On the economic impacts of COVID-19: a text mining literature analysis

Abstract

The COVID-19 outbreak has affected everyday lives worldwide. As governments started to implement confinement and businesses closure measures, the economic impact immediately was felt by entire societies. The urgency of such theme has led researchers to study the phenomenon. Accordingly, the purpose of this research is to provide the state of the art on relevant dimensions and hot topics of research to understand the economic impacts of COVID-19. In this survey, we conduct a text mining analysis of 301 articles published during 2020 which analysed such economic impacts. By defining a set of relevant dimensions grounded on existing literature, we were able to extract a set of coherent topics that aggregate the collected articles, characterised by the predominance of a few sets of dimensions. We found that the impact on "financial markets" was widely studied, especially in relation to Asia. Next, we found a more diverse range of themes analysed in Europe, from "government measures" to "macroeconomic variables". We also discovered that America has not received the same degree of attention, and "institutions", "Africa" or "other pandemics" was less studied. We anticipate that future research will proliferate focusing on several themes, from environmental issues to the effectiveness of government measures.

1. Introduction

The recent outbreak of COVID-19 and its fast proliferation across the globe has changed the daily life routines, causing unexpectable and deep impacts in all sectors of the world economy. This pandemic resulted in a global recession and its extensiveness is only comparable to the two World Wars and the Great Depression (Susskind & Vines, 2020). It is estimated that real Gross Domestic Product (GDP) worldwide declined 4.3% in 2020 and, while the forecast to 2021 shows an increase of 4.0% (World Bank, 2021), there is significant uncertainty about economic recovery.

To limit the fast spread of the pandemic in a context of uncertainty and concern, governments have enacted harsh containment measures (Piccinelli et al., 2021). The main goal was to avoid overwhelming healthcare systems by flattening the growing curve of infections to reduce both the number of infected people and fatalities, holding back for the development of viable vaccines and treatments (Thunström et al., 2020). The lack of knowledge led to unorganized implementation of several different governmental policies of different levels of restrictions to cope with peaks and troughs of infected citizens over time (Sharma et al., 2020). Those policies include limiting citizens mobility by requiring social distancing, lockdowns or business closures, and health measures such as diagnostic tests and quarantine for infected citizens. Containment measures are, on the one hand, crucial to halt the spread of the COVID-19 disease; however, on the other hand, those measures have large economic costs in the short-run. The coronavirus outbreak affected the world economy severely, generating unemployment, decrease in GDP, stock prices and interest rates (Barro et al., 2020), with the containment measures resulting in a deceleration of the economic activity in multiple sectors, such as industrial production, trade or tourism (Deb et al., 2020).

At this stage, after more than one year since the World Health Organization declared the pandemic, it is very important to ascertain the economic impacts of COVID-19. Although this is a novel topic, its importance already resulted in a significant body of literature, which is deemed relevant to assess and take a first insightful view of scholars' perspectives on the economic impact of the pandemic. Such trends can be observed in other fields where literature analyses are already being published, such as in supply chain management (e.g., Queiroz et al., 2020; Magableh, 2021). Following on this vein, our study conducts a literature analysis to determine the state of the art in the field of Economics. We conduct a semi-automated literature analysis of 301 published studies on the economic impact of COVID-19 by using a text mining and topic modelling approach (Moro et al., 2019) to understand the hot research topics, future paths of research as well as the most recent and prominent works emphasis relatively to economic variables, economic impacts, regions, institutions and economic modelling (see, among others, Barrero et al., 2020; Eichenbaum et al., 2020; Sharma et al., 2020). Accordingly, this paper contributes to the existing literature concerning the economic impacts of COVID-19 in the following: i) given the recent focus on determining such economic impacts, a set of papers focusing on this thematic is queried and extracted through an automatic method, allowing to scrutinize a large number of papers and also to provide a first perspective on academic production trends; ii) since those papers are classified on a range of coherent topics, we discuss the several dimensions that have been analysed in the literature, determining how they are connected among each other and their importance, and iii) to identify and interpret the most prominent lines of research on the short-run, patterns of investigation as well as upcoming research avenues.

This article is organized as follows. The next section is dedicated to reviewing the relevant literature on the addressed topic. Next, the methodological approach is detailed. Section 4 is focused on reporting the results, including a critical discussion of the findings in light of existing knowledge. Finally, in the last section, the theoretical and practical implications are drawn, and future research avenues are highlighted.

2. Literature Review

The issue of economic impacts of COVID-19 in a sense of literature review, which is the focus of our work, has not yet been addressed through an automated approach that can extract major research trends and hot topics using text mining techniques. A broader picture on this thematic is provided, as well as the identification and analyses of the relevant fields of research until now and the connectedness among them. Brodeur et al. (2021), through a manual selection of studies, made a literature review analysing dimensions like measurement of virus spread, social distancing actions, macroeconomic issues and socioeconomic consequences of the current pandemic. Callegari and Feder (2022) conducted a literature review on the long-term economic effects of different pandemics on development, including COVID-19, underlining effects on innovation, human and physical capital, using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method. Studies addressing literature reviews about other disruptive events with severe effects on economy like terrorism were performed by Krajňák (2021) and Akça and Ela (2017) or natural disasters by Botzen et al., (2019). However, to the best of our knowledge, some studies analyse such dimension of COVID-19 impacts in different perspectives. The relevance of effects of COVID-19 on economy has justified the production of research from several scopes and it is generally consensual on literature that coronavirus

pandemic generates significant negative economic impacts. On a macroeconomic viewpoint, several studies quantify such impacts, like Barro et al. (2020), Jordà et al. (2020), Altig et al. (2020), Walmsley et al. (2021) or Zhao (2020). Eichenbaum et al. (2020) and Jones et al. (2020) focus on macroeconomic effects of the pandemic and provide several frameworks, remarking the trade-off between health and economic outcomes. Chudik et al. (2020) explores the global macroeconomic effects of COVID-19 in several countries, by an econometric model, concluding that pandemic can lead to a decline in worldwide GDP, however with different impacts across regions. Ginsburgh et al. (2021) also mentioned the issue of regional inequality of impacts on economy as well as Meinen et al. (2021), that addresses the different regional economic impacts of pandemic and their heterogeneity on labour market. The topic of unemployment and labour market effects on Euro Area countries is focuses by Anderton et al. (2020) and by Bauer and Weber (2021) to Germany. Several works underline the relation between economic impacts of the pandemic, government measures and macroeconomic variables. Faria e Castro (2021) analyse the effects of coronavirus outbreak in the United States economy, through an econometric model, relating fiscal policies, public debt, households' income and unemployment. Also, on the United States economy, Lee at al. (2020) investigate the effects of fiscal multipliers. Auray and Eyquem (2020) discuss the effects of lockdown on Euro Area economy on inflation and unemployment, as well as government spending and unemployment insurance. Connecting with economic activities dimension, Barrero et al. (2020) examine the relation of firm-level employment, layoffs, public subsidies and regulatory barriers. Coibion et al. (2020) highlight the effects of government measures, like lockdowns, on macroeconomic variables, businesses and labour market. Baker et al. (2020a) explore how pandemic changes household consumption and impact several economic activities.

Given the great uncertainty in financial markets and economies, during the current pandemic, several studies consider such dimension. Gormsen and Koijen (2020) highlight such dynamics during COVID-19, namely in futures, stock markets and bond markets, Baker et al. (2020b) on stock market volatility, Alfaro et al. (2020) on stock returns in United States or Ramelli and Wagner (2020) on stock prices. Linking this thematic with other financial crises, Umar et al. (2020) state that investments in equity indices are sensitive to economic shocks and found patterns between the coronavirus pandemic and other financial crises, like the European sovereign debt crisis and the Greek crisis. Chang et al. (2020) compare the behaviour of stock markets investors during Global Financial Crisis started in 2007, previous coronavirus crisis of 2003 and current COVID-19 situation. Shehzad et al. (2020) compare, through an econometric model, the volatility of United States, Germany and Italy's stock markets during Global Financial Crisis and COVID-19. This issue is also approached with commodities prices, comparing with oil crash in 2014 (Gharib et al., 2021) and Global Financial Crisis and Turkish currency crisis in 2018 (Sumer & Ozorhon, 2021), both using Granger causality tests. The issues of financial and monetary economics are also addressed on the COVID-19 framework. Emphasis on currencies is given by Ciner (2020) and Narayan et al. (2020) and cryptocurrencies are also mentioned by Chiu et al. (2020) and Corbet et al. (2020). On the role of monetary policies, their effectiveness is analysed through monetary stimulus (Feldkircher et al., 2021), also focusing specifically on Quantitative Easing (Rebucci et al., 2020; Zhang et al., 2020; Bhar & Malliaris, 2020) and Helicopter Money (Drescher et al., 2020; Chakraborty & Thomas, 2020). The importance of funding economies, through credit provision and liquidity access on markets, is also underlined by various authors. Some works consider several countries while other focus on specific countries, such as Funke and Tsang (2020) on China, Debelle (2020) to

Australia, Eichenauer and Sturm (2020) to Switzerland, Pappas and Kostakis (2020) to Euro Area countries, Ozili (2022) to several African countries or Nakatani (2020) to numerous countries. Besides governments, also other several institutions play an important role on management of pandemic economic effects. Mazumder (2020) analyse the financial market reactions to the Federal Reserve of United States (FED) messages; Debelle (2020) and Bhar and Malliaris (2021) also focus on Central Banks importance. The relevance of Organisation for Economic Cooperation and Development (OECD), International Monetary Fund (IMF) and World Bank projections on government policies is evaluated by Konig and Winkler (2020) and the announcements of World Health Organization's by Maneenop and Kotcharin (2020).

Many studies reported a relevant connection between COVID-19 both economic and non-economic impacts. The measures implemented by governments to contain the pandemic, such as lockdowns, lead to a reduction of peoples' mobility and, therefore, to impacts on the environment and migration. Such non-economic impacts are likewise approached by researchers such as Lahcen et al. (2020), who assess the reduction of CO2 emissions on Belgium; also, Malliet et al. (2020) analyse such reduction in France; Helm (2020) with a broad view on environmental impacts. Furthermore, migration, waste management and wildlife are discussed by Rupani et al. (2020).

Comparing the current with previous pandemics, Alfaro et al. (2020) found a similar pattern on stock returns in Hong Kong during SARS outbreak in 2003 relating to those during the COVID-19 outbreak in the United States; Jordà et al. (2020) address the economic effects of several pandemics throughout centuries in different European countries; Barro et al. (2020) use data from the Spanish Flu to make a parallelism with COVID-19 economic impact. Nevertheless, the current context cannot be directly

comparable to previous health crises. Since the SARS outbreak in 2003, the world overcome a global financial crisis which shattered economies worldwide.

Figure 1 highlights the dimensions influenced by COVID-19, which have previously been mentioned in this section, making clear the relationship of each one with the pandemic and also the connection among several of them.

[insert Figure 1 here]

The urgency of assessing COVID-19 impacts has resulted in many already published studies which form a significant body of knowledge worthy of being scrutinized. Moreover, such large set of studies can be analysed using semi-automated techniques that are able to convert qualitative information in written text into quantitative models using text mining approaches. For example, Anwar et al. (2019) performed a bibliometric analysis of more than 27 thousand references by plotting a network of related concepts. Muñoz-Leiva et al. (2021) have also analysed a large body of knowledge using co-word analysis and topic modelling. Therefore, we also adopt a text mining and topic modelling approach similarly to the one followed by Santos et al. (2020).

3. Method

Scientific literature undergoes a peer-review process to assure the quality of the published articles. Then, it is indexed in databases that typically use three main sections for indexation and the corresponding searching purposes: the title, the abstract, and a set of keywords. Arguably, two of the most widely accepted and disseminated databases are Web of Science and Scopus (Cortez et al., 2018). While the former is older, the latter has the advantage of covering a wider range of outlets (Abrizah et al., 2013) and,

therefore, it has been adopted in several recent studies (e.g., Moro et al., 2019; Truc et al., 2021). Thus, we also chose Scopus. Another advantage of Scopus is that it is a broad scope database, covering topics from all disciplines, including Economics, which is the focus of the presented research. As an example, Scopus covers all relevant ACM and IEEE peer-reviewed articles (Meho & Rogers, 2008). Additionally, its flexible querying system enables to search for composed Boolean expressions. Based on the previous literature review section, we queried Scopus through the following query on the 30th of November 2020:

PUBYEAR > 2019 AND (TITLE-ABS-KEY ((covid-19 OR coronavirus) AND ("economic shock" OR "economic impact of covid-19" OR "monetary policy" OR "monetary policies" OR "macroeconomic policy" OR "macroeconomic policies" OR "macroeconomic impact" OR "labor market impact" OR "labour market impact" OR "general equilibrium" OR "public finance" OR "consumption expenditure" OR "public debt" OR "government debt" OR "trade balance" OR "stock market" OR "foreign trade" OR "stock return" OR "financial market" OR "financial shock" OR "GDP growth")))

The result was a total of 313 articles. From those, we found 12 that consisted in editorial notes or letters from the editors, which called to the relevance of understanding the COVID-19 impact but did not report novel contributions to existing literature. Accordingly, those were removed, leaving a total of 301 articles. Additionally, a randomly selected sample of 5% (15 articles) from the 301 was manually assessed in relation to its relevance by the two authors (one is an expert in economic impacts, while the other has published peer-reviewed scientific publications in COVID-19 impacts to the society). Our sample-based assessment enabled us to conclude that the gathered body of knowledge is relevant to the underlined topics, deeming our approach as valid for further analysis.

All the reported experiments in this study were conducted using the R statistical tool, which is open source and offers a set of packages to a myriad of data analysis tasks, including text analysis (Cortez, 2014). Figure 2 shows the undertaken approach. Based on existing literature, summarised in Figure 1, we identified the main dimensions for our analysis. Then, we built the first version of a dictionary that enabled to find words related to each dimension on the articles. The dictionary is a needed input to the next step. However, it needs to reflect the dimensions that are mentioned in each article and, for that, it needs to incorporate words or terms combined by more than one word that represent each dimension and are used by authors in their titles, abstracts and keywords. Thus, we selected a random sample of 20 of the collected articles to assess if each dimension was being correctly captured in those articles. Such procedure enabled to tune the dictionary by including words commonly used by authors. Table 1 shows six examples of randomly selected related terms, which represent such dimensions and, therefore, the resulting dictionary.

[insert Figure 2 here]

[insert Table 1 here]

A text mining procedure that consists in computing the frequency of words in each document is then executed. In comparison to a meta-analysis which is solely based on the quantitative results, the text mining uses all the text, enabling it to include concepts and terms referred by the authors which may reveal important insights that can be assessed through a text mining procedure. Such procedure provides an efficient means for analyzing a large corpus of literature regardless of its size. The output is a document-term matrix, in which each row represents a document and each column represents a term (or word). However, if all words are accounted for, the resulting matrix will be too large because it will contain as many columns as the different

(unique) words existing in all documents. Additionally, such matrix is usually very sparse as there are many specific words that occur just in one document. To address such issue, we used the built dictionary to consider only the dimensions highlighted in Table 1 as columns of the document-term matrix, thus replacing all related terms by each dimension and discarding the remaining words (similar to the study by Santos et al., 2020). Figure 3 depicts the representativeness of each dimension in the form of a word cloud, using the values extracted from the document-term matrix.

[insert Figure 3 here]

There are several topic modelling techniques, from which the latent Dirichlet allocation (LDA) algorithm is arguably the most popular (Moro et al., 2019) and has been extensively used to analyze a set of articles in different domains (e.g., Ambrosino et al., 2018; Santos et al., 2020). LDA requires as inputs the document-term matrix and the number of topics. To find an optimal number of topics, we used the "ldatuning" package from R statistical tool, following the procedure by Canito et al. (2018). Thus, such number was set to seven. The resulting seven topics are therefore characterized by the relevance that each dimension has to the topic, enabling to understand the themes that are addressed in a topic.

4. Results and discussion

In this section, we present the analysis and discussion of the uncovered results. Firstly, we provide a brief overview about journals and publishers that have published under such thematic. Afterwards, we discuss on the computed topics. Our findings enable to gauge about the most recent patterns of research on this thematic and to identify the hot topics. Furthermore, we also discuss on the connection between different topics and

dimensions, providing evidence about the lines of research that have received the most attention. However, we underline that this work focuses on the economic impacts of COVID-19 on short-run, since Scopus was queried at the end of November 2020, as mentioned on previous section.

4.1 Source titles and publishers

The importance of the COVID-19 impact in the economy is patent on the reputation of journals publications and their impact factor, as well as Scopus ranking. More than half of articles are published in journals ranked in Scopus quartile 1 and 2 and in several influent journals (see Table 2 for the journals contributing with most articles). In comparison, conferences and book chapter publications have received lesser attention from researchers in these topics. Since high ranked journals require a thorough screening and peer-review process that can take some months (Huisman & Smits, 2017), we can assume by the large number of published articles that the urgency of the theme was also perceived by editors who may be more willingly to speed up the process while maintaining a rigorous peer-review.

[insert Table 2 here]

4.2 Topics relevance and analysis

In this section, the topics are exhibited and the subsequent discussion, interpretation, connection and implications are explained.

Figure 4 presents the seven unveiled topics, one per graphic. In each one of them, the most important dimensions, with word probability above 1% (from the ones identified

in Table 1), are shown, with the length of each bar (computed using the β distribution value obtained from LDA) representing the relation to the topic. Such topics intend to demonstrate how the dimensions are aggregated in the selected body of knowledge by our query, allowing to select which ones focus on the economic impacts of COVID-19 and which are the main relevant dimensions and their connectedness.

A brief overview of topics will be given and then each of one will be detailed, discussed and connected with others.

Topic 1 focuses almost exclusively on the dimension "financial markets". Topic 2 addresses dimensions of "Europe", "government measures" and with residual weight "other economic crisis". Topic 3 reports works predominantly of "economic impacts", "economic activities" and "non-economic impacts". On topic 4, several dimensions are related and more balanced in their importance, focusing "monetary variables", "financial economics", "America", "institutions" and "Africa". Topic 5 highlights works that analyze essentially "financial markets" and "Asia". Topic 6 emphases studies mainly of "macroeconomic variables", having "financial economics" and "economic models" minor weight. At the end, topic 7 has a more diverse range of dimensions, being connected more strongly "commodities" and "economic models" and with less importance "other economic crisis", "other pandemics" and "economic impacts".

[insert Figure 4 here]

The dimension "financial markets" is highlighted on topics 1 and 5. In the first, that dimension constitutes *per-se* the dominant line of research, since both "monetary variables" and "government measures" are residual. In fact, the thematic of financial markets appears to be very important and studied. About 50% of total works considered

made an approach in this dimension and more than 6% address it exclusively. Therefore, we can ascertain that clearly exists an autonomous line of research about the economic impacts of COVID-19 that analyses financial markets. One of the reasons could be the immediate effects verified on markets, due to restrictions imposed by governments in the pandemic scenario and the turbulence and high volatility observed in stock markets in face of great uncertainty. Such facts also justify the jointly analysis, although residual, with different currencies and government measures. For example, Haroon and Rizvi (2020) highlight the relation of government measures, monitored by the Stringency Index, to flattening the COVID-19 curve and their impact on stock markets. The Stringency Index is part of the tool Oxford COVID-19 Government Response Tracker, such as Economic Support Index or Risk of Openness Index. Such tool is very important to monitor and compare the evolution of pandemic and policy responses worldwide, useful for policy-makers and government responses (Hale et al., 2020).

On topic 5, "financial markets" and "Asia" prevail on analysis, while "monetary variables" and "Africa" are almost insignificant. Indeed, the results suggest that the two main dimensions were studied together several times. About 15% of total works considered "financial markets" and "Asia" together, whereas by aggregating all the other continents, the output is only 17%, with Europe accounting for almost 11%. Undeniably, we can conclude that Asia by itself has an approximately number of works in this dimension that the remaining continents together. This fact cannot be dissociated that pandemic epicentre has started on Asian countries.

Topic 2 emphasizes that much research is focused on a specific region and, in this case, "Europe", with the dimensions "government measures" and "other economic crises" being related to Europe, especially the former. European countries have a predominance

on the set of works considered, with about of 23% of total works mention such dimension. Only Asia is studied in more articles considering the countries, which is discussed when analysing topic 5. While the other continents are included in specific dimensions, like America in topic 4, the European continent is the most important dimension in this topic. Apart from being one of the most mentioned in the papers, the analysis spectrum is vast, focusing on several different dimensions. This did not happen with Asia, that concentrates more than half of their works on "financial markets" or with America that only represents about 10% of total works. In Europe, "government measures" like quarantining policies or stimulus packages seems to have more predominance in studies in comparison with countries of other continents. Policy coordination within the European Union countries, with recovery packages such as the "European bazooka", can help in explaining these results. As previously mentioned, the Stringency Index is an important tool to monitor and compare the pandemic evolution and government measures implemented in several different of countries, including in Europe. A comparison with the previous economic crises is also mentioned, since some linkages with European sovereign debt crisis can also be unveiled.

The dimension "macroeconomic variables" is predominant on topic 6, in which are also underlined "financial economics" and "economic models" with some importance. The remaining dimensions, "Oceania" and "economic activities" are immaterial. The impacts of COVID-19 on macroeconomic variables are quite important, considering the pandemic affects significantly the economic environment and to tease negative impacts, which justifies its prominence, as addressed by Barro et al. (2020) and Eichenbaum et al. (2020), among others. Moreover, about 35% of total studies mention this dimension, attesting their importance. In fact, the pandemic caused a large disruption on the functioning of the world economy and several macroeconomic variables were severely

affected, however in different ways. For instance, a significant contraction of GDP, exports and private consumption was observed while public expenditure and savings increased in many countries (e.g., Douglas & Raudla, 2020, for the United States; Kinda et al., 2020, for Burkina Faso; Drescher et al., 2020, for several European countries). The slowdown of economies impacted also the dimension "financial economics", since such deceleration led to a reduction on grant loans and changes on funding and liquidity in economies worldwide. Some researchers started to model the economic impacts of coronavirus, despite the dimension "economic models" do not have up till now large predominance on this topic. This can be explained because the majority of macroeconomic variables are available monthly and most of economic models used to estimate such impacts require a large number of observations, which is not available yet. Furthermore, it is expected that over time the weight of this dimension will increase and the number of works using different economic models, including econometric models, spread.

Focusing on topic 3, a relationship among "economic impacts", "economic activities" and "non-economic impacts" is established, as well as with "Europe" and "Asia", in a minor scale. About 33% of total works remark the first dimension and it seems to be very closed with the second. Notwithstanding the relevance of economic impacts of COVID-19 across all dimensions, the connection of economic recession, job losses, price spikes, break in productions, bankruptcies or layoffs affects directly economic activities of all sectors. For instance, the difficulties in transporting raw materials generate delays in production and a decrease in production in many sectors; the business closures were also felt across sectors of activities, from agriculture to manufacturing industry. Moreover, the severity of economic impacts felt by different sociodemographic groups on society was very heterogeneous and some groups were

affected more comparing to others, conducting to a retrench on their consumption and savings, as well as poverty increase. Such facts will also lead to a deceleration of economic activities on future (Martin et al., 2020). While some people maintained their income during pandemic, as office employees that work remotely from home, others suffered a partial or even total reduction in their wages and, therefore, their quality of life decrease. One example is on tourism industry, which sector had a total paralysation and many employees stayed in precarious situation. Since tourism plays a crucial role on economies of some countries and/or regions and consequently on employment, wages and reduction of regional asymmetries (Andraz et al., 2016), such group of people were deeper affected than others. These issues were addressed in several studies, including some non-economic impacts, such as environmental issues, like gas emissions and waste management, very associated with several economic activities, such as tourism, construction sector or shipping. The topic also suggests that such thematic is mainly approached on Europe and Asia. Perhaps future studies will extend the measurement of these dimensions together, allowing understand the effects of economy's slowdown on environment, business and economy as a whole, analysing their relation.

Relatively to topic 4, the weight distribution of all dimensions is more balanced and scattered when compared to the remaining topics. Thus, we can conclude there is a stronger relation among those dimensions, however less concentrated in one or two of them. For instance, in terms of the importance of these dimensions in total works, "monetary variables" accounts 13%, "financial economics" and "institutions" both with 12%, "America" with 10%, and "Africa" with 5%, approximately, while in other topics such percentage is much higher. The two main dimensions of this topic can be related to several works, since that more than a few terms of both dimensions are complimentary

when analysed. For example, the liquidity available on economies, to provide funding to banks and therefore granting credit to customers, are related with monetary instruments such Quantitative Easing and, consequently, those policies are decided by institutions such as Central Banks. These issues were addressed in Funke and Tsang (2020), among others. FED is an important player on worldwide monetary decisions, as well as the IMF and, for that reason, America also plays a decisive role on these matters. From another point of view, the results seem to suggest that studies focusing African countries tend to be more embracing, discussing more dimensions than in other countries (see, for example, Ozili, 2022) and highlighting other institutions, such as the World Health Organization, which plays a key role in supporting many developing countries in Africa.

Concerning topic 7, the results suggest a pattern of studies relating a set of five dimensions, specifically "commodities", "economic models", "other economic crises", "other pandemics" and "economic impacts". Once again, similarly to topic 4, there is no predominance of one dimension but instead a linkage among several of them. The first two dimensions have a relevant presence on total studies, with 14% and 25%, respectively, while the next two, more associated with previous situations, are less expressive (7% and 3%, respectively). In this topic, economic modelling has an important role, mainly related with commodities, in opposite to what happened when topic 6 was analysed. One explanation is certainly associated with the fact that many commodities present daily data, unlike most of macroeconomic variables and, in this case, frequently there is a large number of observations available and the requirements required to use such models are accomplish. Commodities prices are very sensitive in contexts of uncertainty, like as exposed, and it is very important to estimate their evolution through time. For example, in one hand, gold and palladium can serve as a

refuge for investors and their price increase as a result, due to higher demand; on the other hand, the demand for crude and aluminium diminished, as a consequence of the economic slowdown and their quantities stored increase, leading to a price decrease. On such scenario, quite a lot of studies aim to understand the impact of the pandemic on commodities through economic models. More extensively, some authors also connect "commodities" and "economic models" with "other economic crises" (see, for example, Sumer & Ozorhon, 2021), allowing the assessment of the current and previous economic crises. Following the same vein, some works intend to predict the economic impacts of the current pandemic and to compare those results with "other economic crises" (e.g., Great Financial Crisis, debt crisis) or "other pandemics" (e.g., H1N1, SARS, Spanish Flu) or, alternatively, estimate economic impacts of previous crises and try to use it as a base for modelling the COVID-19 scenario.

Table 3 shows the distribution of the articles per topic, while also exhibiting an example of an article per each topic for further discussion. Hence, the study by Corbet et al. (2020) is an example of topic 1, primarily focused on financial markets, as this study addresses the market volatility spillovers effect caused by the pandemic. In topic 2, Cacciapaglia et al. (2020) devoted efforts to study government measures to mitigate the pandemic effects, while the article shown for topic 3 (Mukanjari and Sterner, 2020) is a great example of how the pandemic caused economic impacts on several economic activities and how the recovery can cause non-economic impacts, being more environmental friendly, for several countries. Within topic 4, Mazumder (2020) assessed financial economics using monetary variables by studying FED's policies (within the United States of America). He et al. (2020) studied the impact of COVID-19 in the Chinese financial market, which is encompassed within topic 5. Umar et al. (2020) adopted a statistical approach to study financial markets performance by using

macroeconomic variables (topic 6). In topic 7, the study by Chang et al. (2020) is focused on the energy (commodity) market. Specifically, they developed economic models to compare the COVID-19 impact on the energy market with other economic crisis (i.e., the Global Financial Crisis of 2007-2009) and with other pandemics (e.g., the SARS in 2003).

[insert Table 3 here]

5. Conclusions

This study reviews the recent works and reports relevant dimensions and topics of research to understand the economic impacts of COVID-19. The methodology used is based on text mining literature. Such approach makes it possible to identify and aggregate the most prominent lines of research about this thematic based on the textual contents of published articles, synthetizing and bring coherence to the existing body of knowledge.

Our study as some limitations that need to be accounted for. First, the dynamics of COVID-19 and the unprecedented pace at which related studies are being published makes our static view in time to become outdated quickly. Second, the use of automated approaches based on text mining, while enabling to efficiently analyse a large body of knowledge, is solely based on textual contents matching, whereas the human language has many subtleties and style figures that are still hardly perceived by advanced text mining techniques.

The results highlight some important findings about the research focusing economic impacts of the novel coronavirus discovered in 2019, from which some conclusions can be drawn and their effects better understood. First, this research area has quickly

attracted large attention and the existent body of literature is already quite significative. In fact, in few months there are a large number of articles about this issue published in several renowned peer-review journals. Second, the focus of the topics analysis is heterogeneous. While there are topics that approach mainly one dimension, such as the case of "financial markets" in topic 1 and "macroeconomic variables" in topic 6, constituting an autonomous line of research, there are other topics where the analysis is scattered by several dimensions, like topics 4 and 7, allowing to identify the strong connection among such dimensions.

Third, there are predominant dimensions when analysed the economic impacts of COVID-19 and hot topics were identified. Until now, dimensions exist that capture the attention of researchers, to the detriment of others. We concluded that "financial markets", "macroeconomic variables", "Asia", "economic impacts" and "Europe" are the top dimensions scrutinized. By the opposite, "other pandemics", "Oceania", "Africa", "institutions", and "other economic crises" are the less mentioned in the articles. Nevertheless, those continents and the comparison with previous economic and/or pandemic events may gain relevance in the future, with the proliferation of studies.

Fourth, the geographic analysis presents a trend on studies. Asia, where the disease first outbreak, is the continent predominant on articles, followed by Europe, whilst Africa and Oceania have little relevance up until now. However, the focus of the continents research does not show a pattern, since Asia is largely associated with one dimension ("financial markets"), while Europe studies cover several dimensions, from "government measures" to "other economic crises".

Fifth, dimensions such as "commodities" are already quite studied quantitatively and through economic models to assess economic impacts, whereas "macroeconomic variables" tend to be very commonly used beyond economic impacts context. The explanation can be related with data availability, since frequency data of the two dimensions referred is different (the first is mainly daily while the second is mostly monthly). Over time, it is expected that articles focusing on the measurement of economic impacts of COVID-19 increase, from a macroeconomic perspective with relation to environmental issues, allowing future articles to link several dimensions with economic modelling.

Sixth, with the likely proliferation of studies in the future and when the economic impacts are better known, more conclusions can be drawn about the effectiveness of government measures to quell the impacts on economies, the role of institutions and a comparison with the depth of COVID-19 effects with previous crisis, as well as across all the dimensions considered. Moreover, the significant negative economic effects of lockdown policies on short-run, highlighted by this work, may remain in the future, impacting on long-run economic and social welfare and not only during pandemic.

Seven, our results can allow researchers to identify an "opportunity window" in future studies focusing economic impacts of COVID-19, since our work present the state of the art on this issue and summarize the articles published and research patterns about this thematic. Starting from this short-run analysis it would be interesting investigate how dimensions and topics of research changes over time, including their connectedness, allowing understand the path on this thematic research. Will dimensions less scrutinized, like "institutions", "other pandemics" and "other economic crisis" gain importance on future works? On macroeconomic framework, studies approaching the measurement of both short and long-run pandemic impacts on macroeconomic variables

plausibly will proliferate, focusing different regions or countries, through a vast number of models, intending measure and compare the deepness of such impacts. Another avenue of research can address environmental aspects. On one hand, when economy activities had slowdown air quality probably improved on short-run; on the other hand, waste management and environmental concerns may have gotten worse. What the role of pandemic on this subject and their impact? Concerning impacts on business activities, such as bankruptcy and closures, were public policies effective? All the sectors had the same resilience and survival rate? The effectiveness of government measures among countries and their impact in contain both the proliferation of pandemic and minimize the adverse economic impacts can also be addressed, for people and business. Other questions may be raised. Financial system had upheavals during pandemic? Will be affected on long-run due to the event? Another line of research can address the comparison of impacts with previous pandemics or economic crisis.

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Table 1 - Dictionary used to match similar terms.

Dimension	Examples of related terms
economic models	vector autoregression model; input-output model; logit-probit model; CGE model; dynamic stochastic general equilibrium model; Granger causality
financial markets	stock markets; corporate bonds; hedge trading; Eurostoxx; FTSE 100; abnormal returns
financial economics	liquidity; credit; funding; loan; financial economic; financing
macroeconomic variables	gross domestic product; private consumption; exports; public expenditure; industrial production; savings
monetary variables	Euro; US dollar; Yen; cryptocurrencies; Bitcoin; Quantitative Easing
commodities	oil; gold; silver; crude; ethanol; cotton
other economic crises	global financial crisis; debt crisis; great depression; great recession; banking crisis; crash of 1929
non-economic impacts	carbon emissions; waste management; human mobility; pollution; social disparities; air quality
economic activities	agriculture; industrial sector; fishing; manufacturing industry; airline industry; hospitality industry
economic impacts	economic fallout; economic recession; bankruptcies; job losses; financial losses; economic recovery
government measures	public policies; quarantining policies; support packages; stimulus packages; lockdowns; social distancing
other pandemics	EBOLA; MERS; SARS; H1N1; Spanish Flu; Spanish Influenza
institutions	World Health Organization; European Central Bank; World Bank; European Commission; Organization of Petroleum Exporting Countries; FED
Africa	Morocco; South Africa; Mozambique; Mauritius; Sudan; Zanzibar
America	United States; Mexico; Brazil; Cuba; Costa Rica; Aruba
Asia	China; Japan; Thailand; Bangladesh; Dubai; India
Antartica	Antartida; Antarctica
Europe	France; United Kingdom; Spain; Italy; Portugal; Croatia
Oceania	Australia; New Zealand; Papua New Guinea; Cook Islands; Samoa; Solomon Islands

Source: Own elaboration.

Table 2 - Source titles.

Source	Nr. articles
Finance Research Letters	26
Journal of Behavioral and Experimental Finance	7
Economic Outlook	7
Sustainability (Switzerland)	6
Emerging Markets Finance and Trade	6
Applied Economics Letters	6
Journal of Public Affairs	6
Environmental and Resource Economics	5
International Review of Economics and Finance	4
Journal of Industrial and Business Economics	4
Journal of Asian Finance; Economics and Business	4
Journal of Public Budgeting; Accounting and Financial Management	4
Swiss Journal of Economics and Statistics	3
International Review of Financial Analysis	3
Investment Management and Financial Innovations	3
Economics Letters	3
Entropy	3
Emerald Emerging Markets Case Studies	3
Wirtschaftsdienst	3
Journal of Policy Modeling	3
Economics Bulletin	3

Source: Own calculation.

Table 3 - Articles per topic.

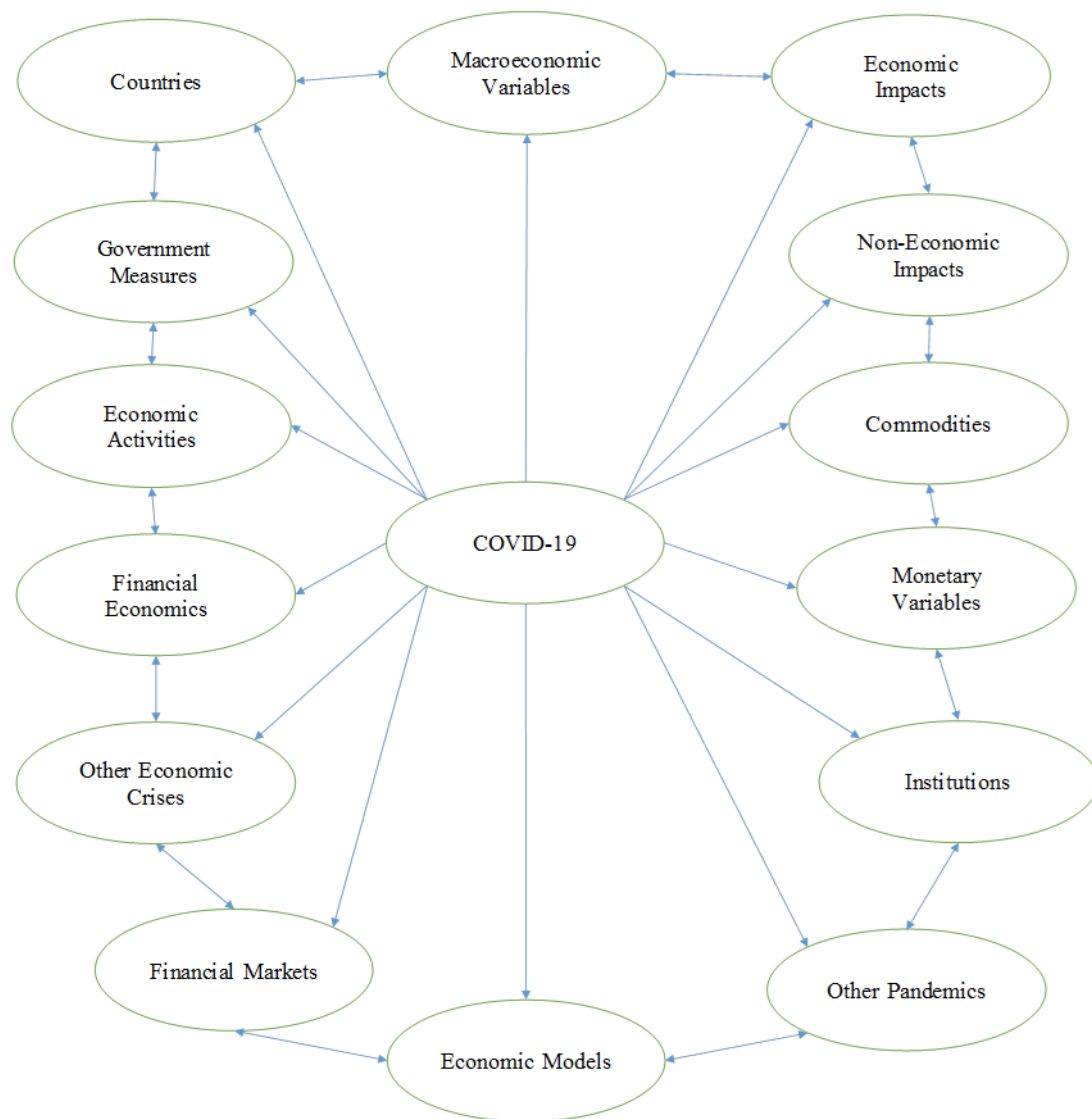| Topic	Nr. articles	Example of article
1	63	(Corbet et al., 2021)
2	38	(Cacciapaglia et al., 2020)
3	57	(Mukanjari & Sterner, 2020)
4	44	(Mazumder, 2020)
5	45	(He et al., 2020)
6	31	(Umar et al., 2020)
7	23	(Chang et al., 2020)

Source: Own calculation.

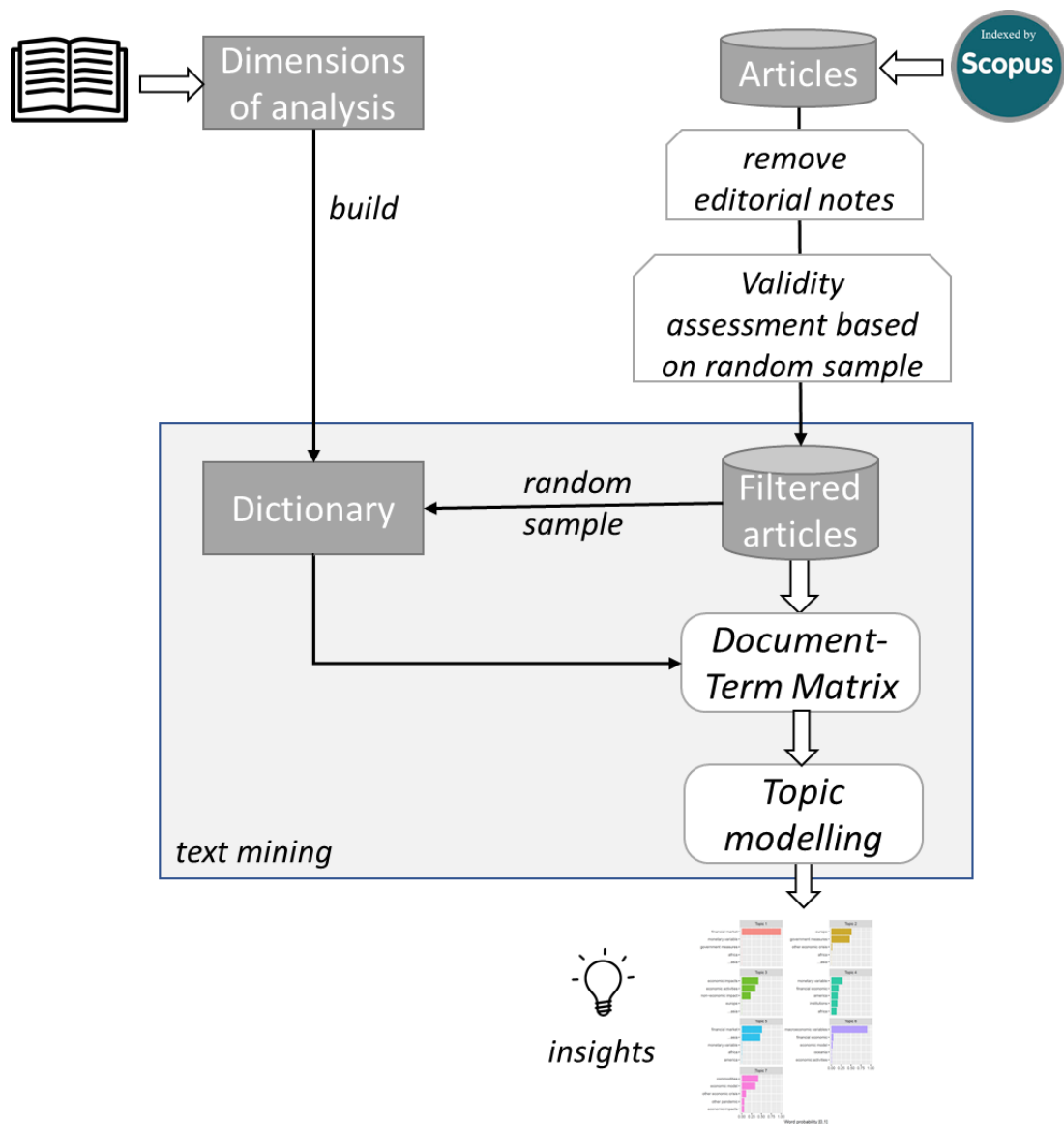Figure 1 - Main dimensions influenced by COVID-19. Source: *Own elaboration.*

Figure 2 – Undertaken approach. *Source:* Own elaboration.

Figure 3 - Word cloud. *Source:* Own elaboration.

Figure 4 - Unveiled topics. *Source:* Own elaboration.