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How the North has transferred its risk of excess mortality due to coronavirus to the South: a draft model of international mortality transfer

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The policy of combating COVID-19 carried out in the North by confinement has the effect of transferring to the South the excess mortality attributable to the virus, because of the major recession that this policy causes and which is transmitted to the South, where it is a source of excess mortality, more than in the North.

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... /... The North is not responsible for the coronavirus. The coronavirus is a pandemic that originated in China and has spread without the leaders of the North having the means to prevent it. But what they are responsible for is the political choice of how to contain the epidemic. This choice shared to varying degrees and according to different timetables by most Northern countries, which was no doubt legitimate given the information available to them, is fundamentally different from the way other infectious diseases (and previous epidemics) are dealt with in the North. The policy adopted, which has led to a deep economic recession in the countries of the North, represents a social choice based on a strong aversion to the risk of death, in other words on the acceptance of paying a considerable price for each death avoided.

The major recession generated in the North by the containment, by being transmitted to the countries of the South, has the effect of transferring there the excess mortality attributable to the virus because, in poor countries, the recession is a source of excess mortality more than in the West. A twofold question then arises. The first, in absolute terms, is a global one: *what is the number of additional deaths in the South for one death avoided in the North* (what could be called the "terms of life trade?", "lethal terms of trade")? The second, in relative terms, is either global or specific to a particular country or group of countries: *what relative increase in mortality in the South (or in a region of the South) is induced by the relative decrease in mortality in the North achieved through containment ?*

The theoretical model presented here allows us to formalize this relationship. It should make it possible to answer the second question for a developing country or a relatively homogeneous group of developing countries. The answer to the first question, asked at the global level only, can only be indicative. The model is based on three relationships or proposals, each of which can be estimated.

Recession in the North is a function of the number of deaths avoided through containment

The recession has ben the price voluntarily paid to contain the epidemic through containment. The parameter to be estimated is either t*he derivative or the elasticity of Product Y with respect to the avoided deaths ME*. This parameter (derivative or elasticity) is itself the result of the combination of two relationships:

- the effect of the containment on the absolute number of deaths avoided, dME (or on a relative number, namely the avoided increase in the mortality rate: dME/M, with M the total number of deaths)[1] :

- and the effect of containment on the Product Y level, dY (or the economic growth rate dY/Y).

The derivative dY/dMe represents the price or cost of a death avoided by containment. The elasticity written (dY/Y)/(dME/M) represents the relative change (decrease) in the Product induced by the increase in the death rate that has been avoided by containment[2]. This is the parameter that will be used below.

This parameter is difficult to estimate. A more or less severe and more or less long containment leads to both more or less avoided deaths and more or less activity decrease.

The first function is not linear (containment flattens the excess mortality curve). Furthermore,

1. Of course, it should also be taken into account that confinement to the North also leads to some indirect excess mortality due to less treatment of diseases other than Covid 19 and lower-income, but to a much lesser extent than in poor countries, as is assumed below.
2. It is the ratio of the cost of confined death avoided to the product per capita (the relative cost of avoided death) weighted by the mortality rate : (dY/Y)/(dME/M)= ¬[(dY/dME)/(Y/P)]x(M/P).

the relationship must be established by assuming what the mortality would have been if it had developed spontaneously or with the sole use of known drugs and the tests necessary for them to be administered "reasonably": one must then take into account the deaths that would then have been possibly caused by the side effects of the treatment administered (ruled out precisely because of fear of these effects).

The impact of containment on economic activity is itself complex and non-linear (it is all the stronger as it flattens the epidemic curve) and may result in particular in effects that are delayed over time.

Although the relationship between avoided mortality (due to containment) and decreased activity (due to containment) is not linear, it is still reasonable to assume what its value is on average. This means assuming a constant substitution rate either between the deaths avoided due to containment and the value of the product lost due to containment, or, again due to containment, between a lower increase in mortality and a lower relative growth of the product (between a decrease in mortality due to coronavirus and a relative decrease in a product due to the same factor).

More and more figures are circulating that gave an order of magnitude of the relationship. If, for example, one accepted the estimate of 60,000 deaths avoided in France, a figure which remains quite uncertain given the difficulty of quantifying the counterfactual mortality, i.e. the mortality that would have occurred if the best non-containment control strategy had been adopted, this would mean for a usual figure of about 600,000 deaths per year a reduction in mortality of about 10% compared to what would have occurred in the absence of containment. On the other hand, for France, the figure of 10% is increasingly cited as the cumulative impact in 2020 of the recession-induced by containment which is only gradually easing. These two coefficients would roughly correspond to a unit elasticity of mortality avoided by containment to its cost in terms of lost product. However, this estimate would have to be corrected to take into account what the drop in Product would have been in the absence of containment and therefore in the event of a "less controlled" epidemic (in particular because of a probable drop in tourism revenues). For example, the "net" elasticity of avoided mortality to the lost Product could be halved compared to the "gross" elasticity. The magnitude of the shock transmitted by the North to the countries of the South depends on their gross elasticity, even if they are only fully responsible for their net elasticity.

Coming back to the French case, with a GDP (2019) of around 2400 billion euros (thus a gross loss of 240 billion or a net loss of 120 billion) and 60,000 deaths avoided, the average cost of deaths avoided by containment would then be around 4 million in gross terms and 2 million in net terms, a figure which is only an order of magnitude, close to what is sometimes reported and which depends fundamentally on the estimate of the number of deaths avoided (by containment).

Recession in the South is a function of the recession in the North

This relationship may seem to correspond in part to the old model of dependence, which was thought to have become obsolete after the emergence of large countries in the South. Without needing to refer to any general theory of dependency, it is a question of estimating, in the current circumstances of the COVID-19 crisis, the impact of the recession in the North on the income of middle- and low-income countries. The relationship is established through multiple channels: the volume of goods imported by the North from the South, affected directly by the fall in income in the North and indirectly by protectionist reactions, exports of services from the

South, including of course tourism receipts which are particularly sensitive to the pandemic, but also the price of raw materials, particularly that of oil and minerals for the countries that depend on them, sometimes especially to migrant remittances, which in some countries are the main source of external resources, but also to direct investments, in short, all the flows that come as a credit to the balance of payments of the country or countries of the South can be affected by the economic situation in the North.

Given the variety of economic structures in the South, the relationship must be specified according to the characteristics of the countries, while the elasticity of income in the South (or in a South country) in relation to income in the North must be differentiated according to whether it concerns the group of African countries or LDCs, or oil-exporting countries, or countries highly dependent on migrant income transfers (Nepal or Maghreb type) or tourism receipts (SIDS type), etc., or whether it is estimated for a particular country. Naturally, a distinction must be made between spontaneous transmission and the adjusted transmission of the measures taken by the international community to cushion the former. Here we are mainly concerned with spontaneous transmission, precisely to show the need for such an adjustment.

A transmission model reduced to its simplest expression consists of measuring *elasticity of income of a country or group of countries in the South* (denoted s) relative to the income of the North (dYs/Ys)/dYn/Yn), which is arithmetically the product of three parameters:

- the elasticity of the value of exports of goods and services (in a broad meaning) of this country or group of countries in relation to the income of the North (dXs/Xs)/dYn/Yn);

- the "trade" dependence of the country or group of countries from the South, measured by the "exports" ratio of this country to its product (Xs/Ys);

- the variation of its product with respect to variations in its exports in the broad sense (dYs/dXs) (a kind of income multiplier from exports of goods and services in a broad meaning).

The product of the last two coefficients corresponds to the elasticity of income (in the South) with respect to "exports". The term "exports" can be replaced by all flows to the country, including exports of goods and services, migrants' remittances and, which makes the relationship more uncertain capital flows. The relationship must naturally be estimated by taking into account the significant impact in the South of the recession in China, reclassified in the North in this case.

The major difficulty for an estimate is that past series have shown a little overall decline in income in the North far from the magnitude of the magnitude of the current decline and that even the 2008-2009 recession, because of its financial origin, has propagated through specific channels, with a cushioned impact in low-income countries. Moreover, the transmission of the recession due to COVID-19 is likely to be non-linear and asymmetric, with ratchet effects (e.g. if the initial decline in income leads to the disappearance of firms, limiting the transmission of a subsequent recovery). A provisional approximation of the short-term income fall induced in the South by the recession due to COVID-19 can then be obtained from the change in the international institutions' forecasts for growth in the South or the various regions of the South in 2020-21 between autumn 2019 and spring 2020.

Mortality in the South is a function of the recession in the South

Through different channels, the fall in income in the South (dYs) increases mortality (dMs) there, all the more so as per capita income is lower

there: (dMs/Ms)/dYs/Ys)= f(Y/P), with f'<o.

A major channel is a decline in the level and effectiveness of health and sanitation spending, which causes a resurgence of traditional mortality factors, such as malaria. Another is the deterioration of the food situation, due to various reasons related to production, transport and, above all, the drop in income. Finally, this has an impact on a whole series of health factors: nutrition, as already noted, healthy housing, etc.

The estimation of the corresponding function, as with the previous one, must of course be specified according to the country, but it also presupposes correctly capturing its non-linearity. It is the reaction of mortality to a fall in income and not to any movement (up or down) in income that is sought... Moreover, it is probably more than proportional to the fall in income (a fall of which the episodes over which it can be observed with the feared magnitude are not so numerous): in other words, it is a question of estimating an *elasticity of mortality in relation to income that is specific to cases where income falls and that is itself a function of this fall* (and/or of the initial level of mortality). This elasticity is written (DMs/Ms)/(dYs/Ys).

Little work has been done on this specific relationship. They suggest elasticity of the order of 0.5, an order of magnitude found in some studies of the impact of income instability on child mortality, which is stronger in lower-income countries. It is still necessary to specify the period over which this elasticity is measured, since the effects of the fall in income may be felt in a staggered fashion over time and irreversible in the short term. Asymmetry due to a negative ratchet effect on health and survival is likely to be important here.

The combination of the three previous relations 1), 2), 3), should make it possible to estimate or simulate how to the mortality avoided in the North corresponds an excess mortality in the South, in a differentiated manner according to the countries. Particular attention should be paid to the countries of Africa south of the Sahara (or to the LDCs). It may be appropriate to look more particularly at the case of excess child mortality, which is very reactive to recession in the South, whereas it is not very reactive to coronavirus in the North. *To a certain extent, the transfer is from lower mortality of elderly people in the North to excess mortality of children in the South.*

Combination of the three sub-models

By combining the three sub-models, we can estimate the *elasticity of mortality in the South* (more precisely in this or that group of countries in the South) *to the mortality avoided in the North* due to the strategy of containing the epidemic through containment. This elasticity is the product of the elasticities estimated (or simulated) in each of the three sub-models.

$$(dMs/Ms)/d(ME_N/M) = (dY_N/Yn)/(dME_N/Mn) \ X \ (dY_S/Ys)/(dY_N/Yn) \ X \ (dM_S/Ms)/(dY_S/Ys)$$

The equation is indeed the product of three elasticities: (i) the elasticity of the Northern product (corresponding to the cost of containment) relative to the avoided mortality, (ii) the elasticity of the Southern product (or of a Southern country) relative to the Northern product, (iii) the elasticity of mortality relative to the product in the South. Note that the product of elasticities (ii) and (iii) is the elasticity of mortality in the South (specified country) to the product of the North: $(dM_S/Ms)/(dY_N/Yn)$.

This triple relationship can also be written in absolute terms, as the product of three derivatives, namely

$$(dMs/dME_N) = (dY_N/dME_N) \ X \ (dY_S/dY_N) \ X \ (dM_S/dY_S)$$

The equation represents *the number of induced*

deaths in the South per death avoided in the North due to containment. Its first term represents the price of one death avoided in the North (by confinement) and the third term represents the mortality induced in the South per unit of product lost (due to the recession), the second term being an economic dependency coefficient. Note here as well as the product of the last two terms, i.e. (dM_S/dY_N) the mortality induced in the South by a unit of product lost in the North. The "model" remains to be specified by summarising how it can be applied either to a given country (or group of countries) in the South or on a global scale.

In short, the structure of the model can be summarized as follows

- The lower coronavirus mortality, obtained in the North by containment, or dME_N, results in lower income in the North, or dYn. The ratio dY_N/dME_N represents the price attributed by the North to a death avoided by containment. In relative terms, the elasticity of the product with respect to the deaths avoided by containment $(dY_N/Yn)/(dME_N/Mn)$ represents the economic shock created by the North in response to the coronavirus. This (negative) elasticity may be of the order of unity.

- The decline of income in the North is transmitted to the South in varying proportions, depending on the level of poverty of the countries and their dependence on the North. For poor and most externally dependent countries, the elasticity of their income relative to that of the North may be greater than unity.

- Lower-income in the South results in higher mortality. In the poorest African countries, the (negative) elasticity of mortality in relation to income is probably close to unity.

For these various reasons, it is to be feared that the lower mortality obtained in the North by confinement will result in a more than proportional increase in mortality in the poor countries of the South. The parameters that express for each country of the South or globally the combined result of the three previous relations are:

- A parameter specific to each type of affected Southern country, βi, *which is the elasticity of mortality in i relative to mortality avoided in the North*, or

$$\beta i = (dMsi/Msi)/(MEn/Mn)$$

This parameter represents *the lethal vulnerability of country i with respect to the mortality avoided in the North by confinement*.

- It corresponds to a global relative transfer parameter which is the elasticity of the global mortality induced in the South in relation to the mortality avoided in the North, i.e.

$$\beta. = (\sum dMsi/\sum Msi)/(MEn/Mn)$$

The parameter β. is the average of the elasticities βi of each country weighted by the ratio of the (normal) number of deaths in each country i to the total (normal) number of deaths in the South[3].

- Still, on a global scale, it corresponds to the previous formula an absolute mortality transfer parameter, or *external mortality multiplier*, so it

$$\alpha = (\sum dMsi/\sum MEn)$$

This « multiplier » α is the sum of mini-multipliers specific to each country i and it is the average of the elasticities βi of each country weighted by the ratio of the number of deaths Mi in each country i to the total number of deaths in the North Mn[4].

3. i.e. by the ratio of the mortality rate μi of country i to the average rate μs of the countries of the South multiplied by the ratio of the population Pi of country i to the total population of the countries of the South P.
4. i.e. by the product of the ratio of the mortality rate μi of

Concluding remarks

It is conceivable that the parameters defined above are easier to interpret in their relative form β than in their absolute form α and easier to use for one country (or homogeneous group of countries) than for all the countries of the South. It should be pointed out that the previous analysis sought to reveal the excess mortality in the South that is attributable to the lower mortality in the North obtained by confinement, which is expressed by partial derivatives and elasticities. Of course the pandemic also has direct effects on mortality in Africa, even if its impact now seems less than feared. However, these "direct" effects do not only "add on" to mortality. They also act jointly or in interaction with the drop in income, particularly in the case of confinement (in the South). Confinement is known to be difficult to apply in low-income countries: for populations living day to day in unsanitary shelters, it makes access to food uncertain and increases the occurrence of violence. In short, in situations of great social fragility and poverty, containment, while partially preventing deaths from the virus, can also increase the number of deaths due to induced activity reduction.

The impact on mortality in the South of the containment of the epidemic achieved in the North by confinement is certainly not easy to establish with precision. But it is sufficiently clear in its principle and modalities to be taken into account in international response policies to the crisis in the South resulting from the pandemic. Indeed, the lethal vulnerability of each poor country with respecy to the mortality avoided in the North by confinement (βi) may constitute a criterion to be considered for the allocation of resources that the international community intends to mobilize to face the effects of the recession transmitted to the South by the North.

country i to the average rate of Northern countries μn and the ratio of the population Pi of country i to the total population of Northern countries Pn.

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