}{\rho^2}}{\frac{1}{\rho^2} + \frac{1}{\eta^2}} + \frac{(1-\omega)\frac{1}{\rho^2}}{\frac{1}{\rho^2} + \frac{1}{(B/A)^2\beta^2+\eta^2}}$$

Thus:

$$\begin{aligned}
C &= 1 - A, \quad B/A = 1 + \frac{\eta^2}{\rho^2}, \quad \to B = \left(\omega + (1-\omega)\frac{1}{1 + \left(1 + \frac{\eta^2}{\rho^2}\right)\frac{\beta^2}{\rho^2}}\right) \\
A &= \frac{\omega}{1 + \frac{\eta^2}{\rho^2}} + (1-\omega)\frac{1}{1 + \frac{(B/A)^2\beta^2+\eta^2}{\rho^2}} = \left(\frac{\omega}{1 + \frac{\eta^2}{\rho^2}} + (1-\omega)\frac{1}{\left(1 + \frac{\eta^2}{\rho^2}\right) + \left(1 + \frac{\eta^2}{\rho^2}\right)^2\frac{\beta^2}{\rho^2}}\right) \\
C &= \left(\omega\frac{\frac{\eta^2}{\rho^2}}{1 + \frac{\eta^2}{\rho^2}} + (1-\omega)\frac{\left(1 + \frac{\eta^2}{\rho^2}\right)^2\frac{\beta^2}{\rho^2} + \frac{\eta^2}{\rho^2}}{1 + \left(1 + \frac{\eta^2}{\rho^2}\right)^2\frac{\beta^2}{\rho^2} + \frac{\eta^2}{\rho^2}}\right)
\end{aligned}$$

Thus:

$$a_1 = \left(\begin{array}{c} \left(\frac{\omega}{1+\frac{\eta^2}{\rho^2}} + \frac{(1-\omega)}{1+\frac{\eta^2}{\rho^2}+\left(1+\frac{\eta^2}{\rho^2}\right)^2\frac{\beta^2}{\rho^2}}\right)x_1 + \left(\omega\frac{\frac{\eta^2}{\rho^2}}{1+\frac{\eta^2}{\rho^2}} + (1-\omega)\frac{\left(1+\frac{\eta^2}{\rho^2}\right)^2\frac{\beta^2}{\rho^2}+\frac{\eta^2}{\rho^2}}{1+\frac{\eta^2}{\rho^2}+\left(1+\frac{\eta^2}{\rho^2}\right)^2\frac{\beta^2}{\rho^2}}\right)v \\ + \left(\omega + \frac{(1-\omega)}{1+\left(1+\frac{\eta^2}{\rho^2}\right)\frac{\beta^2}{\rho^2}}\right)b_1 \end{array}\right)$$

Another way to express this is:

$$\begin{aligned}
a_1 &= \omega\left(b_1 + \frac{\frac{x_1}{\eta^2} + \frac{v}{\rho^2}}{\frac{1}{\eta^2} + \frac{1}{\rho^2}}\right) + (1-\omega)\left(\frac{b_1}{1 + \left(1 + \frac{\eta^2}{\rho^2}\right)\frac{\beta^2}{\rho^2}} + \frac{x_1 + \left(\left(1 + \frac{\eta^2}{\rho^2}\right)^2\frac{\beta^2}{\rho^2} + \frac{\eta^2}{\rho^2}\right)v}{1 + \left(\frac{\eta^2}{\rho^2} + \left(1 + \frac{\eta^2}{\rho^2}\right)^2\frac{\beta^2}{\rho^2}\right)}\right) \\
&= \omega\left(b_1 + \mathbb{E}((\theta|v, x_1)\right) + (1-\omega)\mathbb{E}((\theta|v, a_1)
\end{aligned}$$

For $\rho = \infty$ we reattain:

$$a_1 = b_1 + x_1$$

For $\rho = 0$ we reattain:

$$a_1 = \omega b_1 + v$$

For $\eta = 0$ we reattain:

$$a_1 = (1 - C)(\theta + b_1) + Cv, \qquad C = \frac{1-\omega}{1 + (\rho/\beta)^2}$$

For $\beta = 0$ we obtain ($b_1 = 0$).:

$$a_1 = \frac{1}{1 + \frac{\eta^2}{\rho^2}} x_1 + b_1 + \frac{\frac{\eta^2}{\rho^2}}{1 + \frac{\eta^2}{\rho^2}} v$$

Spread $a_1 - \theta =$

$$\left(\begin{array}{c} \left(\frac{\omega}{1+\frac{\eta^2}{\rho^2}} + \frac{(1-\omega)}{1+\frac{\eta^2}{\rho^2}+\left(1+\frac{\eta^2}{\rho^2}\right)^2 \frac{\beta^2}{\rho^2}} \right)(x_1 - \theta) + \left(\frac{\omega \frac{\eta^2}{\rho^2}}{1+\frac{\eta^2}{\rho^2}} + \frac{(1-\omega)\left(\left(1+\frac{\eta^2}{\rho^2}\right)^2 \frac{\beta^2}{\rho^2} + \frac{\eta^2}{\rho^2}\right)}{1+\frac{\eta^2}{\rho^2}+\left(1+\frac{\eta^2}{\rho^2}\right)^2 \frac{\beta^2}{\rho^2}} \right)(v - \theta) \\ + \left(\omega + \frac{(1-\omega)}{1+\left(1+\frac{\eta^2}{\rho^2}\right)\frac{\beta^2}{\rho^2}} \right) b_1 \end{array} \right)$$

Or

$$\omega \left(b_1 + \left(\mathbb{E}((\theta|v, x_1) - \theta\right)\right) + (1 - \omega)\left(\mathbb{E}((\theta|v, a_1) - \theta\right)$$

$$\omega \left(b_1 + \frac{\frac{x_1}{\eta^2} + \frac{v}{\rho^2}}{\frac{1}{\eta^2} + \frac{1}{\rho^2}} - \theta \right) + (1 - \omega) \left(\frac{x_1 + \left(\left(1 + \frac{\eta^2}{\rho^2}\right)^2 \frac{\beta^2}{\rho^2} + \frac{\eta^2}{\rho^2}\right) v}{1 + \left(\frac{\eta^2}{\rho^2} + \left(1 + \frac{\eta^2}{\rho^2}\right)^2 \frac{\beta^2}{\rho^2}\right)} - \theta + \frac{b_1}{1 + \left(1 + \frac{\eta^2}{\rho^2}\right)\frac{\beta^2}{\rho^2}} \right)$$

Welfare loss

$$W = \left(\begin{array}{c} \left(\frac{\omega}{1+\frac{\eta^2}{\rho^2}} + \frac{(1-\omega)}{1+\frac{\eta^2}{\rho^2}+\left(1+\frac{\eta^2}{\rho^2}\right)^2 \frac{\beta^2}{\rho^2}} \right)^2 \eta^2 + \left(\frac{\omega \frac{\eta^2}{\rho^2}}{1+\frac{\eta^2}{\rho^2}} + \frac{(1-\omega)\left(\left(1+\frac{\eta^2}{\rho^2}\right)^2 \frac{\beta^2}{\rho^2} + \frac{\eta^2}{\rho^2}\right)}{1+\frac{\eta^2}{\rho^2}+\left(1+\frac{\eta^2}{\rho^2}\right)^2 \frac{\beta^2}{\rho^2}} \right)^2 \rho^2 \\ + \left(\omega + \frac{(1-\omega)}{1+\left(1+\frac{\eta^2}{\rho^2}\right)\frac{\beta^2}{\rho^2}} \right)^2 \beta^2 \end{array} \right)$$