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Abstract
This survey presents the recent and rapidly expanding literature, which analyses the economic impacts of the COVID 19 pandemic, by means of Computable General Equilibrium (CGE) modelling. It does so not only by contrasting and assessing the different methodological approaches, and the key findings of the simulation exercises, but also by putting the various contributions in a historical perspective. This is necessary, because each CGE based study should be evaluated while keeping in mind when it was realized, since questions, priorities, expectations have been constantly changing during the spreading of the pandemic.

Keywords
CGE models, COVID-19, economic impact, environmental impact

JEL Codes
C68, D58, Q51, F62, I10

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ABSTRACT

This survey presents the recent and rapidly expanding literature, which analyses the economic impacts of the COVID 19 pandemic, by means of Computable General Equilibrium (CGE) modelling. It does so not only by contrasting and assessing the different methodological approaches, and the key findings of the simulation exercises, but also by putting the various contributions in a historical perspective. This is necessary, because each CGE based study should be evaluated while keeping in mind when it was realized, since questions, priorities, expectations have been constantly changing during the spreading of the pandemic.

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1. Introduction

Computable General Equilibrium (CGE) models are workhorses for empirical macroeconomic analysis. They could be considered as a generalization of input-output models, with which they share data, calibration methods and the degree of industrial detail. Contrary to input-output models, however, they allow for structural adjustment processes in production, consumption, and trade patterns, driven by relative prices, in a way consistent with the Walras-Arrow-Debreu general equilibrium theory.

Nowadays, many variants of CGE models exist, and CGE models have also been successfully interfaced with other models, like microsimulation, ecological, land use, energy, etc. In its simplest formulation, however, a CGE simulation exercise is a comparative static one, with no time dimension: a baseline general equilibrium is contrasted with a "counterfactual" one, calculated after changes in some parameters or exogenous variables. Therefore, CGE models are especially useful to analyse the structural change occurring inside a macroeconomic system, triggered by specific shocks.

CGE models are very data demanding, complex, and their development requires a substantial amount of time and resources. On the other hand, they constitute a very flexible tool, which could be applied to analyse a wide range of issues. Studies based on this class of models have been considered like those more typical in other fields, where expensive machinery and laboratories are employed. In economic terms, a knowledge

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production technology characterized by high fixed costs and relatively low marginal costs (Hillberry and Hummels, 2021).

When the Covid-19 pandemic erupted in the early months of 2020, CGE modelling was readily regarded as one of the most effective tools available for the analysis of the economic impacts of the pandemic and its associated containment measures. This was due to a combination of factors. First, the global crisis was intrinsically a real economy one, as opposed to the 2008 financial one. CGE models suit, because they are Walrasian frameworks focusing on exchanges of tangible goods and services, where money and finance play no role, and only relative prices matter. Second, the crisis is a systemic one, with effects propagating through multiple markets, industries, and regions. Aggregated macro-econometric models are not very useful, whereas "meso-economic", disaggregated ones (like CGE) are. Third, because of its "low marginal cost" technology, CGE modelling can provide simulation results in relatively short time, provided that a reliable model is already available, and the researchers have correctly identified what exogenous parameters to alter inside it.

Time was, and still is, key. The scientific response to the Covid-19 pandemic has been not only a rush to developing new and effective vaccines, but also to rapidly scrutinize economic and social effects, as well as to assess available policy options for containment and recovery. To this end, many CGE models have been instrumental to the realization of some "instant papers", that is, studies developed and published (normally as citable working papers) in a matter of a few weeks.

Each CGE based study, then, should be evaluated while keeping in mind when it was realized. Questions, priorities, expectations have been constantly changing during the spreading of the pandemic. The whole history of the sanitary crisis is a chain of surprises: about its duration, about the availability and effectiveness of vaccines, about social norms, variants of the virus, number and duration of infection waves, etc. Consequently, most studies could be regarded as rapid in terms of both realization and obsolescence.

For all these reasons, this essay cannot be framed as the classic literature survey, where the various papers are classified and composed into a coherent critical synthesis of the "state of the art". Even if we could still consider what economic impacts of Covid-19 were considered and possibly how they were technically modelled, we cannot forget that the whole material is not homogeneous, and it is also highly time dependent. Therefore, before contrasting the different features of the models, we opt for presenting the various papers in a historical sequence, which also considers what the key policy issues were at the time when each study was publicized.

2. A Historical Perspective

Serious respiratory diseases due to the Sars-CoV-2 virus were initially detected in the Chinese city of Wuhan in the late months of 2019, but only in January 2019 did the epidemy spread at such an alarming level that the authorities imposed unprecedented sanitary measures, including limitations to mobility of people and goods, first in the region and subsequently in the whole country. On March 11th, 2020, the World Health Organization officially declared COVID-19 a global pandemic. Many other countries in the world were then forced to adopt draconian containment policies, many of them with immediate and severe economic consequences.

At the time when the crisis seemed to have hit only or mainly China, the main concern was about the economic consequences of the disruption of value chains, given the role of China as "manufacturer of the World". Not surprisingly, then, some of the earliest studies on COVID-19 economic impacts focused on international trade (Bekkers et al. 2020, DG Trade 2020a/b, Maliszewska et al. 2020, OECD 2020, Park et al. 2020).

When the pandemic reached Italy and other European countries, then other regions in the world, the various governments introduced similar, drastic measures, including prohibitions to mobility of people and goods, closing of all non-essential economic activities ("lockdown"), massive use of web-based communication services and working at distance, and others.

Some CGE based studies then tried to assess the economic impact of such measures, which involved two main problems. First, an identification of the nature of the shock, as well as of the economic entities initially involved. Second, an estimation of the duration and severity of the shock, for which no data nor previous experience were available.

About the first point, the economic shocks directly and indirectly generated by the COVID-19 are a complex combination of demand and supply impacts. On the demand side: changes in consumption patterns, as some goods and services are not available anymore; reduction in aggregate consumption, both because of reduced income and higher precautionary savings, permanent variations in consumer habits. On the supply side: reduced labour force due to illness, quarantine, lack of immigrant workers; idle productive capacity imposed by lockdown restrictions, difficulties in retrieving essential intermediate factors.

Computable general equilibrium models are best suited to analyze supply side shocks, as demand and income levels are naturally endogenous in them. Therefore, many studies appearing since spring 2020 simulated exogenous reductions in productivity or resource endowments (see for example Lahcen et al. 2020, Park et al. 2020, Roson & Costa 2020), with quite hypothetical magnitude and characteristics. Demand side effects were somehow considered in some studies as well (see, for example, Arriola et al. 2021, Dixon et al. 2021, Malliet et al. 2020, Roson & Van der Vorst 2021), although they can more effectively be managed in demand-driven models, like input-output ones (Robinson et al. 2021, van Seventer et al. 2021) which, on the other hand, cannot easily deal with the supply side.

As the pandemic spread, some governments introduced income support measures for affected sectors and households, whose impact was considered in some CGE based articles (for example, Arriola et al. ibid., Dixon et al. ibid., Nechifor et al. 2020a/b, Nechifor et al. 2021, Park et al. ibid., Porsse et al. 2020). Also, some researchers took advantage of the flexibility of CGE models, to assess not only economic but also environmental consequences of the lockdown and mobility restrictions (for example, Lahcen et al. ibid., Malliet et al. ibid., Roson & Van der Vorst ibid.). Interest for these analyses was likely triggered by news, reporting wild animals seen active in urban environments, clean water, fishes repopulating canals, etc., suggesting that COVID-19 was bad for humans, but beneficial for the environment.

During summer and fall 2020, the incidence of the pandemic appeared to progressively fade away, so that many restrictive policies were relaxed, and a debate started about how to help the economy recover in the medium term, beyond the emergency phase. Some CGE studies contributed to the debate by providing simulations for the different policy packages under discussion (for example, Lahcen et al. ibid., UNDP 2020).

In 2021, time has come to take stock of the burgeoning but rather diversified literature on CGE simulations for the assessment of economic impacts of COVID-19. Indeed, this is precisely when we started working on this survey.

To this end, perhaps the most informative forum was provided by the 24th annual Conference on Global Economic Analysis, virtually held in June 2021, organized by the GTAP consortium, which is a leading association of CGE modelers. There, several studies were presented, and it was then possible to contrast the various approaches and results, considering also research that was not officially published yet.

There are two themes that emerged as especially interesting. First, one can notice that there is a fundamental difference between the early studies of 2020 and those presented mid-2021. It is the availability of (some) macroeconomic data on the actual impact of the pandemic on the various economies. This data allows some “re-calibration” of parameters in CGE models, to make them closer to reality (for example, Roson & Van der Vorst ibid.). This method was even adopted for a rare kind of CGE model, generating results on a quarterly basis (Dixon et al. ibid.).

Secondly, a stimulating debate took place around the actual meaning and usefulness of CGE-based exercises in this context. Most CGE models are comparative static, simulating a general equilibrium for the economic system, where all (or the majority) of markets (for resources, factors, goods) have resumed to an equilibrium state, with flexible prices and equality between supply and demand. Some authors presenting at the conference (e.g., Robinson et al. ibid.) convincingly argued that the COVID-19 economic shock was, instead, characterized by fixed prices and persistent market disequilibria in the short run. Therefore, fix-price models, for instance input-output models, could be better suited to understand and assess the economic consequences of COVID-19 (Robinson et al. ibid.).

We believe there are two main objections to this argument. The first is a technical one. As already stated, models like input-output, which are demand driven and Keynesian in spirit, can easily accommodate demand side shocks, but not very well those from the supply side (like output constraints). Only by appropriately ad-hoc tuning some final demand components one could somehow simulate the supply shocks (e.g., Arndt et al. 2020, Robinson et al. ibid.).

More generally, there is the key question of whether CGE models are the appropriate tools to replicate the actual behavior of economic systems, after a major exogenous shock of this nature. Probably not. CGE models are atemporal, identifying a tendential, hypothetically future equilibrium state, which could never be reached. As such, they are most useful in the identification of market forces, pushing the economy in a certain direction. If forecasting or realistic simulations are the objective of a numerical exercise, macro-econometric models (or similar ones) could be better suited. Alternatively, CGE models could be interfaced with the latter, to generate the desired sectoral breakdown, which aggregate macro models cannot provide (e.g., McKibbin & Fernando 2020a/b).

3. A Tentative (and Imperfect) Taxonomy

One of the key considerations in each of the CGE studies under review is how to simulate the COVID-19 shock by changing certain parameters or exogenous variables. Here we propose a tentative taxonomy of the different studies available by autumn 2021, with a focus on the shocks that are implemented.

At the beginning of the pandemic in spring 2020, some early studies mainly took a supply-side approach. Based on earlier research stemming from health economics (e.g, Arndt & Lewis 2001, Dixon et al. 2010, Lee & McKibbin 2012), several studies introduced an epidemiological shock affecting the labour market (McKibbin & Fernando 2020a/b, Kabajulizi & Boysen 2021). These studies adjust parameters for labour productivity and/or endowments. As such, they simulate workers becoming less productive when they get sick or must take care of dependents, and a decline in labour force availability, because of people falling sick or, in the worst case, passing away. For instance, Keogh-Brown et al. (2020) apply this approach to their CGE model, in combination with an epidemiological demographic model, to simulate the early impact of COVID-19 in the UK.

Other early studies took a similar approach, but with a different reasoning. These studies focused on the impact of governments’ sanitary measures to contain the spread of the virus, such as industry shutdowns or working-from-home directives. Roson & Costa (2020) model a 10% reduction in productivity for all primary factors, in Italy and in France, by adjusting the relevant productivity parameters in the model. This simulates the production capacity that is rendered unused because of COVID-19 lockdown measures. A distinction is made between short and medium term where, in a short-term scenario, values for all elasticity parameters are 50% lower than those adopted in the long run. A similar kind of shock is also considered by Lahcen et al. (2020), who simulate a decrease in working time by 10-20%, according to the concept of *90% economy* (The

Economist, 2020). Porsse et al. (2020) combine a supply-side shock to labour, due to the impact on workers' health, with closures of non-essential sectors in Brazil.

Productivity itself may refer to a specific factor, to an aggregate composite, or to total factor productivity. Chitiga-Mabugu et al. (2021) lower a productivity parameter in a production function combining labour and capital, whereas Roson & Costa (ibid.) reduce, by the same amount, the productivity of all primary factors. Chitiga-Mabuga et al. (ibid.) also include other supply-side channels, such as a decrease in the world prices for oil and minerals, and an increase in transportation costs.

Yet other studies implemented a mixture of demand and supply side shocks. Nechifor et al. (2020a, 2020b, 2021) identify five channels through which the pandemic affects an economy, in their analyses for Ethiopia and Kenya: labour productivity, demand for exports and tourism, internal trade costs, domestic demand, and remittances. Factor productivity, trade costs, remittances, FDI and even export and tourism demand are relatively straightforward to shock, since they may be linked to naturally exogenous parameters in a CGE setting. As stated in the previous section, shocking demand components is more complicated. In Nechifor et al. (2020b) this is done by changing households' budget allocation, such that less spending goes to hospitality and transportation, but households spend relatively more on all other commodities. Another approach is taken by Aydin & Ari (2020), who look at whether falling oil prices can partly offset the negative impact of decreasing foreign demand in Turkey. The authors introduce a two-pronged shock in the model: a sharp decline in foreign demand for tourism, air transportation and travel, and falling oil prices between -25% and -50%.

Many studies, especially during early stages of the pandemic, focused on international trade and issues such as disruptions to supply chains. These studies often implemented a combination of demand- and supply-side shocks. Generally, these studies considered increases in trade costs, lower factor productivity, diminished labour availability, in combination with one or more demand-side shocks. The World Trade Organization (WTO) released one of the earliest impact assessments, focusing on trade, in April 2020. The report analysed the possible evolution of international trade, under three recovery scenarios: V-shaped, U-shaped, and L-shaped. The shocks included both health-related effects and effects related to social distancing and lockdowns (Bekkers et al. 2020). As in Park et al. (2020), a reduction in labour supply was simulated, alongside a reduction in demand and supply for specific sectors, bringing about higher trade costs (Bekkers et al. ibid.). The OECD models consider reductions in the supply and productivity of labour, in the demand for certain products, increasing trade costs and temporary restrictions in the movement of people (OECD 2020a).

A different methodology is used in some reports of the DG Trade at the European Commission (DG Trade 2020a, 2020b). The DG Trade studies are based on GDP forecasts for the year 2020 by the Deutsche Bank Research group, which include pandemic impacts. Trade costs are endogenously adjusted to match the forecasted levels of GDP, so that it is possible to build a scenario of international trade consistent with given projections of GDP (DG Trade 2020a, 2020b). Lastly, Maliszewska et al. (2020) also focus on the effects on GDP and international trade and include a mix of supply- and demand-side effects. Besides the standard supply-side shocks such as trade costs and a fall in labour availability, they model a decline in international tourism by introducing a 50% consumption tax on international tourism-related services. Moreover, the analysis includes a switching demand pattern by households, like Nechifor et al. (2020b), where a smaller percentage of the household budget is allocated to commodities and services that require close human interaction (Maliszewska et al. 2020).

As mentioned in section 2, CGE models are more readily suited to model supply-side shocks than demand-side shocks. Nevertheless, given that COVID-19 also significantly impacted the demand side, several studies managed to introduce shocks to the demand, indirectly. In Arriola et al. (2020), for instance, in addition to labour and trade shocks, the authors introduce a reduction of demand. simulated through a consumption tax. Real demand is assumed to decline initially by 33%. An initial simulation is used to calculate the demand elasticity, determining the appropriate magnitude of the tax to achieve the desired reduction in demand (Arriola et al. 2020, 2021).

Dixon et al. (2021) take yet another approach to simulate a demand-side shock, in addition to several supply-side effects, such as a reduction in aggregate investment. They consider three demand shocks. Firstly, the authors assume a 15% inward shift of the demand curves for US exports in the first year of the pandemic. Secondly, the study introduces a 26.7% reduction in the average propensity to consume, during the first quarter of 2020. Lastly, there is a cut to household expenditure for non-essential goods and services (Dixon et al. 2021).

UNDP (2020) models a decline in demand due to the pandemic in Cambodia, by directly shocking industry output levels. For example, for the garments industry, it is found that a 13.1% decline in output would result because of a 20.1% decrease in export demand (UNDP 2020).

Roson & Van der Vorst (2021) model a decline in spending by international and domestic tourists in the Spanish region of Andalusia. This is obtained by lowering the inflow of income, generated outside the regional boundaries but employed locally to finance tourists' expenses. Another study that focuses on the impact of COVID-19 on tourism is Leroy de Morel et al. (2020), which consider different categories of tourism, and their demand forecasts, to analyse the effects of the pandemic in New-Zealand.

Some studies make use of SAM-multiplier models (a generalization of input-output models) to directly simulate demand-side effects. For instance, in Robinson et al. (2021) the final demand components of the GDP (consumption, investment, government expenditure and exports) are treated as exogenous. The model is then used to assess the impact on production levels of actual, observed and estimated variations in the demand elements.

Similarly, van Seventer et al. (2021) conduct a SAM-multiplier analysis for South-Africa. This study treats factor income and distribution, household income and expenditure as endogenous. Their scenarios include a range of possible recovery and reconstruction policies. Arndt et al. (2020) used a similar approach, for South-Africa as well. This earlier study considers forced reductions in production and demand in 10 sectors, a 40-75% fall in export demand, and a 65-80% contraction of investment expenditure. The COVID-19 shock is most often modelled as a mix between demand- and supply-side effects, as is clear from the studies discussed so far. Therefore, researchers were faced with the question of whether to choose a method that better represents shocks to supply (e.g., CGE) or a method that gives a more accurate representation of shocks to demand (e.g., I-O models).

Some studies take into account the environmental implications of the pandemic. Malliet et al. (2020) employ a neo-Keynesian CGE model, in which prices adjust slowly to clear markets. bringing about temporal market disequilibria. This study mixes several scenarios: a climate scenario with a fiscally neutral carbon tax, and a COVID-19 scenario with significant shocks to demand and the prices of oil. Lahcen et al. (ibid) include data on housing energy efficiency, to model the effect of a sustainable investment policy for housing during the pandemic. Roson and Van der Vorst (ibid.) make use of estimated relationships between output levels and pollution emissions, to measure some environmental effects of falling tourism demand in Andalusia.

Lastly, we select some studies that model government support mechanisms to mitigate the negative economic impact of containment measures. Nechifor et al. (2020b) include several of these government measures for their analysis of COVID-19 on the Kenyan economy, with a focus on short-term recovery from the pandemic. Government spending is adjusted according to official documents (e.g., Kenya's Economic Stimulus Plan), fiscal measures such as tax relief are included, as well as government foreign loans. Other studies such as Park et al. (2020) and Porsse et al. (2020) include fiscal policy that was implemented to provide economic relief. Unlike the shocks to demand, fiscal policy is straightforward to shock in a CGE model, and therefore a fiscal stimulus can be included without too much hassle. Arriola et al. (2021) use OECD and IMF estimates of government expenditure and filter out cyclical changes in government spending to obtain government spending specific to COVID-19. These estimates are then used to shock government expenditure in the CGE analysis. Some studies include additional government spending to reflect increased expenditure on the medical sector to support the fight against COVID-19 (e.g., Dixon et al. 2021, Nechifor et al. 2020a/b).

To summarize the various approaches and methodology, we present here Table 1, classifying the various contributions in the literature, in terms of type of shock.

Table 1: a taxonomy of studies on COVID-19 impacts using CGE models

Study	***COVID-19 shock***
Arndt et al. 2020	- SAM multiplier model - Forced reductions in production and demand in 10 sectors - A 40-75% fall in export demand - A 65-80% contraction of investment expenditure
Arriola et al. 2020	- Shock to labour supply and a 5% drop in labour productivity - Increasing trade costs - Decline in demand modelled through a tax on consumption
Arriola et al. 2021	- A 4% loss of labour productivity, adjusted by sector - Consumer demand shock
Aydın & Ari 2020	- Falling oil prices - Decreasing foreign demand for non-recoverable sectors such as tourism
Bekkers et al. 2020	- Reduced labour supply - Reduced demand and supply in specific sectors - Rising trade costs
Chitiga-Mabugu et al. 2021	- Decreasing exports - Decreasing world prices for oil and minerals - Fall in remittances - Diminished domestic productivity - Increase in transport costs
DG Trade 2020a/b	- Increase in trade costs
Dixon et al. 2021	- Nearly full stop of international and domestic travel for tourism and business - A 40% decrease in aggregate investment - An initial 15% inward shift of demand curves for US exports - An initial 26.7% fall in the average propensity to consume - An initial 90% decrease in spending by households on non-essential goods and services
Kabajulizi & Boysen 2021	- Increase or decrease of labour supply, depending on the sector - Decline in labour productivity - Reduced inflow of remittances - Change in spending shares within the government budget, relatively more to the health sectors and less to other sectors - Increase in government spending on the health sector via foreign aid
Keogh-Brown et al. 2020	- Epidemiological shock to labour, affecting labour availability
Lahcen et al. 2020	- Decrease in working time by 10-20% - Demand decreases to 90%, depending on the sector
Leroy de Morel et al. 2020	- Decrease in inbound and outbound travel - Decrease in the arrival of international tourists - A decrease in average labour demand

	- A decrease in the availability of primary factors - Changing consumer spending patterns - Changes in export patterns
Maliszewska et al. 2020	- Decreasing labour supply - Rising trade costs - Drop in international tourism - Demand switch by households
Malliet et al. 2020	- Variation in exports, household consumption and investments by sector - Negative shock to the international price of oil
McKibbin & Fernando 2020a	- Shocks based on epidemiological assumptions - Decrease in labour supply - Shocks to equity risk premia - Increased production costs - Changes in consumption demand - Increase in government expenditure
McKibbin & Fernando 2020b	- Shocks based on epidemiological assumptions - Decrease in labour supply - Increased production costs - Changes in consumption demand - Shocks to equity risk premia
Nechifor et al. 2020a	- Decline of factor productivity - Diminished internal trade - Decrease in demand for export, tourism and international aviation - Fall in remittances and FDI
Nechifor et al. 2020b	- Decline of labour productivity - Diminished internal trade - Decrease in demand for export and tourism - Changed internal demand - Fall in remittances
Nechifor et al. 2021	- Decline of labour productivity - Decrease in exports and foreign tourism - Fall in remittances - Changed internal demand - Increase in internal trade margins
OECD 2020	- Increase in trade costs
Park et al. 2020	- Higher trade costs - Negative productivity shock which also affects demand
Porsse et al. 2020	- Supply-side shock to labour - Closures of non-essential sectors
Robinson et al. 2021	- SAM multiplier model - Changes in household consumption by sector and type of household
Roson & Costa 2020	- Negative shock to productivity parameters
Roson & Van der Vorst 2021	- Decrease in available spending to foreign tourists
UNDP 2020	- A decline in demand modelled by directly shocking industry output levels per sector
	Government support measures for economic recovery
Arriola et al. 2021	- Filter out cyclical government spending trends to obtain COVID-19 "discretionary" spending - Estimates of transfers to households and firms

Dixon et al. 2021	- Additional government spending, mainly on medical goods and services - Transfers to households
Lahcen et al. 2020	- Government investment in sustainability measures in the construction sector
Malliet et al. 2020	- Implementation of a fiscally neutral carbon tax
Nechifor et al. 2020a	- Additional government spending - Job support package and business support
Nechifor et al. 2020b	- Additional government spending - Fiscal policy - Foreign loans
Nechifor et al. 2021	- Additional government spending - Fiscal policy - Foreign loans
Park et al. 2020	- Increased government spending on health - Fiscal stimulus
Porsse et al. 2020	- Fiscal stimulus
Robinson et al. 2021	- Simulation of income support programs
UNDP 2020	- Transfers to households and fiscal relief measures
van Seventer et al.	- Comparison of a range of income support interventions to households

4. Concluding Remarks

We have reviewed several studies, aimed at assessing some economic consequences of the COVID-19 pandemic. All these studies share the computable general equilibrium modelling framework as their key methodological approach.

Our survey has revealed different “phases” in the history of COVID-19 CGE modelling, with different modelling strategies followed in each phase. At the beginning of the pandemic, there was a need for fast, “instant” studies that could shed some light on what was happening to the global economy. Not much was known at that time, so the researchers were faced with the difficult task of determining how to simulate the pandemic shock and how to estimate its magnitude and effects. As 2020 progressed, more information and data became available, allowing later studies to use some real-world data to get more accurate and useful simulations. This tendency continues far into 2021, although the situation is still under evolution, and we cannot claim that the field has evolved sufficiently to generate a consolidated literature. For instance, most of the studies we are considering are yet to be published in peer-reviewed scientific journals, and are only available as working papers, reports, or conference communications.

Our survey makes clear that the economic impact of the pandemic can be modelled in several different ways. Early studies focused on the epidemiological shocks. Later, the emphasis was more on the impact of government measures to contain the spread of the virus. Furthermore, several analyses include government responses to help the economy recover.

We have also highlighted the difficulty to model the mixture of supply- and demand-side effects, typical of COVID-19. CGE models are better suited to analyse the former, yet COVID-19 has manifested itself on the demand side as well, for which models with fixed prices and Keynesian in spirit may be better suited.

We believe that there is no general solution to the dilemma of what model, or combination of shocks, or set of assumptions, fit better. It all depends on what you pretend from the model. General equilibrium models are essentially comparative static: they assume an initial equilibrium; they contrast it with a counterfactual one. As such, they highlight how the economic structure is set in motion, to move from point A to point B. However, some markets may recover back to equilibrium in a relatively short time, others may require many years (e.g, real estate). CGE models cannot adequately replicate short term adjustments in the economic system, but they could be fruitfully employed to investigate the structural adjustment dynamics, induced by exogenous shocks, like that of COVID-19.

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