# Values, Volumes, and Price-Volume Decompositions: On Some Issues Raised (Again) by the Health Crisis

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**Abstract** – The health crisis has highlighted the need for national accounts able to trace the activity and financial situations of various groups of economic agents as quickly as possible. It also raises several questions about how real GDP aggregates quantities of heterogeneous goods and services that meet very different needs, the relative priorities of which have been, at least temporarily, affected by the crisis. We focus on two aspects of this question: the theoretical properties of chaining volumes at market prices for the market component of GDP and the related problems of measurement and aggregation for its non-market components. Beyond the short-term shock, the crisis provides an opportunity to revisit some substantive issues regarding the interpretation of production and volume growth indicators, issues that the post-crisis period should continue to fuel.

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When the health crisis began, INSEE set out as soon as possible to assess its impact on two of the main national accounts indicators: gross domestic product (GDP) and household spending. These were snapshot assessments, whereas forecasters usually only provide assessments for an entire quarter. At the time, assessing an impact on a quarter's GDP or household spending would have implied a forecast of the duration and conditions for lifting the first lockdown restrictions, which nobody was able to provide. France was the first country to offer such snapshot assessments. Other countries gradually followed suit, after which the data returned to the usual form of quarterly and annual estimates, paving the way for many comparative comments on the extent and course of the shock between these different countries: where had GDP dropped most, why and how, and when would it return to its pre-crisis level?

This context has highlighted the usefulness of national accounts and of early estimates of its main aggregates, which are essential for calibrating measures to support the economy. The crisis has also led to renewed interest in the use of input-output tables, a key component of national accounts, which help to assess interdependencies between sectors and therefore the risks of spillover effects, both upward by demand constraints, and downward by supply constraints (Dauvin *et al.*, 2020; OFCE, 2020; Baqaee & Farhi, 2020; Barrot *et al.*, 2021).

But there have been questions, particularly regarding the measurement of certain output items. What was the value of continuing to measure self-production of housing services by homeowners? How would the drop in government output be measured? Did the methods used ensure international comparability of data? Some of these questions are addressed in this article, but its main theme is broader. Beyond the questions about certain sectoral components of GDP, there is the question of the meaning of their aggregation: even with perfectly well measured sectoral outputs, what meaning could be given to their aggregation when their changes were following highly contrasted paths?

The crisis has thus highlighted an aspect of real GDP that we do not always bear in mind: the fact that it also relates, in its own way, to the category of composite indicators that reduce to a single figure a set of core data that can be very disparate. All that is aggregated indeed relates to production flows of goods and services. But this remains a patchwork, combining current consumptions, light and heavy capital goods, services, including a growing share of intangible services, health care, teaching hours and so on. What distinguishes GDP from other composite indices is the aggregation of these components based on a metric that seems to make them perfectly commensurate, the money metric. As long as nominal GDP is concerned, and for its market component, it is not physical quantities of goods that are aggregated but only the income generated by their production. This is a good reason to favour what is called the "income" reading of GDP for which aggregation does not seem to pose any problem: since incomes can be added and subtracted, it makes sense to calculate their aggregate and then to examine how it is distributed before or after redistribution between major categories of economic agents – which is what agent accounts do – or at the microeconomic level of companies and individuals – as do various attempts to disaggregate accounts at a higher level of granularity (Alvaredo *et al.*, 2020; INSEE, 2021). Actually, it is this dimension of income that the users of the figures had most in mind during the crisis: not what the drop in GDP represented in terms of fewer cars or meals at restaurants, but what it represented in terms of less earned income for the companies or establishments concerned and, therefore, solvency and risk of bankruptcy, with their potential consequences on the labour market.

However, the question of the meaning to give to the aggregation of quantities rather than monetary values remains central. It arises first when turning to the question of the purchasing power of this income, since it involves comparisons of the baskets of goods that different levels of income allow to consume when there are simultaneous price variations, therefore a comparison of groups of quantities of heterogeneous goods. And it is as an aggregate of variations in quantities that the growth of real GDP is presented when we want to read it as an indicator of production rather than a measurement of the income generated by this production. This reading in terms of production is required, in particular when considering the case of public services, which are productive of in-kind services directly made available to households (Carnot & Debauche, 2021), but without being income generators in the usual sense of incomes generated by a company's sales.

However, this concept of aggregate in volume of production is complex and must be approached without excessive positivism and in full awareness of the issues it raises. As well explained by

Vanoli (2002, pp. 512–518), such an aggregate is not the objective measurement of a tangible reality as is that of a physical magnitude; rather, it is a conventional object, the interpretation of which can give rise to debate. The challenge is to find the most accurate of these interpretations, both in times of crisis and in normal times.

In order to do so, can we proceed without the economist's toolbox, particularly the concept of consumer utility? Public accountants are frequently reluctant to using such concepts, because of the fear of being drawn too far into issues of well-being measurement, which GDP does not purport to provide. Clearly distinguishing between measuring GDP and measuring well-being is indeed essential. But this cannot dispense with any reference to the associated concept of consumer utility, as illustrated by the pre-crisis debate on the handling of new services from the digital economy.[1] On the one hand, we have seen economists spontaneously inclined to express this problem in terms of utility or the contribution of these new goods to well-being – Aghion *et al.* (2020) use the term of "utils" to describe the unit of account implicit in calculations of real GDP – and, on the other hand, public accountants reminding us that this was going beyond what is normal to ask of GDP, but at the risk of ending up in a somewhat uncomfortable position. They cannot just recall what real GDP does not measure; they must be able to give a positive definition of it, and this is difficult to do without reference to this concept of utility because we do not see how to aggregate quantities of heterogeneous goods and services according to any other target standard than the service rendered to the consumer. This is ultimately acknowledged by accountants when they invoke the connection between marginal utility and market price to justify the aggregation of quantities according to these market prices (Lequiller & Blades, 2014). It was even to strengthen this link that the 1993 System of National Accounts (SNA) extended the practice of calculating chain-linked volumes by updating the reference price system annually rather than keeping it at its base year level. This chaining enables weighted prices to be as representative as possible of the instantaneous relative marginal utilities of various goods and services, rather than referring to increasingly dated relative utilities as you move away from the base year.

However, this relationship to the concept of utility raises other issues. We know, for example, that chaining, which appears very well founded in theory, can have undesirable properties, especially in the event of a large-scale economic shock. One argument, which has long halted its acceptance, is that it makes the comparison of the state of the economy at two distant dates $t$ and $t'$ dependent upon the path followed between these two dates, whereas the comparison of the two states should, in principle, only involve their individual characteristics (Berthier, 2003). This problem of path dependence is well known to price statisticians. It explains that they do not use chaining at a sub-annual level because this could lead to a continuous drift in the general price level in the presence of seasonal movements affecting prices and quantities on a cyclical basis without any trend component. The same problem leads the SNA to advise against chaining for items whose non-regular changes alternate upwards and downwards. However, this type of movement is precisely what we experienced with the crisis. Added to this is the fact that the crisis, by temporarily changing preferences, may have further weakened the reading of GDP in terms of consumer utility, which has temporarily ceased to be a stable benchmark.

The reference to economic concepts is, therefore, both necessary and a source of many questions. Questions about path dependence, the instability of preferences and their consequences for reading aggregates have been raised in recent works by Baqaee & Farhi (2020) and Baqaee & Burstein (2021). The question is, what economic concept did GDP measure against in such a disrupted context? Related questions arise at the microeconomic level: the property of non-homotheticity of preferences that we will see to be the cause of the path dependency problem prohibits the assumption that price increases have the same impact for households with different incomes, forcing the consideration of differentiated measurements of inflation between categories of households (Jaravel, 2021; Jaravel & Lashkari, 2022).

The aim of this paper is to propose some introductory discussions of these topics. It will initially focus on the market sector. A few simulations show that it seems possible to put the problem of path dependence into perspective, but only in the presence of rigid relative prices, which would have made them temporarily

1. *See Blanchet* et al. *(2019) for a review.*

deviate from their function of revealing the instantaneous marginal utilities of goods and services. This is not without paradox, since the good performance of the indicator would, therefore, have been due to the relaxation of the assumption that usually legitimises it. Anyway, this relaxation has been only partial and temporary, as the effects of the health crisis are now being combined with those of a geopolitical crisis that is disrupting both absolute and relative prices. Having temporarily escaped path dependence does not, in any way, mitigate the general problem of which it is only one of the manifestations: the impossibility of constructing volume indicators that are consistent with any assumption about the form and evolution of the preferences of economic agents, a problem encountered when reading long-term growth indicators.

We then, more briefly, address the issue of aggregating the market output thus obtained and non-market output. Here, the question is what sense it made to continue to aggregate the provision of intensive medical care and teaching hours, both between themselves and with the number of meals in restaurants, given the very different nature of the types of services rendered. One can argue that it is only temporarily that the aggregation of all these elements would have lost its meaning, and that the return to normal conditions of activity should make it possible to return to its usual reading. But the conclusion must be more nuanced. While the context of the crisis has had a temporary magnifying glass effect on problems of interpreting real GDP, these problems also arise in assessing long-term growth; therefore, they cannot be neglected in normal times, particularly if the post-crisis situation leads to non-marginal changes in our growth model.

## 1. Volumes, Prices and Consumer Utility: Some Reminders

As just mentioned, GDP does not measure well-being, but this does not make it possible to avoid the question of how it is related to it (Schreyer, 2016; Blanchet & Fleurbaey, 2020). Firstly, because it is one of its main uses to show whether the economy is doing well, and this can only be assessed in terms of its contribution to the ultimate well-being of individuals. Secondly, from a more technical point of view, both public accountants and price statisticians cannot escape using the akin concept of consumer utility when they want to legitimise their practices concerning volume/price decompositions.

As a first approximation, it remains of course possible to reduce this problem of volume/price decomposition to simply substracting the effects of general price rises from aggregate nominal changes, and this is how the problem is generally perceived. For example, in a simple case in which nominal income increases by 3%, assuming that all prices increase by 2% in parallel with quantities that all increase by 1%, it is natural to assume that overall real growth is also 1%. But such a characterisation only works well if you do not move too far from this double assumption of stability for both relative prices and consumption or production patterns. The difficulty is to have a characterisation of what we call volume that also works when the relative price and/or consumption patterns become distorted. If, as another example, we take the case of two goods initially consumed in the same quantity of 1, with changes in nominal income and relative prices leading to the new consumption basket of respectively 1.05 and 0.95, shall we say that there has been growth, decline or stability in the total volume of consumption? To take a third example, shall we say that there is more overall growth when the quantity of good 1 increases to 1.1 while that of good 2 remains stable, rather than the reverse. Everything depends on what is thought to be the gains and/or losses in utility associated with these unequal movements of the quantities of the two goods.

The reference to utility therefore appears inescapable. With regard to price statistics, whose indices feed the accounts, the "constant utility" index serves as a reference model that measures the increase in nominal income required to maintain the same level of final utility when prices rise (Sillard, 2017); dividing a nominal income by this type of index leads to a concept of real income that is necessarily related to that of consumer utility. With regard to accounts and the direct measurement of volume as a chained product of increases in the quantities of goods weighted by their prices, justification of the weighting by the fact that prices reflect relative utilities also means that what is measured links with utility. Ultimately, in the continuous-time language of the Divisia indices (the theoretical model underlying chaining; see Hulten, 1973), if the prices $p_i$ of goods consumed in quantities $q_i$ perfectly represented their current marginal utilities $\partial U / \partial q_i$, one could directly write $\sum_i p_i dq_i = \sum_i \left(\partial U / \partial q_i\right) \cdot dq_i = dU$ and there would be perfect equivalence between the instantaneous growth in utility and the instantaneous growth in volume, an equivalence that

would therefore be also guaranteed for long-term changes.[2]

The link to well-being or utility in the broad sense is, of course, much more partial and complex for two main reasons. The first is a given: overall well-being or utility depends on factors other than those covered by national accounts, *a fortiori* those of the market sub-field on which we focus initially. The second is that even if well-being depended only on market consumption, the aim of national accounts could still not be to measure or even approximate this well-being, but only an intermediate concept of standard of living. The two concepts are related but distinct. Standard of living refers to the means available to people to lead their lives as they see fit; the way to weight them must consider their contribution to their well-being or utility and, all other things being equal, an increase in the standard of living therefore contributes to well-being, but there is no reason to observe a systematic proportionality between the two variations. Comparisons of standards of living between people can thus differ significantly from comparisons of well-being. An important tradition in economic theory of equity (and in political philosophy following Rawls) postulates that it is the standard of living that is most relevant to public policy, while the more subjective concept of well-being depends in part on purely private life choices.

More technically, the difficulty in establishing a strict correspondence between volumes and utility stems from the fact that prices only partially reflect the marginal utilities of goods and services. They only provide information about their *relative* marginal utilities, i.e. only a correspondence between the ratios $p_i/p_j$ and the ratios $\left(\partial U/\partial q_i\right)/\left(\partial U/\partial q_j\right)$: the relative prices indicate whether there is more gain in increasing the quantity of a good 1 or good 2 by the same percentage, and it is in this respect that they make it possible to say whether the standard of living increases or decreases when these quantities change in an uncoordinated manner, but without saying what the absolute values of the gains or losses are.

An elementary theoretical framework can help to clarify all this. Suppose that, in addition to the vector $q=\left(q_1\ldots q_m\right)$ of production/consumption of goods giving rise to monetary value, well-being depends on a group of other determinants $z=\left(z_1\ldots z_n\right)$, which can be both elements of exogenous context as well as production, consumption or, more generally, actions outside the scope of what is put in national accounts, in keeping with Hulten & Nakamura (2017) or more recently with Fleurbaey *et al.* (2021). Let us then assume that it can be accounted for with a utility function $U\left(q,z\right)=f\left(g\left(q\right),z\right)$ where $g\left(q\right)$ is a scalar function of the vector $\left(q_1\ldots q_m\right)$. This form is not general because it assumes separability of the effects of $q_i$ and $z_j$; it is, therefore, a very simplified version of the type of interaction between the economic and non-economic spheres considered by Fleurbaey *et al.* (2021), but it already captures much of the idea that well-being results from a combination of market or quasi-market factors and other contextual or behavioural elements of agents. We can assume that $g$ is the function that measures standard of living, and we can see clearly how $U$ may vary significantly from $g$ for two reasons: the presence of other determinants of well-being $(z)$ and the transformation of $g$ by $f$, which can be specific to the individual.

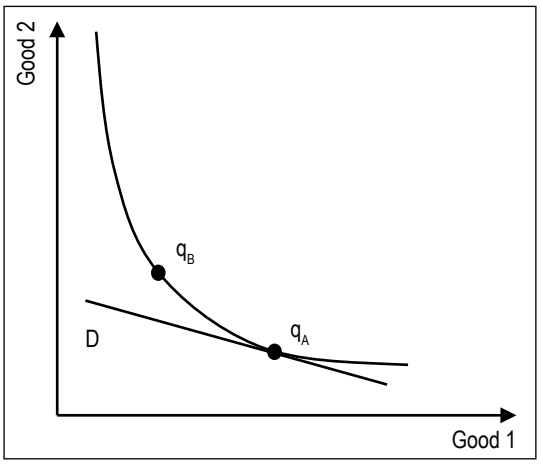
What can we then quantify that relates to the function $g$, under the additional simplifying assumption of the representative agent? Let's start by restating the importance of doing this with chaining rather than volume calculations at base year prices. The problem posed by the latter is illustrated in Figure I for two goods.

If $q_A$ is the base year quantity vector $A$ and $D_A$ the associated budget line $R = p_{A,1}q_{A,1} + p_{A,2}q_{A,2}$, the ratio of volumes at base year prices between $q_B$ and $q_A$ equals $\left(p_{A,1}q_{B,1} + p_{A,2}q_{B,2}\right)/\left(p_{A,1}q_{A,1} + p_{A,2}q_{A,2}\right)$ and is greater than 1 because $q_B$ is located above the line $D_A$. Yet, in this example, $q_B$ provides exactly the same utility as $q_A$. There is more because all the points between the isoquant and the initial budget line are seen as corresponding to increases in volume although they correspond to losses in utility.

Faced with this problem, the contribution of chain-linked volumes is to take into account the gradual changes in the slope $-p_2/p_1$ when moving along the isoquant. If $\mu$ is the proportionality coefficient between prices and marginal utilities, the movements along the isoquant verify both $dU = (\partial U/\partial q_1)dq_1 + (\partial U/\partial q_2)dq_2 = 0$ and $p_1dq_1 + p_2dq_2 = \mu dU = 0$, whatever the unknown value of $\mu$. The chaining of infinitesimal movements, all of which are neutral, leads us to say in the end that $q_B$ corresponds to no more or less

2. *There is a similar link with the concept of consumer surplus, i.e. the addition of marginal utilities associated with the consumption of each good unit. Accountants are accustomed to saying that GDP or income do not measure this surplus because they value all quantities* q *at the marginal utility of the last unit consumed. But this objection only concerns the interpretation of levels of GDP. In terms of variation, calculating integrals* ∫pdq*, chain-linked volumes are akin to a calculation of surplus variation between two dates.*

Figure I – **Inconsistency between preferences and measurement of aggregate volume at base year prices**




Reading Note: At prices of period A represented by the straight line $D_A$, the combination $q_B$ represents a higher volume than the combination $q_A$, yet it offers exactly the same utility. The set of points located between the line and the isoquant also correspond to a growth in volume compared to $q_A$, although they correspond to lower utilities.

volume than $q_A$. Along the isoquants, the ordinal structure of preferences is respected.

But what about the cardinal properties? Among all the $g$ functions that are candidates for representing ordinal preferences, real GDP quantifies the one that verifies the fact of growing in the same way as all its arguments when these all grow at the same rate, i.e. the function $g$ that would be homogeneous of degree 1, verifying $g(\lambda q) = \lambda g(q)$ for all $\lambda$, since the volume indicator is forced to verify this homogeneity property: when all the items grow at the same rate, overall growth follows the same rate, regardless of the weights given to the various items.

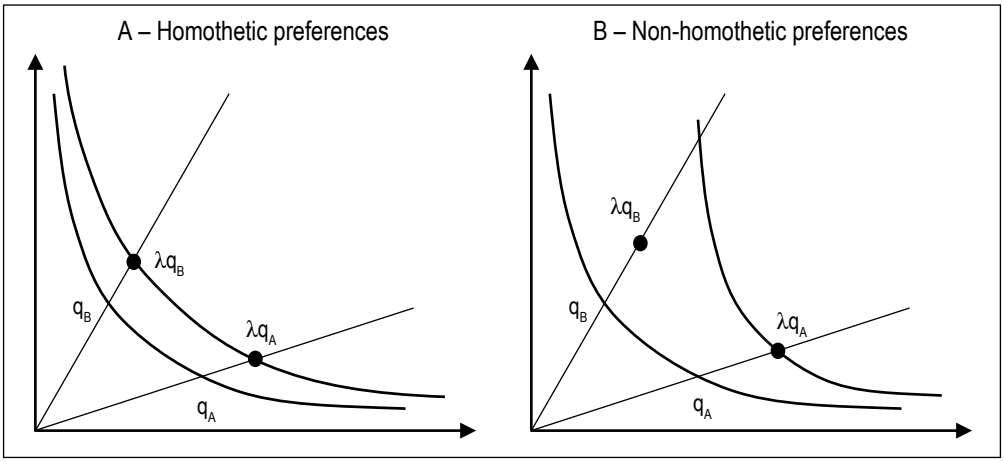
Unfortunately, this possibility to link volume and utility is not guaranteed; it is the exception rather than the rule because it requires a strong assumption about the type of preferences for goods $q_i$. For these preferences to be representable by a homogeneous function of degree 1, they must verify a homotheticity assumption, namely that indifference between any two baskets $q_A$ and $q_B$ implies indifference between the baskets $\lambda q_A$ and $\lambda q_B$, for any value of $\lambda$. However, this assumption is not validated by observation: in particular, it is in contradiction with the fact that consumption patterns become distorted when incomes rise. As soon as this assumption is no longer verified, the volume measures something that maintains a connection with the group of eligible $g$ functions but cannot be one of the elements of the group. This problem affects the interpretation of the aggregate over a long period and is at the root of the problem of path dependence where there are irregular economic changes.

This is illustrated in Figures II and III. Homotheticity is assumed to be verified in Figure II-A. In this case, the same increase in volume by a factor $\lambda$ along the two oblique axes corresponds to comparable increases in the associated utility levels: we start at the same first isoquant including the points $q_A$ and $q_B$, and we arrive at the same second isoquant including the points $\lambda q_A$ and $\lambda q_B$. But this is no longer the case in Figure II-B: here, the volume indicator continues to consider that there is the same growth to go from $q_A$ to $\lambda q_A$ and from $q_B$ to $\lambda q_B$, although the latter point is less valued in terms of overall utility. This problem could be avoided only if we knew how to quantify the fact that this multiplication by $\lambda$ produces less utility when it is carried out from $q_B$ than from $q_A$, information that we do not have.

Path dependence stems directly from it, as illustrated in Figure III. Going from a point $q_A$ to a point $\lambda q_A$ corresponds to growth in chain-linked volume at a ratio $\lambda$ if the movement takes place in a radial manner, but in the example offered, it corresponds to growth in volume of $\lambda' > \lambda$ by an alternative looped path through the points $q_B$ and $\lambda' q_B$. If we then return to point $q_A$ radially, the volume is thus declared increased by $\lambda' / \lambda$ while we have returned to the starting point.

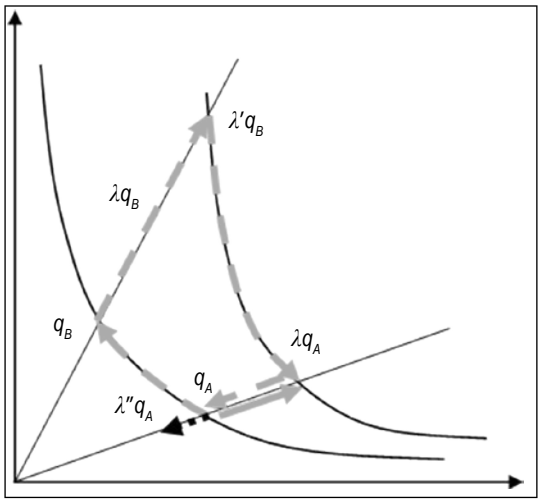
Summarising this initial review, we have identified two risks of inconsistency between volume indicators and consumer preferences: one that is inherent in volume calculations at base prices shown in Figure I, and one that affects the calculations at chained prices illustrated in Figure III. In order to avoid these two problems, there is, in theory, a third method, that of equivalent income. Equivalent income associates with each isoquant the minimum income required to reach this isoquant, once chosen a reference price system; it is detailed in Box 1. This measurement of standard of living classifies baskets of goods in a way that fully respects the ordinal preferences of the consumer. At the same time, with regard to the structural problem that non-homothetic preferences constitute, it cannot provide a definitive answer, which is by nature impossible: the consequence of non-homotheticity is that the assessment of growth between two points depends on the price system chosen as a reference. Replaced in this framework, the path dependence that is often presented as a specific pathology of chaining or

Figure II – **Importance of the homothetic preferences assumption**




Reading Note: Graph A represents two indifference curves for homothetic preferences: indifference between baskets $q_A$ and $q_B$ implies indifference between baskets $\lambda q_A$ and $\lambda q_B$, which is not the case for the indifference curves represented on Graph B, where $\lambda q_A$ is preferred to $\lambda q_B$. In both cases, a volume index indicates that the passages from $q_A$ to $\lambda q_A$ and from $q_B$ to $\lambda q_B$ represent the same growth of $\lambda$, which is consistent with the utility variations in the homothetic case (A) but not in the non-homothetic case (B).

Figure III – **Non-homotheticity and path dependence**




Reading Note: When moving linearly from $q_A$ to $\lambda q_A$ (grey continuous arrow), the volume increase is $\lambda$, but it is $\lambda' > \lambda$ if we follow the grey dashed trajectory. If we close this trajectory by returning directly from $\lambda q_A$ to $q_A$, we see that the volume has increased by $\lambda' / \lambda$ while we have returned to the starting point (grey dotted line). And, by exceeding the point $q_A$ towards the left, we can have points $\lambda'' q_A$ with $\lambda'' \leq 1$ to which chain-linked volumes higher than the starting volume (black dotted line) are associated, while the final level of utility is lower than in $q_A$.

of continuous-time Divisia indices, is therefore only one possible manifestation of a more fundamental problem that no approach to standard of living can avoid.

## 2. Path Dependence in a Crisis: Is It Possible to Put the Problem into Perspective?

Was this problem of path dependence, demonstrated theoretically, so severe in response to the crisis? And if this is not the case, how did we escape it? These questions are particularly relevant given that the crisis also led to a temporary distortion of preferences between categories of goods. When preferences change, it is even more difficult to imagine any stable correspondence between output indicators and consumer satisfaction, while it is always on the basis of this satisfaction that we would like to assess matters.

Regarding the example in Figure III, in practice, two factors are involved, one that decreases the risk of path dependence and one that increases

Box 1 – **Non-homothetic preferences: What does the alternative approach using equivalent incomes offer?**

Without embarking on an exhaustive review beyond the scope of this article, it is useful to describe another perspective on the concept of volume: the equivalent income approach (Fleurbaey & Blanchet, 2013). This approach makes it possible to be fully consistent with ordinal consumer preferences by associating a monetary value to each utility isoquant – a so-called money metric utility – once a stable reference price system has been chosen. This concept corresponds to the traditional concept of the expenditure function in microeconomic consumer theory, i.e. the level of income necessary to obtain a given level of utility at given prices.

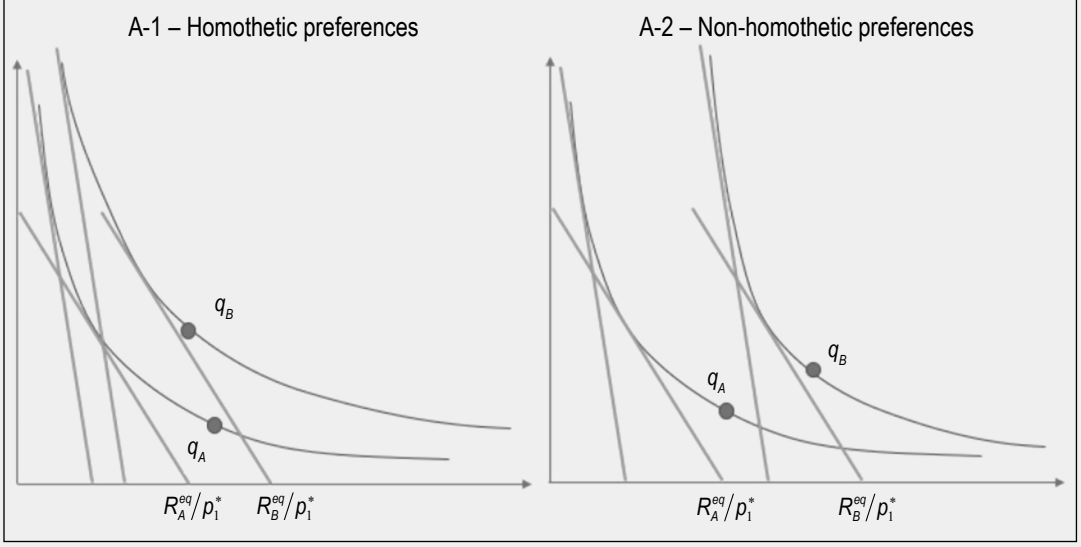
Figure A shows the method for homothetic preferences. In the $p^*$ reference price system, each isoquant is associated with the minimum monetary income required to reach the isoquant. On the graph, it is reconstructed from the points of intersection of the tangents to the isoquants with one or the other of the two axes, for example, the points $R_A^{eq} / p_i^*$

➔

Box 1 – *(contd.)*

or $R_B^{eq} / p_1^*$ on the horizontal axis for the isoquants containing the market baskets $q_A$ and $q_B$. The method associates a much higher income to the point $q_B$ than to the point $q_A$. Choosing a reference price system may give the impression of returning to a calculation of volume at the price of a base year, but the difference is that, contrary to the situation in Figure A, all the points of the same isoquant are this time attributed to the same monetary equivalent.

Figure A – **The equivalent income approach**




How does this relate to chain-linked volume calculations? For homothetic preferences, the relative difference between the two isoquants thus assessed is independent of the price system used as a reference: the ratio between equivalent incomes is the same with the reference price system giving budget lines with more strongly negative slopes. We are therefore in a case in which chain-linked volume and equivalent incomes overlap. They assign the same values to all points of the same isoquant, and multiplication by the same factor of all quantities increases the chain-linked volume and equivalent income by the same factor, regardless of the reference prices used for the latter.

For non-homothetic preferences, the contribution of the equivalent income method is to avoid the problem of path dependence. It does this by construction: at given reference prices, the assessment of various states depends only on their characteristics, not on the trajectory chosen to move from one to the other. On the other hand, the comparison of states becomes sensitive to this reference price system, as seen in Figure A-2. The ratio of abscissae to the origin is higher for the steeper of the two price systems. There is a similar problem with the associated concept of constant utility index (Sillard, 2017). The calculation of the increase in income that is required to preserve utility in the face of a given price increase depends on the level of utility taken as a reference, as soon as the consumption patterns depend on this level of utility. The result is not the same depending on whether you take a low level of utility as a reference in which some essential expenditures weigh heavily in the budget or a high level of utility in which they weigh much more lightly. The fact that it is impossible to propose a price index with universal value is a well-known problem assumed by price statisticians. It is normal that the same applies to the dual concepts of volume or standard of living.

Regardless of the point of view taken, the problem is that the price system or the utility used as a reference can gradually lose relevance over time. You might want to remedy this by updating them step by step, but in doing so, you inevitably encounter the problem of path dependence. It is therefore necessary to choose between this problem and that of having indicators whose message varies depending on the states that are taken as reference.

it. The risk decreases because a return to the pre-crisis situation has no reason to take place following such a circuitous path as that represented in Figure III. If the movement is only a round trip on a unique road, the second leg must precisely compensate for what was done on the first leg. This is the case in continuous time, even if the two movements are not at the same speed. But this is no longer necessarily true in discrete time: relying on an approximation in discrete time acts in the opposite direction and accentuates the risk of not falling back to the starting value. One stylised example will confirm this possibility, always with a simplified framework with two goods, and a general equilibrium approach that makes it possible to treat both the effects of supply shocks and preference shocks.

We use a simple type of preference with two market goods, with a component $g$ of the CES/Stone-Geary–type well-being function, which is written $g(q_1,q_2)=\left[\alpha_1(q_1-\beta_1)^{\rho}+\alpha_2(q_2-\beta_2)^{\rho}\right]^{1/\rho}$ where $\sigma=1/(1-\rho)$ is the elasticity of substitution between $q_1-\beta_1$ and $q_2-\beta_2$. The preferences represented here are homothetic, and the function $g$ is a homogeneous function of degree 1 when $\beta_1$ and $\beta_2$ are both equal to zero; they are non-homothetic when one of the $\beta_i$'s is non-zero, $\beta_i>0$ corresponding to an essential good, the consumption of which must be at least equal to $\beta_i$, and $\beta_i<0$ corresponding to a non-essential good, the consumption $q_i$ of which can be zero and only ceases to be zero for a high enough income or a low enough price. In simulations, good 1 is considered essential ($\beta_1>0$) and good 2 non-essential ($\beta_2<0$).

Given this pattern of demand, there is a basic supply structure with a total population $l_1+l_2=1$ distributed in both sectors producing both goods $q_1$ and $q_2$ with labour productivities $\pi_1$ and $\pi_2$. In the initial state, we assume a workforce distribution that maximises the function $U$. The initial equilibrium prices $p_1$ and $p_2$ of the two goods are deducted, first in relative value, then at absolute level depending on an exogenous overall amount of liquidities $M=p_1q_1+p_2q_2$. The initial values of the parameters are set at $\alpha_1=0.25,\ \alpha_2=0.75,\ \beta_1=1,\ \beta_2=-1,\ \sigma=0.5,$ $\pi_1=\pi_2=2$ and $M=1$.

From this initial state, the supply shocks are modelled as shocks in $\pi_i$, which may include the case $\pi_i=0$ of a full interruption of activity, but only for good 2, the non-essential good. The sectoral allocation of the workforce is assumed to be fixed throughout the duration of the shock because redeployment is impossible over the short term. On the other hand, there are two assumptions regarding prices:

- Adjustment of prices balancing supply and demand of both goods, always under the constraint $M=p_1q_1+p_2q_2$. The fixity of $M$ accounts for policies of economic support thanks to which economic agents always have the same nominal budget to spend, but where the negative supply shocks result in price rises of the goods concerned, ensuring full balance between supply and demand in nominal value.

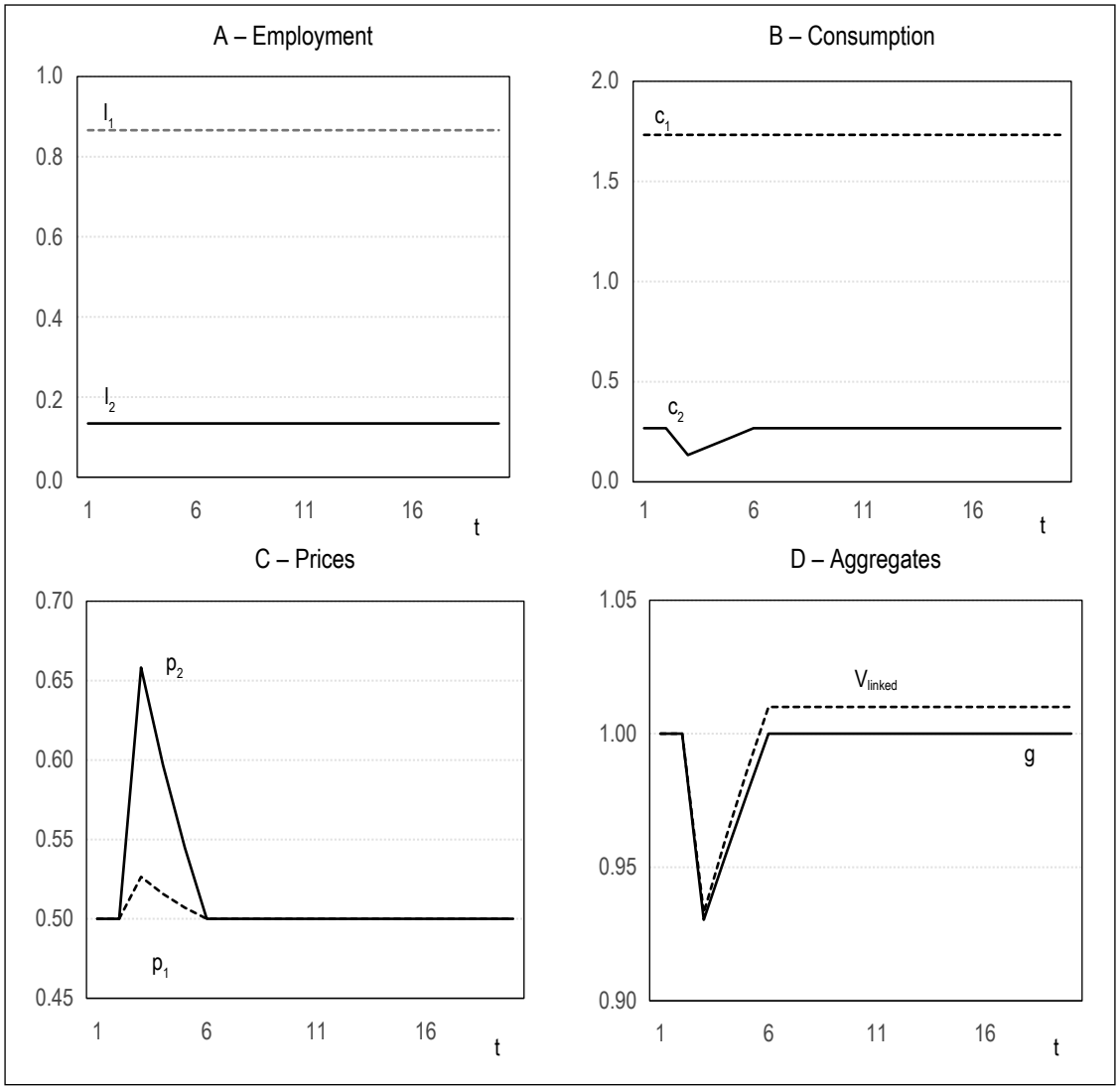
- Completely rigid prices and, therefore, rationing of quantities. The result is forced nominal savings, as has been observed in practice. It can then contribute to price rises at the end of the crisis, among other inflation factors, which could be accounted for by authorising spending of this saving and a gradual return of price adjustments, but here we focus on the question of measurement during the shock phase.

Figure IV shows an initial simulation with a productivity shock in sector 2 that divides it in two between periods 2 and 3, after which it returns linearly to its starting value in three periods. The allocation of labour remains unchanged by assumption (Figure IV-A), with a change in production/consumption that entirely reflects that of productivity (Figure IV-B) and complete price flexibility (Figure IV-C) that makes prices rise temporarily, particularly for the good affected by the productivity shock. The result for chain-linked volume is a 7% drop at the start of the shock, followed by a recovery phase which, at the end of the crisis, leads to new volume slightly more than 1% above its initial level (Figure IV-D), although we returned precisely to the starting point in terms of price and consumption, as the plot of the function $g$ reflects. We are therefore confronted with a path dependence problem despite a return to normal exactly through the same trajectory as the initial drop. This is explained by the choice of time units: between periods 2 and 3, the whole of the downward shock is computed with quantities valued at pre-crisis prices, the increase that follows is valued at crisis prices, which overweight the importance of the return to pre-crisis quantities for good 2.

On the other hand, this problem disappears if we simulate the same shock with totally rigid prices (Figure V) by rationing good 2 on the market with forced saving corresponding to the amount of unmet demand for the good. The fact that price rigidity makes it possible for the volume indicator to completely recover its initial level is mechanical: since the weightings of the quantities are constant, the fact that they recover their starting values leads to recovery of the same aggregate.

Paradoxically, we would have therefore been partially protected from the effects of path dependence by a temporary relaxation of the link between prices and instantaneous relative marginal utilities of the two goods, i.e. the link used in normal times to legitimise aggregation by prices. Can we live with it? Yes, if we remain in the scenario of a perfectly reversible transitory shock with a return to the initial conditions. In this case, we need only consider the volume indicator as a measurement of the decrease in production with respect to the marginal utilities

Figure IV – **Simulation of a sectoral productivity shock, with labour market rigidity and flexible prices**




Reading Note: Productivity in sector 2 changes from 2 to 1 on date 3 and then returns to its original value in three periods. With labour market rigidity, the consumption of good 2 changes in the same way. The supply-demand balance is achieved by a price shock on $p_2$, as well as a smaller price shock on $p_1$. The function $g$ is the component of total utility that the volume index of consumption intends to replicate. Assessed with chain-linked volumes, this volume indicator replicates the initial loss in $g$, but ultimately returns to a level higher than that at the start, while the economy returns to exactly the same point.

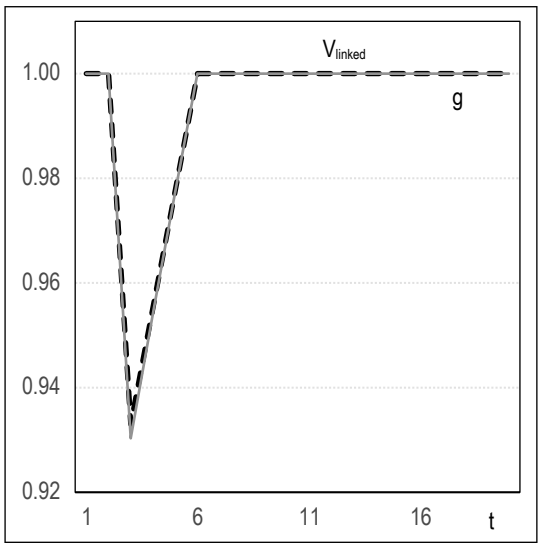
that the various goods and services have in normal times.

This also applies to transitory distortions of preferences. During this period, the supply shocks overlapped preference shocks: there were fewer options for consumption of certain goods and services and less consumer desire, with variable weights of the two types of shocks depending on the goods. Inversely, we also saw the appearance of new types of consumption (PCR tests, masks), which we can consider as obligatory consumption symmetric with consumption prohibitions of some goods, or consequences of consumer preference trends in favour of these goods, with a combination of obligation and desire to protect oneself. The easiest way to neutralise all of this is to view these constraints and preference distortions only as temporary changes, the fact that prices did not overreact allowing the volume index to quickly recover the numbers we have during normal times at the end of the disruption.

## 3. More Structural Issues on Growth Measurement

However, apart from the fact that relative prices have not been that stable during the period of interest, the problems of constraints on consumption choices and distortions of preferences have no reason to disappear with the end of the crisis. The truth is that both were already present before the crisis: the issue of constrained spending was often mentioned as a possible explanatory factor for the discrepancies between measurement

Figure V – **Simulation of a sectoral productivity shock, with rigid labour market and prices**




Reading Note: Same assumptions as for Figure IV-D but with rigid prices. The volume indicator returns to its initial value at the end of the crisis.

and perceptions of standard of living, and the economic growth in recent decades has clearly been accompanied by significant changes in preferences. These are two subjects for which the usual conceptual framework of volume/price decomposition is poorly equipped and could take new forms in the post-crisis world.

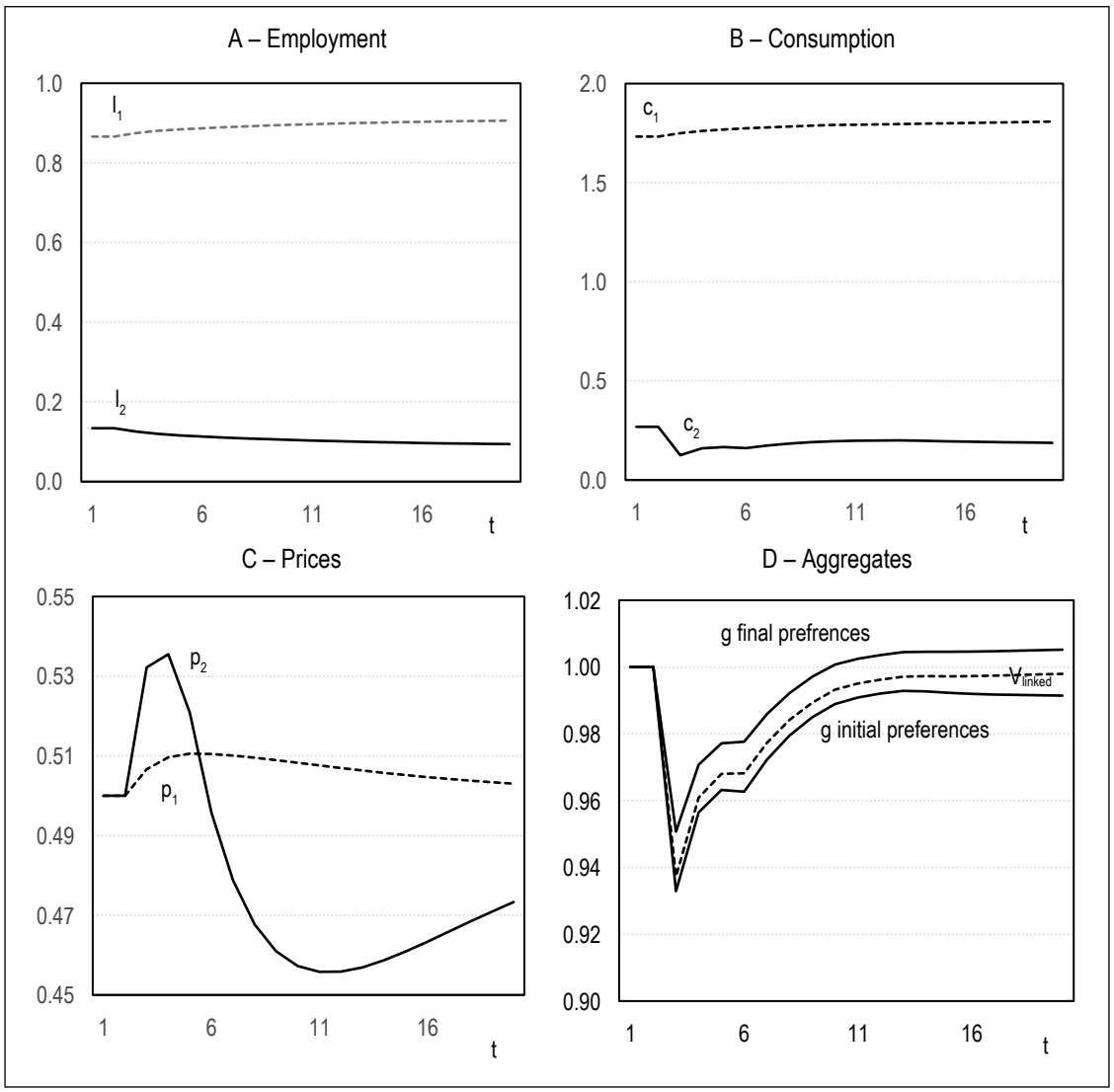
In particular, one expects growth to turn greener and less exposed to the risks of international interdependencies. This kind of shift in the pattern of growth could, of course, manifest itself in a conventional way through price signals; for example, if the goods and services produced locally are more expensive than those usually imported, or if greening involves increasing prices of polluting goods, either spontaneously or through their taxation. If this is the case, it is to be expected that the volume and price components will accurately reflect how household living conditions are impacted. But, particularly regarding greening, part of the shift could be forced by regulations that would combine varying degrees of prohibition on consuming brown goods, or obligations to switch to green goods. And it could also result from changes in preferences between these different types of goods.

Let's take a closer look at this last example in which the problem of path dependence would combine with the loss of a stable reference point for assessing the utility derived from baskets of goods. This is the situation described in Figure VI, which simulates the same productivity shock on the non-essential good 2 but accompanies it with a gradual and lasting change in preferences that accentuates its non-essential character. The simulation takes the form of a drop in the parameter $\beta_1$ causing it to drop from −1 to −1.25 between periods 3 and 6, after which it remains at this level. Faced with this long-lasting distortion of preferences, it is evident that it is no longer possible to assume indefinitely rigid prices and a rigid sectoral distribution of labour. We therefore assume gradual decreases in their distance from to current optimum values, at the rate of 10% per period for the labour market, and 25% per period for prices. The labour market thus adjusts very gradually over the 20 simulation periods (Figure VI-A), and the production/consumption of the two goods reflects the combination of this movement as well as, for good 2, the temporary impact of the negative productivity shock (Figure VI-B), this shock temporarily raising the relative price of this good, before the distortion of the pattern of preferences causes it to drop in a lasting way.

How then do the overall initial and final economic situations compare? In terms of utility, and in light of a change in preferences, one possibility is to compare the two states based on final preferences, which is the solution favored by Baqaee & Burstein (2021); at the end of the period, individuals are asked to judge how their situation seems better or worse than before the crisis, with their current preferences. In view of a return to the initial supply conditions, the final state is preferred to the initial state because it is based on the current resources optimised for the preferences of the final period (Figure VI-D). It is the opposite with an assessment based on initial preferences, with utility that emerges lower after the crisis. Between the two, the chain-linked volume indicator gives an intermediate profile. We can see this a convenient pragmatic compromise, and it is in any case difficult to offer much better in current statistical production, but in the end, it is not possible to say to which economic concept this median trajectory corresponds: it is an approximate measure of a reality that looks different depending on the angle of view.

Again, the use of equivalent income is another way to address the issue of preference instability (see Box 2 and the Online Appendix, link at the end of the article), as well as the issue of choice constraints. Regarding the variation of preferences, one virtue of equivalent income is to be comparable between people with different preferences: two people with the same monetary utility in the sense of equivalent income can be considered to have the same standard of living,

Figure VI – **Transient productivity shock accompanied by a persistent negative preference shock for good 2, with partially flexible labour market and prices**




Reading Note: The supply shock decreases productivity $\pi_2$ from 2 to 1 in period 3, which then returns to its initial level in period 6. The preference shock consists of causing the coefficient $\beta_2$ to drop from −1 to −1.25 in the function $g(q_1,q_2)=\left[\alpha_1(q_1-\beta_1)^\rho+\alpha_2(q_2-\beta_2)^\rho\right]^{1/\rho}$, this drop being gradual from period 3 to period 6. This leads to a distortion of the labour market structure and spending in favour of good 1. The relative price of good 2 loses ground after the increase induced by the initial supply shock. The variation in $g$ can be assessed based on terminal preferences or initial preferences. The chain-linked volume never returns to its initial level. It has an intermediate change between that of $g$ calculated with terminal preferences – which is higher after the shock than before – and that of $g$ calculated with initial preferences.

regardless of their differences in preference and consumption. The comparison between the situations of a person who has changed preferences between two periods is formally and ethically similar to this comparison between two people with different preferences, regardless of whether or not they are examined at the same period (Fleurbaey & Tadenuma, 2014). If an individual changes preferences but keeps the same budget, this approach concludes that her standard of living and economic situation have not changed, even if her consumption pattern has changed. However, the problem remains of choosing the reference price system which is mobilised to quantify these monetary equivalents of utility, with a result that depends on the choice of this reference system: there is no definitive way to escape the relativism implied by preference instability.

## 4. Questions on Non-Market Services

We will return for conclusions on these post-crisis perspectives, but first we need to look at the non-market case. Not only is there the same general aggregation problem, but there are also problems regarding joint observability of quantities and prices at the level of individual goods and services. We are going to look at both topics.

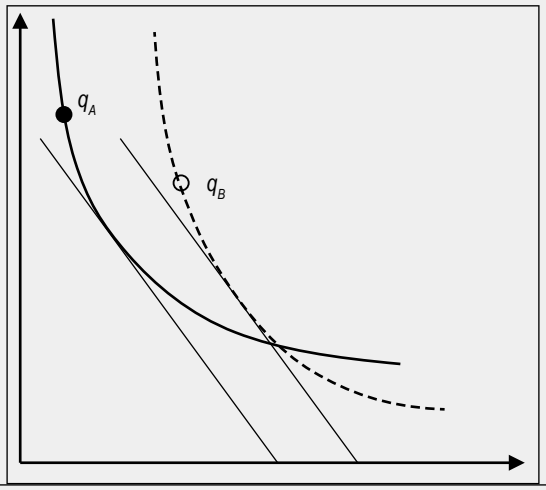
In the market sector, quantities are not always observed, but turnover and value added are, and the monitoring of prices of goods and services allows measuring volumes by difference that we then re-aggregate according to relative prices. For public utilities, temporarily leaving aside the cases of health and education, the main data available are not prices but costs, primarily wages and consumption of fixed capital. When only this data is available, it has to be used both as a measure of price and nominal output. This leads to the assumption that overall productivity does not change, an assumption that is accepted for service activities offering little room for productivity gains but that remains reductive. This assessment principle was maintained during the crisis: the contribution of the labour factor was considered to have dropped as hours worked, without distinguishing between those worked on-site and those that were teleworked, due to the lack of evaluations of the relative productivity of teleworking. The novelty was only to have to mobilise sub-annual information on these hours worked when we usually use information on annual working hours. Normally, the quarterly accounts could quantify the fact that the output of public services decreases during the holidays, as does market output, but to do so in order to immediately correct the series of their seasonal variations would be an

Box 2 – **Equivalent income, variable preferences and non-monetary determinants of well-being**

While it does not provide an unequivocal solution to the problem of non-homothetic preferences, the equivalent income approach offers ways of dealing with changes in preferences (Fleurbaey & Tadenuma, 2014), always conditionally to the choice of a reference price system. It also provides a framework for differential treatment of a pure change in preferences between market goods, without changes in other determinants of well-being, and the case in which those other determinants are changed.

Let us first consider the case of a pure change in preferences represented by Figure B. At given reference prices, it is possible to say that the situation is better in the state $q_B$ than in the state $q_A$ with the different preference systems associated with these two states. On the other hand, the problem remains that of choosing relevant reference prices because a reference price that differs substantially from that shown on the graph could lead to a reverse ranking.

Figure B – **Equivalent incomes and changes in preferences**




In particular, this approach will make it possible to say that the situation of the individual does not change if their income and reference prices do not change: the change in her basket of goods then results only from a change in her tastes, which is relevant as long as the latter does not result from changes in the external environment that affects her well-being elsewhere.

Yet the same does not apply if the individual experiences, for example, deterioration of her health, which shifts her preferences in favour of medical expenses rather than other types of consumption, i.e. changes in one or more components $z$ of the function $U(q,z) = f(g(q),z)$. In this case, the equivalent income approach makes it possible to quantify a monetary equivalent of the shock affecting $z$, i.e. to quantify how much cash income must be increased for the individual to regain the same level of overall utility $U$ despite the negative shock with $z$.

This allows constructing generalised standard of living indicators (Boarini *et al.*, 2021) taking into account both monetary and non-monetary determinants of well-being, including the provision of non-market in-kind services, which are another category of elements of $z$ intervening positively on overall well-being.

unnecessary detour that is normal to dispense with.

Ordinarily, however, the calculation goes further in the two important special cases of education and health. For education, the output measurement is the number of students receiving educational services, only modulated based on the level of education, and again based on relative costs: the assumption is that there is more education produced for, and consumed by, a student receiving higher education than by a primary school student, considering the different costs for the two populations. Again, although the provision of these services is unevenly distributed over the year, it is the total annual volume that is directly distributed over four quarters. But this output measurement in volume, based on the number of pupils or students, would have been of no help in assessing the effects of a crisis that did not affect the number of pupils enrolled, at least over the school year in progress. The effect specific to the crisis was therefore added by proceeding in the manner described above, mainly by assessing the hours worked, without distinguishing between hours of on-site teaching and hours of distance learning assumed to have equivalent productivity – information on class closures or numbers of dropouts was also taken into account, but without these two types of additional data having significantly changed the results.

The case of health is the most specific. The default method uses the count data of medical acts, weighted by their fee schedules. Here too, the normal use of these data is annual, but infra annual data could also be used. As the quarterly accounts could not immediately mobilise this information due to transmission delays, they initially made the assumption that the additional volume caused by the epidemic was counterbalanced by putting other care on hold. The more precise data subsequently used for the accounts published in October of the same year showed an additional cost in the first quarter, which was directly interpreted as an increase in volume, including the part of the additional cost corresponding to exceptional bonuses, which were considered as remuneration for additional work and not as a supplement to the price of the service for identical work. However, in the second quarter, deprogramming of care prevailed over management of the epidemic, resulting in a decline in activity (Houriez, 2020).

What can be learned from all of this in view of measuring aggregate output? A number of questions arise. Let us set aside the problem of productivity, excluding education and health. There is an obvious problem in considering it as being trendless but, for the crisis period, having reduced productivity per capita in line with hours worked is an assumption that seems quite acceptable.

With regard to health, a first point is that the health crisis would have revealed a structural underassessment of the value of the service rendered. This is not necessarily specific to health services given that the same essential character and the problem of their under-compensation have also been brought to light for a large number of retail jobs. This is another reason to use with caution the idea that prices and costs are the exact reflection of the social values of goods and services, even in normal times. It is an assumption chosen for its practical nature, not an uncontested law.

This case of healthcare production raises yet another question. By its nature, aggregation made it play a role in cushioning the crisis, and it would have been even more pronounced if an assessment more in keeping with its essential role had been made. We did as if additional intensive care had helped to compensate for the loss of meals in restaurants, an arithmetic that obviously poses a problem given the very different purposes of the two activities: what has been cushioned by the additional efforts in care activities has been the direct negative effect on well-being of the health shock, i.e. a downward shock on one of the factors outside the scope of GDP determining overall well-being. In the terms of the simple modelling discussed above, we were not talking about compensation between movements of opposite signs within the set of goods and services $q$, but between a component $q_i$ of this vector and a component of vector z. In such a situation, only quantifying the additional production effort with $q_i$, without counting the negative shock it compensates for gives an unbalanced view of what is happening. This is an aspect of the general problem of so-called "defensive" expenditures, which aim to avoid ill-being rather than generate well-being. How to count them has always been a topic for national accounts, the difficulty being to draw a steady line between what is strictly defensive and what has a net positive value. This question cannot be bypassed in the event of an exogenous shock: there is a problem in giving the same value to an increase in one of the $q_i$'s, under an unchanged $z$ environment and a similar increase of the same $q_i$ that only serves to compensate for a negative shock in the $z_j$ which, among the $z$, would represent the state of health.

Another way of formulating things is to say that it is difficult to bring such defensive activities into the category of "wealth creation", following a term sometimes used to provide an idea of what GDP intends to measure. Presenting intensive care stay as a form of wealth creation that would have partially counterbalanced the deficit of wealth creation in the market sector is certainly not the best way to categorize them. It is as corrections of the direct effect of $z_j$ on $U$ that the contribution of the healthcare system must be counted, and this only makes sense in an approach that, symmetrically, would negatively count this shock that healthcare systems tried to cushion; here, an approach in terms of equivalent income would potentially be better able to take it into account by trying to quantify the monetary equivalent of this negative shock on $z$ (cf. Box 2). And, once again, this is a problem that crosses the border between public and market services: negative external shocks on well-being can receive market responses too, including in this area of health.

For education, this problem of defensive expenditures is avoided. In this case, the concept of "wealth creation" can be understood in the fullest sense of the accumulation of human capital (Canry, 2020). Here, we need to know by how much the crisis has affected this accumulation process, and how to account for it. The question is more about putting productions dedicated to the satisfaction of current consumption needs and production or transmission of knowledge aimed at preparing for the future on the same levels. This latter form of production would have more a place on a sustainability scoreboard alongside the quantification of what is done or not done in the other dimensions of this sustainability, including the environmental component, as discussed in the Stiglitz report (2009).

Next, when it comes to numbers, the question of the quality of human capital thus accumulated is obviously much more complex than simply counting the teaching hours consumed by students (see, for example, Angrist *et al.*, 2021). In general, an indicator of the "volume" of investment implies quantifying the expected benefits over time. For investments in the market sector, it is assumed that the market is able to reveal investors' expectations regarding return on investment, assuming that these expectations are, on average, reasonable and neglecting the fact that this return for the investor ignores the possibility of negative externalities, another major problem posed by accounts at market prices. In the case of education, it is rather positive externalities that are expected, even more difficult to quantify than individual return on this investment. Add to this the fact that the crisis has revealed even more so than usual that this investment is a co-production whose teaching hours are only an input, as it also partly involves domestic labour, of which home-schooling has abruptly and unequally increased the importance.

To conclude on the case of non-market services, we have emphasised thus far the direct quantification of volumes and the significance of their aggregation with those of other market goods and services. But, during the crisis period, a problem also appeared when moving from volumes to values, symmetrical of those encountered when moving from values to volumes for market goods. Two options were available for the imputation of values during periods of forced activity reduction. The first has been adopted in Europe and is, therefore, shared by all the countries in the European Union: consider that the output of these services in value remained equal, as usual, to their cost of production, including the wages of employees placed in a situation of forced inactivity. The counterpart is a formal increase in unit production costs, thus a price impact and potentially the kind of destabilising effect for the aggregate that we saw on the market sector in the case of a strong price reaction at the heart of the crisis. The other option would have been to consider unchanged unit costs and treat remuneration of unworked hours in the same way as subsidized partial activity in the private sector, i.e. a type of insurance against technical underemployment directly provided by the government, with the same result as the first option in terms of overall impact of the crisis on public finances, but avoiding an artificial gap between real and nominal public productions.

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From all this emerge somewhat mixed messages about the contribution of national accounts in times of crisis and what they tell us about their contributions in normal times. Viewed from a first angle, they emerge strengthened. The crisis has clearly demonstrated the need for these accounts: indicators of the financial situation of the various economic agents, in both flows and stocks, are needed, and these indicators must be linked to each other by a coherent accounting framework. Such a framework inevitably ignores many aspects of what works well or poorly for

societies and the well-being of their members, but the portion of this functioning expressed in terms of monetary flows is large enough to make its monitoring as important as it is.

The headline indicator of national accounts, real GDP, is, however, a complex object, consisting of heterogeneous components the cumulation of which is not always easy to discuss. It was built by successive additions to meet various types of demands, and its practical calculation involves methodological compromises the accumulation of which can sometimes make us lose sight of what we wanted to measure at the outset. The crisis is an opportunity to rethink some of these problems. Does it, therefore, help us to specify more clearly what GDP measures? Once accepted that it does not measure well-being, is there a characterisation that is simple, fair and complete?

Answering this question by presenting it just as a one contribution among others to well-being poses the problem of characterising the relative importance of this contribution – the exact place of $g$ and its weight in relation to $z$ within the function $f$. What other terms should be used? We have seen that the term "wealth creation" sometimes used did not necessarily adapt well to many aspects of the period. The crisis rather led to favour the expression of "measurement of economic activity". Indeed, this term was appropriate for the context and fits with the way in which matters have been assessed in practice. It is a deviation of activity with respect to the norm that has been evaluated. To a large extent, quantifying this sub-activity has often consisted in just estimating the decrease in hours actually worked, making it akin to an activity indicator in the sense of labour market statistics. We have even seen that it is in these terms that the estimate was directly built for a large part of government activity.

Relevant in times of crisis, this characterisation is nonetheless insufficient in normal times. When comparing GDPs 10 or 20 years apart, it is not levels of activity that are compared, but rather the quantities of goods and services that these levels of activity generate on both dates, to address the question of how productivity has increased between the two dates, the question that, in particular, has been at the centre of the pre-crisis debate on the mismeasurement of growth.

Is real GDP then better characterised as a measurement of output? Yes, of course, but with a large number of difficulties and questions which, taken literally, do not turn out to be much easier to master than that of the measurement of the well-being to which this output contributes. Even the assumption of efficient markets perfectly revealing the relative utilities of goods is not enough to fully protect against inconsistencies in an assessment of volume growth, whether at chained prices or let alone at base year prices. The problem is even bigger when preferences are changing or when the crisis increases awareness of the differences between prices or costs and the social values of what is produced, if we think that it is based more so on the latter that real output must ultimately be assessed.

The question of the limits of the equivalence between monetary values and social values does not just concern remunerated activities. It also encompasses two other traditional limits of national accounts: the question of the production boundary, i.e. that of productions not remunerated at all, and the question of externalities since market values only express the values attributed to things by their direct consumers, not the indirect effects on other consumers, both those of today and those of future generations. This question, of course, will become even more important with the demand for greening for post-crisis growth. If we keep the characterisation of real GDP as a measurement of output, all these topics suggest doing so with all the required caveats, avoiding looking at it as "the" measurement of this output, but only as "a certain way" of measuring (through market prices or costs) "a certain part" (not necessarily stable) of this output. □

**Link to the Online Appendix:**
https://www.insee.fr/en/statistiques/fichier/6472317/ES532-33_Blanchet-Fleurbaey_Online-Appendix.pdf

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