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**Article**

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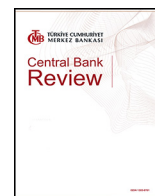
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# Inflation, perception of economic uncertainty and COVID-19: Evidence from Central Bank communication



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## ABSTRACT

Do extreme events have a significant effect about textual sentiment? The purpose of this article is to highlight the need to correct the estimation of indicators of economic uncertainty. The indicators were constructed from textual data about the perspective of extreme events. For this purpose, based on data extracted from the minutes of meetings of the Monetary Policy of eighteen Central Banks, we estimated two variables of perception of economic uncertainty: the first using only a traditional sentiment dictionary and the second incorporating terms associated with the extreme event (COVID-19 Pandemic) in its word list. Initial results show that there is a significant effect of COVID-19 on the estimation of the perception of economic uncertainty; this effect acts as an accelerator that potentiates its impact. It was evident that incorporating conjunctural issues - be it local or global - is indispensable when performing sentiment analysis in texts during extreme events. Moreover, failing to take conjunctural issues into account throughout the estimation process can result in variables with biased information.

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## 1. Introduction

The COVID-19 pandemic is a global outbreak of coronavirus. The rapid spread of this virus led the World Health Organization (WHO) to characterize it as a pandemic in 2020. COVID-19 has become a worldwide problem and has led to profound changes in the entire international situation. In the economic-financial scope, the 2020 pandemic took a heavy toll on economic activities. According to estimates by the International Monetary Fund (IMF),<sup>1</sup> the pandemic caused a 3.3% retraction in the world economy in 2020; however, economies that are in the Euro Area showed a drop of 6.6%.

During the pandemic, economic agents end up developing negative expectations, which in turn lead them to save most of their economic resources as a precautionary measure. Consequently, there is a downturn in the economy. Companies then reduce prices as a way to try to warm up the market again. This

whole process occurs continuously until the effects of the shock dissipate throughout the economy. According to [Chang and Velasco \(2020\)](#), the success of economic policies implemented during the pandemic is inextricably related to people's expectations of future policies. The negative expectations of economic agents can end up becoming a hindrance for policy makers due to their adaptive nature. The more negative expectations are, the greater the possibility is that the efficiency of economic policies will be somewhat compromised.

Regarding the influence on inflation, [Cavallo \(2020\)](#) identified an ambiguous effect when realizing that social distancing rules caused inflation on essential consumption baskets (such as food) and deflation regarding transport spending. This reasoning goes against [Jonas \(2013\)](#), which, when examining the risks of a pandemic, concluded that social distancing can induce the individual to give up consuming some goods and services. [Moore \(2017\)](#) avers that inflation decreases in response to an uncertainty shock. When investigating the influence of the pandemic on the Indonesian economy, [Sihombing et al. \(2020\)](#) found a negative relationship between death rate and economic growth.

The new coronavirus behaved as a true catalyst, capable of enhancing the effects on economic variables, especially uncertainty. The greater the economic uncertainty, the greater the

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<sup>1</sup> World economic outlook: <https://www.imf.org/en/Publications/WEO/Issues/2021/03/23/world-economic-outlook-april-2021>.

postponement of decisions regarding consumption, production, and investment. According to Carlsson-Szlezak et al. (2020), household savings will increase while consumer spending will decrease more and more. On constructing two uncertainty proxies for New Zealand Greig et al. (2018), they find that an uncertainty shock results in lasting drops in consumption and investment. On correlating expectation and uncertainty Nowzohour and Stracca (2020), they observe that if economic agents expect an increase in uncertainty in the future, risk aversion would prevent consumption from increasing. Therefore, the increase in uncertainty negatively affects the consumption of economic agents due to negative expectations and this causes inflation to fall.

Economic uncertainty quickly escalated and almost instantly showed a boom in mid-March 2020. As noted by Leduc and Liu (2020), the VIX (Volatility Index) - which is responsible for measuring the degree of volatility of the shares of the S&P 500 and regularly used as a measure of uncertainty - reached a peak in March 2020. This peak surpassed the one from the Global Financial Crisis of 2008. Thus, an exogenous and unexpected shock of economic uncertainty arising from the spread of the new coronavirus will, at first, affect global financial markets. The degree of connection between these markets and the almost immediate response to external events provides a good measure of analysis. Albuлесcu (2020) empirically verified that the announcement of new cases and deaths related to COVID-19 increased the volatility of the US financial market through the volatility of the S&P 500.

By quantifying the weekly change in uncertainty, Baker et al. (2020) investigate the economic impact and the speed in which COVID-19 spreads. Altig et al. (2020) found a significant increase in economic uncertainty in the US and in the UK in March 2020 in response to the pandemic and its possible economic outcomes. The consequences of economic policy uncertainty and the risk of crash in the US stock market was examined by Liu et al. (2020). The global outbreak of COVID-19 has strengthened the negative correlation between economic policy uncertainty and the risk of crash in the stock market. In this highly uncertain scenario, monetary policy shocks will affect economic activity significantly more leniently as reported by Aastveit et al. (2013). If, under normal circumstances, the increase in uncertainty alone requires greater attention from economic policymakers, in a conjuncture taken by extreme events, it is essential to act quickly to mitigate its possible effects. On investigating the consequences of shocks of economic uncertainty induced by COVID-19, Pellegrino et al. (2020) realized that the loss of production could be up to twice as big as what happened during the Great Depression of 1929 and that only an aggressive monetary policy would be able to minimize these losses (Greenspan (2004), Bekaert et al. (2013) and Pinshi (2020)).

It is common knowledge that economic uncertainty cannot be measured in a usual way. This is related to the fact that it is a non-quantifiable variable.<sup>2</sup> For this reason, researchers apply alternative techniques to measure it. Jurado et al. (2015) use volatility as a measure of uncertainty. Baker et al. (2016) and Ferreira et al. (2019) deploy text regression methods combined with a specific dictionary to build the Economic Policy Uncertainty (EPU) and the Brazil Economy Uncertainty Indicator (IIE-Br) based on newspapers.

In this work, we will not estimate an indicator of economic uncertainty, but a variable capable of measuring the perception of economic uncertainty by policymakers through the minutes of Central Banks. Shapiro and Wilson (2022) estimate the preferences of the Central Bank from the sentiment expressed by policymakers in their internal meetings. As for the reaction of policymakers, Cieslak et al. (2021) claims that the increase in uncertainty drives

the response of policymakers policy towards macroeconomics. In addition, the uncertainty related to inflation leads to a more aggressive stance. Measuring this sentiment is of utmost importance, for this information might provide the rationale behind the decision-making process on monetary policy carried out by Central Banks.

In an environment of high uncertainty, the policy maker is faced with a scenario of high information asymmetry, and this directly impacts on his posture in relation to the monetary policy decision-making. The effect on the formulator's decision-making is ambiguous: i) he can wait so as to have a better appraisal of the situation or ii) he can make the most aggressive decision to contain the advance of uncertainty. However, in both positions the consequences can be severe for the economy. By waiting until a better appraisal of the real situation is obtained, the monetary policy may lag behind, and new expectations may already have been formed; therefore, the effect of an increase in interest rates would be inefficient in terms of affecting the production and/or consumption of goods and services. By adopting an aggressive stance, the formulator may have undertaken a wrong appraisal due to the fact that he did not wait to grasp the new conjuncture properly and, as a consequence, the monetary policy may not have enough strength to provide the recovery of the economy and the exit from a state of recession.

The literature that makes use of Central Bank minutes as a source of study has grown significantly. Since it presents the conduct of monetary policy in detail, it ended becoming a valuable source of analysis. Jitmaneroj et al. (2019) advocate greater clarity on the part of the Central Bank as a way to reduce the uncertainty of interest rates and inflation. The minutes of meetings of the Monetary Authorities are a powerful communication tool used by Central Banks. (Apel and Grimaldi (2012); Bholat et al. (2015); Grignani and Fontana (2018); Rybinski (2018); Bennani (2020); Bennani et al. (2020); Kryvtsov and Petersen (2020); Haldane et al. (2020)). Using the minutes of the Monetary Policy meetings of eighteen Central Banks<sup>3</sup> and applying the text regression metric, we constructed indicators capable of measuring the perception of economic uncertainty by policymakers by capturing the implicit information obtained by extracting the textual sentiment contained in these documents for each of the eighteen countries observed in this work. In other words, the textual analysis of the minutes allows us to try to decode the preferences of Central Banks.

The purpose of this work is to promote a reformulation in the estimation process of variables that measure textual sentiment during special circumstances (extreme events). Our objective is to reduce a possible asymmetry in information, which can arise when disregarding relevant data in a local or global scenario. For this purpose, we initially estimated the variable of perception of economic uncertainty using only the list of words with sentiments of uncertainty proposed by Loughran and McDonald (2011). These authors are great authorities in the field of textual sentiment analysis,<sup>4</sup> their dictionary is currently the most used in this subject and several studies make use of it annually (Li et al. (2014), Heston and Sinha (2014), Picault and Renault (2017), Correa et al. (2017), Gandhi et al. (2019), Taylor and Keselj (2020), Li et al. (2020), Guo et al. (2022) and Das et al. (2022)). Then, we added the words: "pandemic", "covid", "coronavirus", "severe", "drastically",

<sup>3</sup> Reserve Bank of Australia, Central Bank of Brazil, Central Bank of Chile, Czech National Bank, European Central Bank, Magyar Nemzeti Bank, Central Bank of Iceland, Reserve Bank of India, Bank Indonesia, Bank of Japan, Reserve Bank of New Zealand, Narodowy Bank Polski, South African Reserve Bank, Bank of Korea, Sveriges riksbank, Türkiye Cumhuriyet Merkez Bankası, Bank of England, The Federal Reserve.

<sup>4</sup> Available at: <https://sraf.nd.edu/loughranmcdonald-master-dictionary>.

<sup>2</sup> For further details, refer to Knight (1921).

“dramatically” and “worst” in order to capture possible additional impacts caused by extreme events.

This study is close to the recent literature by [Leduc and Liu \(2020\)](#), [Baker et al. \(2020\)](#) and [Altig et al. \(2020\)](#) in discussing the relationship between economic uncertainty and COVID-19 regarding its measurement. However, what sets this work apart from others is that we are working with policymakers' perception of economic uncertainty. In addition, we aim to include terms directly associated with extreme events (in this case, the COVID-19 pandemic) to improve accuracy in capturing textual sentiment in order to eliminate the existence of any bias due to the non-integration of these terms in the dictionaries used throughout the estimation process.

The initial results suggest the need to calibrate the list of words used to estimate textual sentiment variables during extreme scenarios. The indicator that considered the terms associated with COVID-19 showed better performance in the simulation exercise compared to the indicator estimated only with the economic uncertainty words from the dictionary proposed by [Loughran and McDonald \(2011\)](#). As an empirical exercise, we simulated inflation dynamics through Fixed Effect (FE) and Fixed Effect with Instrumental Variables (FE-IV) models. The results of these models indicate that the variable that incorporated the terms related to extreme events (COVID-19) in its estimation has a negative and significant effect on inflation. Model III (FE-IV Uncertainty\_Covid) presented a reduction effect of 0.4149 standard deviation in inflation from a change in standard deviation in the perception variable of economic uncertainty associated with COVID-19 over inflation. We concluded that the extreme event acted as an accelerator of the perception of economic uncertainty. It became evident the importance of incorporating environmental factors related to extreme events in the estimations of textual variables and that omitting or disregarding the presence of local or global events with the ability to directly interfering with estimated sentiment can provide biased results. In the case of this work, by disregarding these events, the perception of economic uncertainty on the part of the Central Bank could be overestimated or underestimated, which could have an impact on the conduct of monetary policy.

The rest of this article is organized as follows: section 2 describes the data used to construct the indicators and the variables used in the empirical exercise; section 3 presents the process of estimating the variables of perception of economic uncertainty; the empirical exercise of simulation of inflationary dynamics is observed in section 4; in section 5, the results are discussed; in section 6, we display an exercise in robustness; in section 7, we conclude the article.

## 2. Dataset

Documents referring to Monetary Policy decisions (minutes of meetings or communiqués) were collected directly from the websites of the Central Banks of each of the eighteen countries. We decided to work with all the documents in English in order to eliminate any possible bias linked to the local language of each country. Due to a lack of harmony in relation to the number of documents published annually, all of them were standardized in quarterly data. In those cases where banks published more than one meeting minute in the same month, the texts were united and considered as one document only. Central Banks with less than four meeting minutes published per year were discarded from our count. [Table 1](#) presents this information regarding the number of meeting minutes published per year.

In an innovative way, we constructed the COVID intensity variable, which is composed of the frequency of the words “pandemic”, “covid”, “coronavirus”, “severe”, “drastically”, “dramatically” and

**Table 1**  
Monetary policy minutes by country per year.

Country	Monetary Authority	2020	2019	2018
Australia	Reserve Bank of Australia	12	11	11
Brazil	Central Bank of Brazil	8	8	8
Chile	Central Bank of Chile	9	7	8
Czech republic	Czech National Bank	9	8	8
Europe (Euro Area)	European Central Bank	9	8	8
Hungary	Magyar Nemzeti Bank	12	12	12
Iceland	Central Bank of Iceland	10	8	8
India	Reserve Bank of India	6	6	6
Indonesia	Bank Indonesia	12	8	8
Japan	Bank of Japan	9	8	8
New Zealand	Reserve Bank of New Zealand	4	4	4
Poland	Narodowy Bank Polski	12	11	11
South Africa	South African Reserve Bank	7	6	6
South Korea	Bank of Korea	9	8	8
Sweden	Sveriges riksbank	6	6	6
Turkey	Türkiye Cumhuriyet Merkez Bankası	10	8	9
United Kingdom	Bank of England	8	8	8
United States	The Federal Reserve	8	8	8

Source: authors' elaboration.

**Table 2**  
Number of coronavirus-related terms in Central Bank minutes.

Country	2020Q1	2020Q2	2020Q3	2020Q4
Australia	40	39	32	35
Brazil	4	10	5	2
Chile	5	9	6	10
Czech republic	7	5	4	16
Europe (Euro Area)	83	50	39	28
Hungary	20	43	28	41
Iceland	3	10	6	14
India	77	22	25	43
Indonesia	11	23	12	4
Japan	62	186	151	190
New Zealand	26	44	38	46
Poland	3	8	4	10
South Africa	7	5	5	2
South Korea	43	60	67	52
Sweden	14	22	41	27
Turkey	7	10	9	6
United Kingdom	36	66	46	65
United States	42	53	44	30

Source: authors' elaboration.

“worst” in the documents. Using a word count metric, we added up all occurrences of these terms per quarter. We transformed qualitative information into quantitative information, thereby making it possible to numerically measure these data and obtain the COVID intensity time series, which was later used in empirical models. [Table 2](#) displays the number of terms associated with the COVID-19 pandemic per Central Bank. As the main objective is to measure only the words concatenated to the pandemic, we disregarded the data obtained between the years 2018 and 2019 for two reasons: i) the purpose is to observe the discussion related to the pandemic in 2020 and ii) the values were practically zero in 2018 and 2019. This variable makes it possible to verify the intensity of the discussion about COVID-19 by each Central bank.

Building on the discussion outlined in the previous paragraph, we also designed [Table 3](#), which presents the relationship between the number of words related to the pandemic (extreme event) and the total number of words of uncertainty per country. By bringing this data to the fore, we did not seek to measure the relationship between discourses versus importance given to the COVID-19 pandemic by country. Its purpose is solely to present information regarding the presence of terms associated with COVID-19 in documents written by policymakers. It is possible to see a negative

**Table 3**  
Relationship between the number of pandemic-related words and the total number of uncertainty words per country.

Country	Uncertainty words	COVID-19 words	Percentage
Australia	415	151	36.38%
Brazil	194	21	10.82%
Chile	166	36	21.68%
Czech republic	157	34	21.65%
Europe (Euro Area)	751	201	26.76%
Hungary	304	132	43.42%
Iceland	178	33	18.54%
India	592	174	29.39%
Indonesia	102	38	37.25%
Japan	1080	593	54.9%
New Zealand	546	155	28.38%
Poland	57	25	43.85%
South Africa	147	19	12.92%
South Korea	447	225	50.33%
Sweden	583	108	18.52%
Turkey	239	32	13.38%
United Kingdom	793	216	27.24%
United States	798	171	21.43%

Source: authors' elaboration.

relationship between the number of cases and the percentage of words related to the pandemic in the documents analyzed. However, it is also necessary to consider the population size of the countries. It is crucial to highlight the fact that Brazil (one of the countries most affected by COVID-19 in the world) has given very little attention to the debate regarding the pandemic through the minutes of the Central Bank. Considering that we are referring to a document of extreme importance for the market and that reflects the vision of policymakers, this table provides some insights that can be used as input for future contextualization of this theme.

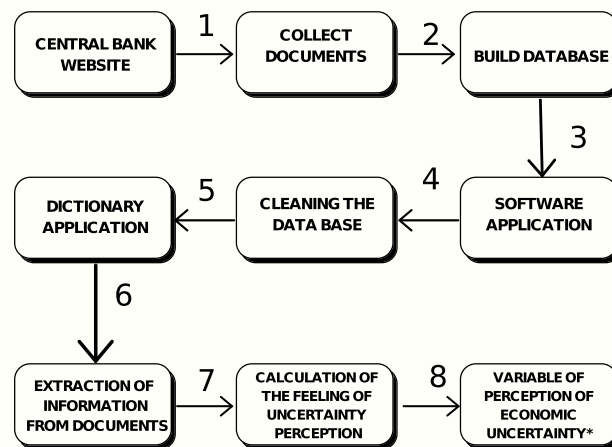
The macroeconomic data used in the empirical models was captured through the database from the Federal Reserve Economic Data (FRED) and from the Organization for Economic Co-operation and Development (OECD). Information regarding the number of COVID-19 cases and deaths was taken from the WHO Coronavirus Disease (COVID-19) Dashboard.<sup>5</sup> Finally, all variables used in the empirical exercise were standardized. Table 4 shows the descriptive statistics. It is essential to remember that all the data presented refer to the year of 2020, without considering the subsequent period.

Inflation averages 3.06 and has reached 22.37 in Turkey; the average COVID-19 mortality rate is 0.010 and has reached a maximum value of 0.1422. The COVID intensity variable has a mean of 10.82 and a standard deviation of 26.09, the minimum value of zero is linked to the observations for the quarter of 2018 and 2019, considering the fact that the COVID pandemic did not exist, so there would be no way to mention it in the analyzed documents. The period of analysis covers January 1, 2018, to December 31, 2020, the

**Table 4**  
Descriptive statistics.

Variable	Obs	Mean	SD	Min	Max
Inflation	216	3.062278	3.299588	-.847	22.37
Uncertainty perception	216	3.745713	1.62255	.5204914	11.54159
COVID uncertainty perception	216	4.398828	2.044213	.5204914	11.54159
Covid Intensity	216	10.82407	26.09886	0	190
COVID mortality rate	216	.0108679	.0229066	0	.1422737

Source: authors' elaboration.



**Fig. 1.** Indicator construction and estimation process.  
Source: Authors' elaboration

time series of this study are composed of 12 quarterly observations.

### 3. Indicator of perception of economic uncertainty

As discussed in the introduction, the inability to assign probability to future events makes it necessary to adopt non-traditional estimation techniques to measure economic uncertainty. In this study, the variables of perception of economic uncertainty were estimated using text regression and a dictionary. Fig. 1 presents the construction of the indicators of perception of economic uncertainty estimated in this research, the estimation procedure is performed twice for each Central Bank: i) variable that uses only the dictionary of uncertainty proposed by Loughran and McDonald (2011) and ii) variable with terms related to the extreme event is incorporated. Therefore, the only difference between the estimation processes is the word list. The steps described in Fig. 1 serve as a guide for the purposes of replication or construction of textual sentiment variables from dictionaries.

Initially, it is essential to access the website of the Central Bank in question and manually collect all the documents that will compose the analyzed sample (this procedure can also be carried out through web scraping. However, some Central Banks do not allow this direct extraction). After the document is captured, the entire database is organized chronologically. Sorting the documents is essential, because the software itself is not capable of sorting them and, when working with disordered data, the extracted information will be biased and will not correspond to

<sup>5</sup> Available at: <https://covid19.who.int/>.

reality. We use the R software during the entire process of estimating the variables. Despite making use of a machine learning technique, the algorithm needs supervision throughout the estimation procedure. It is crucial that it be working in perfect harmony with the software due to the fact that the latter is not able to handle the documents if these are not “ready” for the procedure. In other words, the algorithm is responsible for: converting documents into .txt files; cleaning; importing the dictionary so that only the selected words are counted; disregarding everything else that is not essential for the estimation; counting; and dealing with weight calculation and generation of the time series for each Central Bank.

It is mandatory to convert .PDF files into .txt files due to the restrictions that PDF presents; this allows the software to be able to count the words. After this step, we carry out cleaning procedure on the textual data: i) we transform the entire text into lower case, thus avoiding that the same word is counted in different ways (example: Risk, risk and RISK); ii) we remove numbers iii) we remove punctuation, iv) we remove double spaces and v) we remove line break, paragraph break and sample page. Cleaning the sample is essential: this prevents measurement errors by the software, since working with dirty documents will produce untrue results and consequently erroneous analyses.

The next stage consists in the application of the specific dictionary for the subject addressed. Thus, the algorithm extracts only the words related to the discussed hypothesis. All other words are disregarded because they have no value for the discussion about the perception of economic uncertainty. It is the dictionary that enables the information that measures the degree of perception of economic uncertainty per document. Having this individual information, the weighting of the words is used to calculate the weight of each of the terms locally (within the document) and globally (within every sample). Finally, through the method of text regression, we obtain the textual feeling of perception of economic uncertainty and economic uncertainty associated with COVID-19. We generated the two-time series observed in this work.

### 3.1. Sentiment calculation

The algorithm based on the weight metric of words proposed by Chisholm and Kolda (1999) was calibrated to calculate the local and global weight of each term within its own document and its weight in the entire sample. The application of a logarithm was carried out solely for the purpose of adjusting the frequency of terms in each document and eliminating possible outliers. The presence of outliers is expected in the documents in which the discussion about the pandemic begins. Despite that, these terms associated with COVID-19 will have their impact softened on the calculation of sentiment due to the metric used, which prevents the addition of words that increase the magnitude of the variables estimated in this work. Equation (1) calculates the weight of each word.

$$P_{ij} = \begin{cases} \frac{(1 + \log(Tf_{ij}))}{(1 + \log(a_j))} \log \frac{N}{df_i}, & \text{if } Tf_{ij} \geq 1 \\ 0 & \text{if } Tf_{ij} = 0 \end{cases} \quad (1)$$

where  $P_{ij}$  depicts the weight of the word  $i$  in the document  $j$ ;  $Tf_i$  represents the frequency of a term  $i$  in the document  $j$ ;  $a_j$  is the average of the frequency of words present in the text  $j^6$ ;  $N$  is the total text in the sample and;  $df_i$  represents the total number of

<sup>6</sup> The average frequency of the observed words obtained through the equation:  $a_j = \frac{1}{n} \sum_{i=0}^n FP_j$ , where  $n$  represents the number of terms considered in the study in question;  $FP$  is the frequency of words appearing in the text  $j$ .

documents with at least one occurrence of the word  $i$ .

By obtaining the individual weight of each word of economic uncertainty present in the minutes of the Central Bank of a given country, it is possible, with this information, to estimate the individual textual sentiment of that document. To obtain this sentiment, Equation (2) is applied.

$$WPEU_j = \sum \text{Weight of words perception of economic uncertainty} \quad (2)$$

Where the term  $WPEU_j$  is the textual sentiment of perceived economic uncertainty of the document  $j$ .

The time series of the Central Banks are obtained by grouping the individual sentiment of each document. We built eighteen indicators which were capable of measuring the perception of economic uncertainty through the optics of policymakers and other eighteen indicators that measure the same perception with the addition of the effect of COVID-19 over the period from January 1, 2018 to December 31, 2020.

## 4. Empirical strategy

This section has the sole purpose of simulating some empirical exercises; it is known that methodologically it is necessary to work better on the weighting of variables in order to verify macroeconomic impacts. But since this is not the main purpose of this article, this section is limited to the idea of showing the dimension of the effects generated by both variables of perception of uncertainty that were constructed in this research.

### 4.1. Inflationary dynamics

The first empirical exercise consists in the observation of a simple inflation model. To do so, a simulation of the relationship between inflation and the variables of uncertainty perception was performed using a fixed effect estimator.<sup>7</sup> Two fixed effect models were calibrated for panel data for the eighteen countries with a view to capturing the functioning of the inflationary dynamics. As previously mentioned, one of the models incorporated the variable of perception of economic uncertainty in its “pure” form and the other the variable of perception of economic uncertainty plus terms related to the COVID-19 pandemic. equation (3) represents this dynamic.

$$\pi_{it} = \gamma_0 + \alpha_i + \gamma_1 \pi_{it-1} + \gamma_2 U_{ncerit} + \varepsilon_{it} \quad (3)$$

Where  $\pi_t$  is the inflation of country  $i$  in  $t$ ,  $\gamma_0$  a constant,  $\alpha_i$  the idiosyncratic effect for country  $i$   $\pi_{it-1}$  country's inflation rate  $i$  in the previous period,  $U_{ncerit}$  is the economic uncertainty perception variable estimated in this work only with the list of uncertainty words proposed by Loughran and McDonald (2011) and  $\varepsilon_{it}$  is the error term.

Equation (4) follows the same association with Equation (3), adding the variable of perception of economic uncertainty associated with COVID-19.

$$\pi_{it} = \gamma_0 + \alpha_i + \gamma_1 \pi_{it-1} + \gamma_2 U_{ncerCOVIDit} + \varepsilon_{it} \quad (4)$$

Where  $U_{ncerCOVIDit}$  is the variable of perception of economic uncertainty estimated from the addition of terms related to the extreme event.

<sup>7</sup> All models and variables of this study passed the specification tests (variable stationarity and error autocorrelation tests), the results will not be presented here because it is not the objective.

**Table 5**  
Results of FE and FE-IV model.

Variable	Model I	Model II	Model III
<b>Uncertainty</b>	-0.1717***	—	—
<b>Uncertainty_Covid</b>	—	-0.2329***	-0.4149***
<b>Inflation<sub>t-1</sub></b>	0.4691***	0.4493***	0.4185***
<b>Constant</b>	-0.0040	0.0045	0.0080
<b>Obs</b>	198	198	198
<b>R2</b>	0.4271	0.4127	0.3283
<b>Legend:</b>	*p < .1	**p < .05	***p < .01

Source: authors' elaboration.

The results of Equations (3) and (4) can be seen in Table 5. However, the mechanics between inflation and economic uncertainty are defined by a negative correlation. Despite this, there is currently no evidence to determine who influences whom. Hypothetically, both variables influence each other mutually. Forbes (2016), when discussing the effect of uncertainty on the economic agent's decision, mentions the probable endogeneity between economic uncertainty and inflation. This means that the two variables of perception of economic uncertainty may be directly interfering with inflationary expectations and vice versa. In order to

circumvent this possible endogeneity problem, we estimated a model of instrumental variables of fixed effects (FE-IV) for panel data with the variable of perception of economic uncertainty associated with the COVID-19 pandemic. The COVID-19 mortality rate in 2020 and the COVID intensity indicator are used as instruments.

4.2. FE-IV

The model with instrumental variables (FE-IV) in which we instrumented the indicator of perception of economic uncertainty from the perspective of policymakers associated with the extreme event by variables that capture the dimension of COVID-19 in 2020. The following representation follows:

First Stage:

$$Uncertainty_{COVID_{it}} = \beta_0 + \beta_1 Z_{it} + \beta_t + \epsilon_{it} \tag{5}$$

Where:  $Z_{it}$  is a vector of instruments formed by two indicators (Intensity of COVID-19 and Mortality rate of COVID-19 in 2020) that measure the pandemic in each country in 2020. The COVID variable intensity is measured by the number of citations of terms associated with extreme events in each quarterly document, and the



**Fig. 2.** Comparison of uncertainty perception variables.  
Source: authors' elaboration.

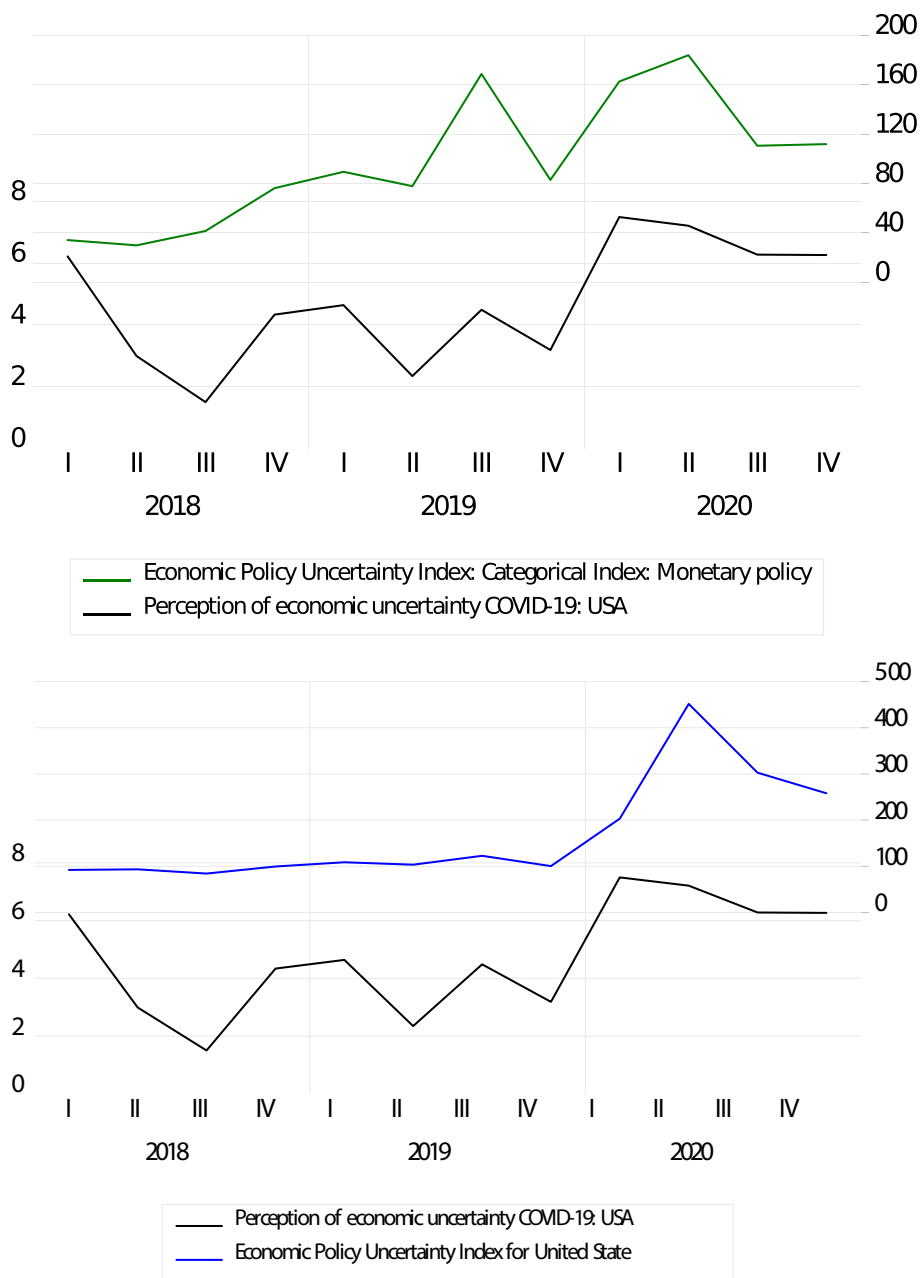


Fig. 3. USA comparative  
 Fonte: Authors' elaboration.

COVID-19 death rate ( $\frac{N^\circ \text{ total of deaths}}{N^\circ \text{ total of cases}}$ ) which is the number of deaths related to COVID-19 in the country in 2020.<sup>8</sup>

Second Stage:

$$\pi_{it} = \gamma_0 + \gamma_1 \pi_{it-1} + \dots + \gamma_n \pi_{it-n} + \varphi_2 \widehat{Uncertainty}_{COVIDit} + \varepsilon_{it} \tag{6}$$

where:  $\widehat{Uncertainty}_{COVIDit}$  is the perception of uncertainty associated with COVID-19 estimated at the first stage.

### 5. Results

#### 5.1. Corrected economic uncertainty perception variable

The addition of conjunctural terms associated with the extreme event, which in the case of this research is the COVID-19 pandemic, enhanced the results. Fig. 2 shows a comparison between the two variables of perception of economic uncertainty built in this work. As one can see, until December 2019 both trajectories are superimposed. The difference is observed from the first quarter of 2020. We can see the magnitude of this effect and how much it intensified the perception of uncertainty on the part of policymakers throughout 2020. It is evident that COVID-19 acts as an accelerator

<sup>8</sup> In the case of the European Central Bank, all countries that make part of it.



on the perception of uncertainty.

The unexpected shock of uncertainty caused by the pandemic causes the variable that considered the terms concatenated with the extreme event to show a significant increase in all countries observed. The magnitude, however, depends on the importance each country has given to the theme. For example, countries that paid more attention to the pandemic in their Monetary Policy documents showed greater disparity: Australia, the United States, Japan, the United Kingdom and the Eurozone. On the other hand, countries that did not devote so much attention exhibited closer indices, in this case: Brazil, Chile, Poland, South Africa and Turkey.

The exposed data corroborates the hypothesis raised in this work. It is necessary to correct the estimation process of textual sentiment variables under the effect of an extreme event, be it local or global. The words used influence the estimation of sentiment directly and, consequently, the capture of the necessary information. Disregarding them causes the underestimation of the real impact of the extreme event on the perception of economic uncertainty. Consequently, policymakers might end up making wrong decisions due to the asymmetry of existing information since the data set will be providing biased information and the formulator, by acting more aggressively in these situations, might turn out to choose a policy that may not be enough to combat such aggressive effects, thus prolonging an economy's cycle of recession.

### 5.2. Inflation dynamics simulation

The coefficients of the three models estimated in this work can be seen in Table 5. As expected, uncertainty has a negative effect on inflation; increasing values of one variable are associated with decreasing values of the other variable. Model I (FE Uncertainty), which included only the uncertainty perception variable estimated with terms from the dictionary proposed by Loughran and McDonald (2011), presented a result of  $-0.1717$ , which means that a change of standard deviation in the economic uncertainty perception variable will result in a reduction of 0.1717 standard deviation in inflation. In turn, model II (FE Uncertainty\_Covid) which started to incorporate the terms related to the COVID-19 pandemic in its construction process, exhibited an effect

of  $-0.2329$ . The change in standard deviation in this variable will imply a reduction of 0.2329 standard deviation in inflation. Now, considering the instrumental variables, model III (FE-IV Uncertainty\_Covid) had an effect of  $-0.4149$ , that is, the variation in the standard deviation in the variable of perception of economic uncertainty associated with COVID-19 will imply a reduction of 0.4149 in the standard deviation of inflation. The simulation of inflationary dynamics corroborates the previous debate. The results confirm that the variable estimated without the terms related to the extreme event is underestimating the effects of uncertainty on inflation. Despite maintaining the direction of the expected signal, the coefficient of the variable that did not incorporate terms related to the extreme event is smaller in terms of magnitude and the statistical significance is low.

The empirical literature presents studies that show that the greater the economic uncertainty, the greater the postponement of decisions regarding consumption, production and investment and, consequently, the lower the inflation. Baker et al. (2016) identified a negative relationship between uncertainty and investment. Istrefi and Piloiu (2014) show that inflation expectations are sensitive to uncertainty shocks.

Negative expectations are fueled, both by economic agents and by policymakers. As long as uncertainty is high, this process occurs continuously. However, the discussion in this work is centered on the perception of uncertainty on the part of policymakers. Schymura (2017) avers that because of their effect on economic agents, uncertainty shocks have negative impacts on monetary policy, thereby increasing its sensitivity and compromising its efficiency. Thus, when performing an empirical simulation exercise, one notices that the effect of uncertainty - which is extremely significant - is being ignored. Policymakers, in addition to all pressure they are already under, start to deal with the stress of the extreme event. Therefore, if the results are biased (underestimated or overestimated) the conduct of monetary policy may not be efficient and not work, in some circumstances it may even aggravate the situation.

The negative expectations of economic agents can end up becoming a problem for those who formulate these policies, due to their adaptive nature. The greater the their negative degree, the

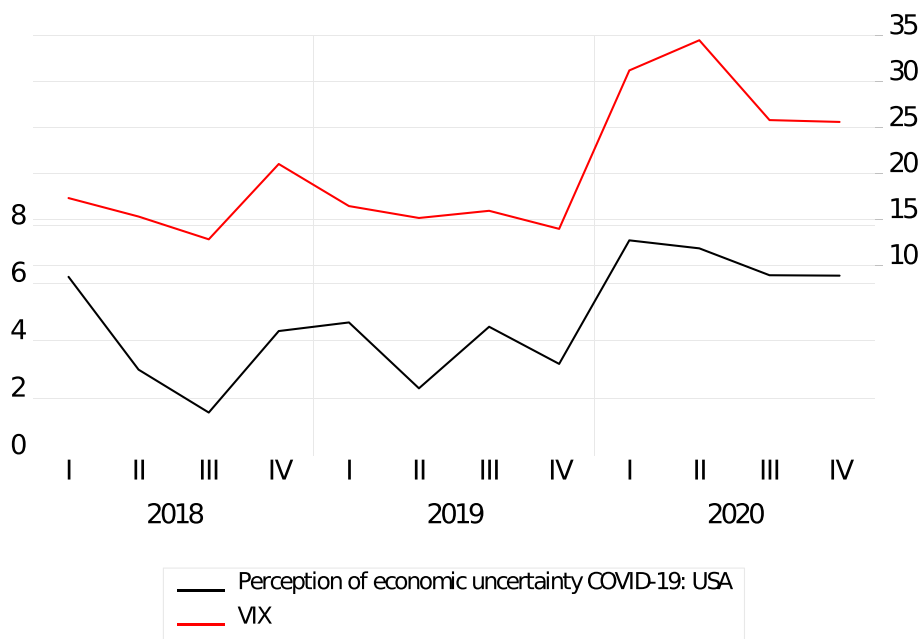


Fig. 3. (continued).

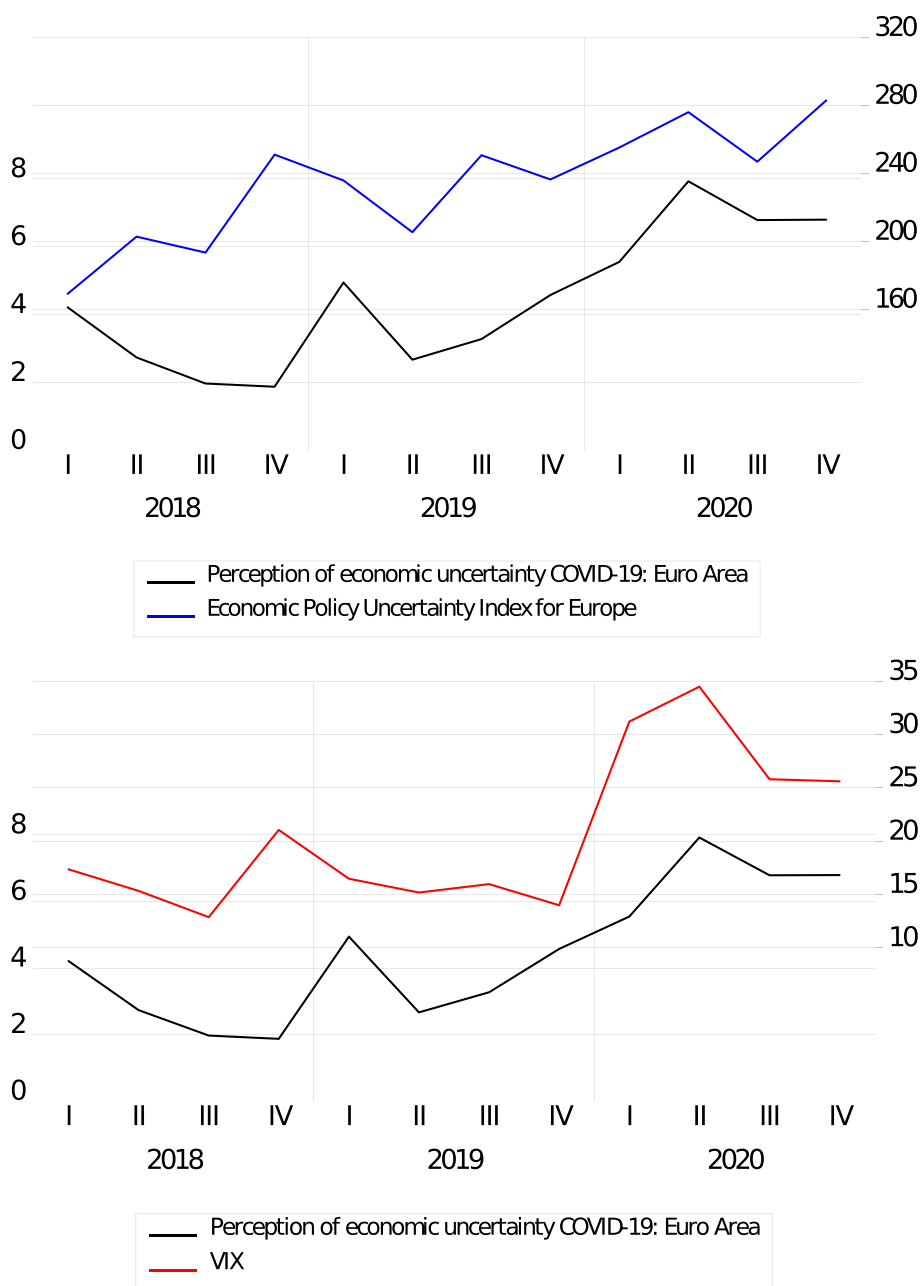


Fig. 4. Euro Area comparative  
 Fonte: Authors' elaboration.

greater the possibility of them becoming irreversible and, consequently, compromising the efficiency of economic policies. Chang and Velasco (2020) found that the success of economic policies implemented during the pandemic is directly related to people's expectations of future policies.

The results found show the importance of including the conjunctural information in the variable of perception of economic uncertainty constructed in this work. Thus, when performing

estimates involving text regression methods, it is necessary to incorporate terms associated with extreme events capable of altering the local or global conjuncture because discarding these additional data, may underestimate or overestimate the results obtained, which might compromise the analysis performed and return inefficient inputs for policymakers. In the case of this work, the COVID-19 pandemic acted as a real catalyst and potentialized the effects on the perception of economic uncertainty. With that in

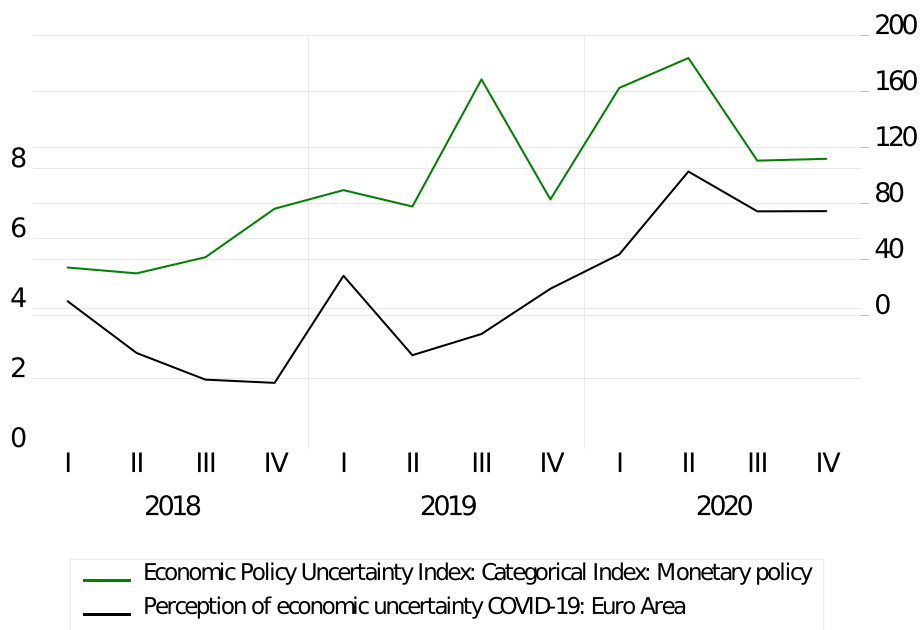


Fig. 4. (continued).

mind, the effect on inflation was also intensified, as verified in the simulation carried out in models II and III.

### 6. Robustness

With the purpose of verifying the robustness of the constructed variables, some of the variables in this work were compared with other measurements of uncertainty consolidated in the literature: i) Economic Policy Uncertainty Index: Categorical Index: Monetary policy; ii) Economic Policy Uncertainty Index and iii) VIX - CBOE Volatility Index. For this exercise, only the indicators constructed for the United States, Euro Area and South Korea were used. We decided to work with these countries on the grounds that they encompass data from three continents, thereby providing a good sample.<sup>9</sup> The results can be seen in Figs. 3–5.

The Economic Policy Uncertainty Index: Categorical Index: Monetary policy and the Economic Policy Uncertainty Index are constructed by Baker et al. (2016) who use newspapers that discuss monetary policy uncertainty and economic policy uncertainty. The authors defined a specific set of detailed terms capable of performing this measurement. Both indicators are currently quite consolidated and are frequently used in works that uncertainty into account (to name a few here). The VIX - CBOE Volatility Index or just the VIX index is known as the fear of markets index and measures the market volatility which arises from the expectations of the S&P 500. One considers the VIX a powerful tool capable of measuring the risk and sentiment of the investors, especially in extreme scenarios.

The economic uncertainty perception variable constructed for the US compared to the MPU, EPU and VIX indices, as can be seen in Fig. 3, showed a similar behavior with the same trend from the fourth quarter of 2019 onwards. However, when compared with the MPU and EPU, there is a slight mismatch in the first three quarters of 2018. The same thing does not happen with the VIX. This shows particular elements of our index and that can be explained by a more conservative posture of the policy makers than that of the

newspapers from which indexes are extracted. Regarding Fig. 4, which repeats this same exercise for the Euro Area, the behavior is similar to what was discussed for the United States. However, the divergence appears in the third quarter of 2019 when the indicators show a fall followed by an increase. This once again can be explained by characteristic components of our variable. Finally, Fig. 5 relates our variable with indicators for South Korea. The trajectory and behavior are similar over the years 2019 and 2020. A relevant mismatch is seen in the first year though. As can be seen in all the comparisons presented, the variable constructed in this work captures the environment of uncertainty generated by the COVID-19 pandemic more precisely.

Regarding variables constructed solely from documents from Monetary Policy meetings, their performance was quite satisfactory. It is known that documents are subject to possible bias, such as the perception of the writer due to the economic situation and the sudden change in posture due to growing uncertainty. Adding the terms related to the extreme event (COVID-19 pandemic) provided an approximation of reality between the perception of uncertainty and the Monetary Policy Uncertainty, Economic Policy Uncertainty and VIX indicators.

### 7. Final considerations

Measuring the scale of the economic impact of the COVID-19 pandemic will only be possible in a few years. In this work, in order to capture the effect provided by COVID-19 on the perception of policymakers, terms associated with the pandemic were incorporated into the list of uncertainty words proposed by Loughran and McDonald (2011), which is used to estimate the perception of economic uncertainty. It was found that the pandemic acted as a real accelerator on the perception of economic uncertainty and disregarding the possible impact that extreme events (whether local or global) may have on this type of analysis might result in biased information, which does not reflect the reality. Researchers and/or policy makers are likely to underestimate or overestimate the result of their analyses and, consequently, their economic policy solutions may be inefficient. The robustness exercise that simulate the inflationary dynamics revealed that the uncertainty associated

<sup>9</sup> Performing the exercise for the eighteen countries would make the article huge.

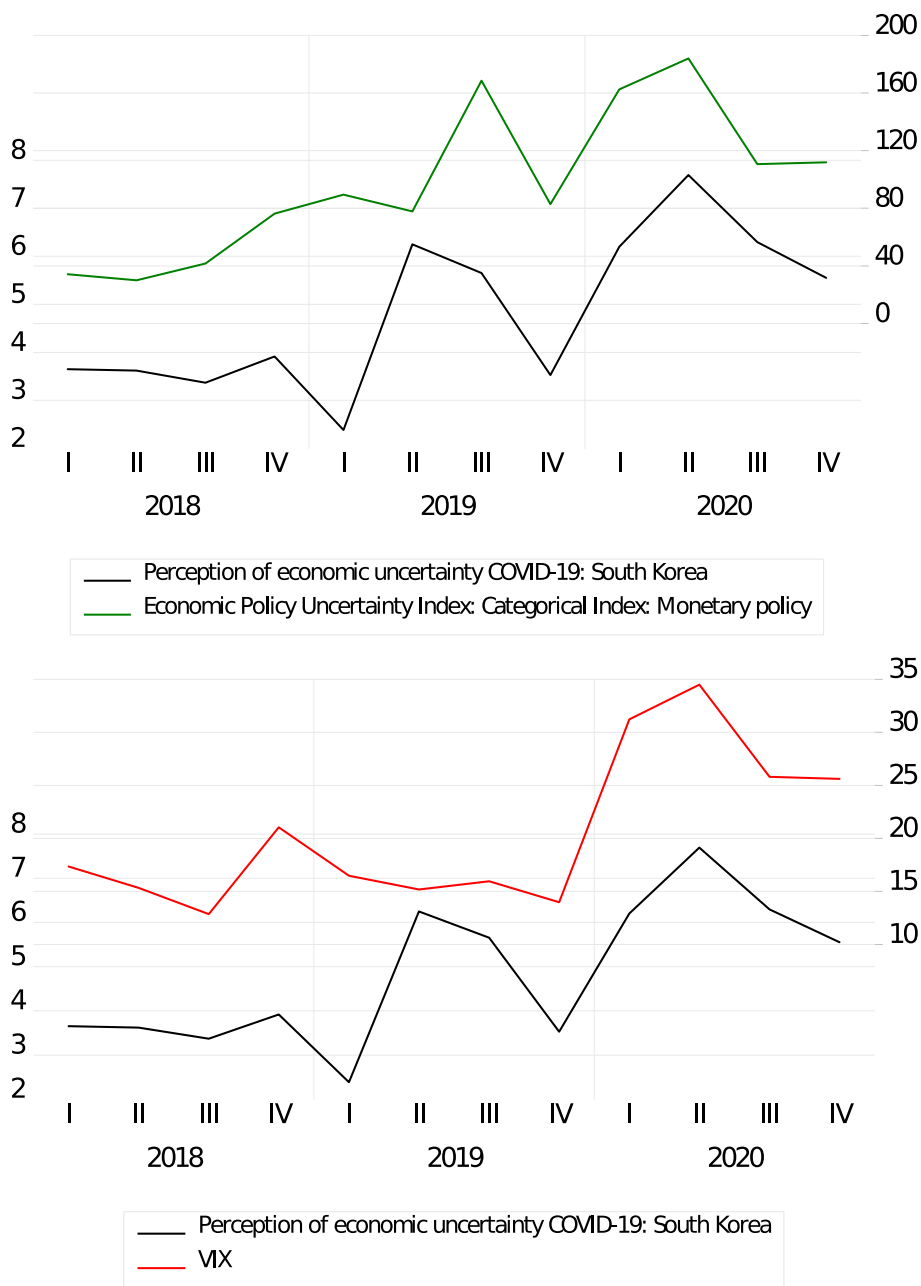


Fig. 5. South Korea comparative  
Fonte: Authors' elaboration.

with the pandemic has a greater impact on inflation.

It is expected that, in an extreme scenario, a change of posture will occur. As well observed by Cieslak et al. (2021), policymakers act aggressively to avoid costly endogenous results to their political actions. Therefore, the inflationary uncertainty of these formulators is correlated with their expectations (which may be distorted) about the rise in inflation and, therefore, the adopted monetary policy may be inefficient to promote the recovery of the economy. However, if policymakers wait too long to make a decision in order to try to read the situation better, new expectations may have been formulated and this would make monetary policy inefficient in relation to production and consumption. Despite conducting policies in a scenario fraught with inevitable uncertainty, Cecchetti

and Schoenholtz (2021) reminds us that policymakers can and should reduce the uncertainty they themselves create.

Finally, it is essential to state that the final purpose of this work is not to measure the quantitative impact of the pandemic based on qualitative information. But rather, expose the need to incorporate terms related to a particular event that can change the local or global conjuncture when performing estimations that involve textual sentiment analysis, thus reducing the asymmetry of information created by such an event. When talking about the magnitude of the effect in the results section, this is linked solely to the attention given to the COVID-19 pandemic by the perception of formulators in their monetary policy documents and not to the actions and measures on the part of each Government. We only

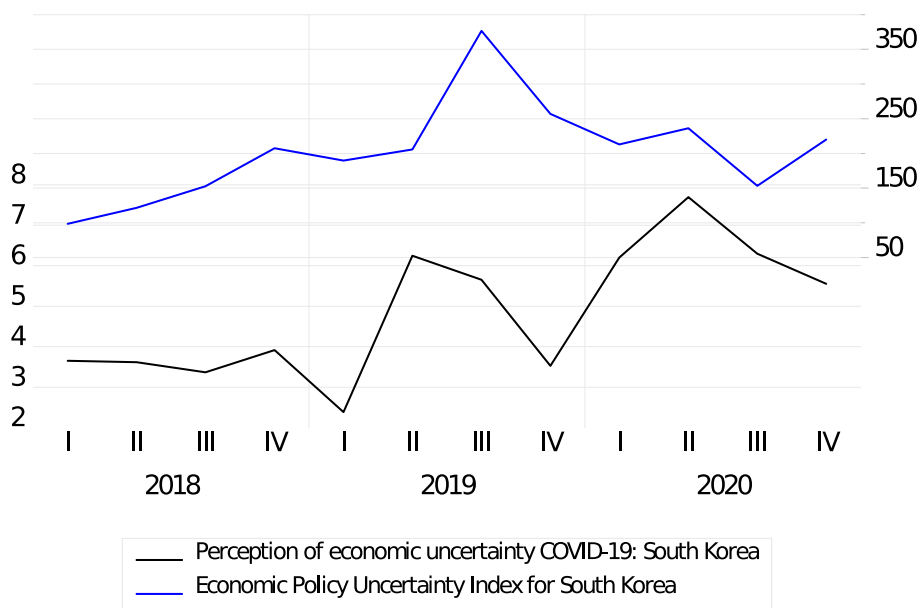


Fig. 5. (continued).

sought to present a relationship between this information and not point out a possible causality. The empirical exercises were applied solely to corroborate the hypothesis discussed above: the effects were likely to be underestimated or overestimated. However, for a study that aims to accurately measure the qualitative impact of the pandemic on macroeconomic indicators, it is necessary to include weighting components when constructing uncertainty variables. Using just a few words might render this assessment incomplete.

For future work, we suggest incorporating terms related to a particular episode whenever one carries out a study that involves analysis of textual sentiment in events capable of altering the local or global scenario. Clearly, by ignoring this information, one's conclusions are liable to be biased. It is also possible, due to the ease with which news are disseminated, to create indicators from unstructured data capable of observing this information in real time and providing analyzes that are closer to the conjunctural reality.

**Declaration of interest**

The authors declare that they have no conflict of interest.

**Availability of data and material**

Yes.

**Code availability**

Yes.

**Declaration of competing interest**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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**APPENDIX A. Loughran-McDonald: list of uncertainty words**

Abeyance, abeyances, almost, alteration, alterations, ambiguities, ambiguity, ambiguous, anomalies, anomalous, anomalously, anomaly, anticipate, anticipated, anticipates, anticipating, anticipation, anticipations, apparent, apparently, appear, appeared, appearing, appears, approximate, approximated, approximately, approximates, approximating, approximation, approximations, arbitrarily, arbitrariness, arbitrary, assume, assumed, assumes, assuming, assumption, assumptions, believe, believed, believes, believing, cautious, cautiously, cautiousness, clarification, clarifications, conceivable, conceivably, conditional, conditionally, confuses, confusing, confusingly, confusion, contingencies, contingency, contingent, contingently, contingents, could, crossroad, crossroads, depend, depended, dependence, dependencies, dependency, dependent, depending, depends, destabilizing, deviate, deviated, deviates, deviating, deviation, deviations, differ, differed, differing, differs, doubt, doubted, doubtful, doubts, exposure, exposures, fluctuate, fluctuated, fluctuates, fluctuating, fluctuation, fluctuations, hidden, hinges, imprecise, imprecision, imprecisions, improbability, improbable, incompleteness, indefinite, indefinitely, indefiniteness, indeterminable, indeterminate, inexact, inexactness, instabilities, instability, intangible, intangibles, likelihood, may, maybe, might, nearly, nonassessable, occasionally, ordinarily, pending, perhaps, possibilities, possibility, possible, possibly, precaution, precautionary, precautions, predict, predictability, predicted, predicting, prediction, predictions, predictive, predictor, predictors, predicts, preliminarily, preliminary, presumably, presume, presumed, presumes, presuming, presumption, presumptions, probabilistic, probabilities, probability, probable, probably, random, randomize, randomized, randomizes, randomizing, randomly, randomness, reassess, reassessed, reassesses, reassessing, reassessment, reassessments, recalculate, recalculated, recalculates, recalculating, recalculation, recalculations, reconsider, reconsidered, reconsidering, reconsiders, reexamination, reexamine, reexamining, reinterpret, reinterpretation, reinterpretations, reinterpreted, reinterpreting, reinterprets, revise, revised, risk, risked, riskier, riskiest, riskiness, risking, risks, risky, roughly, rumors, seems, seldom, seldomly, sometime, sometimes, somewhat, somewhere, speculate, speculated, speculates,

speculating, speculation, speculations, speculative, speculatively, sporadic, sporadically, sudden, suddenly, suggest, suggested, suggesting, suggests, susceptibility, tending, tentative, tentatively, turbulence, uncertain, uncertainly, uncertainties, uncertainty, unclear, unconfirmed, undecided, undefined, undesigned, undetectable, undeterminable, undetermined, undocumented, unexpected, unexpectedly, unfamiliar, unfamiliarity, unforecasted, unforeseen, unguaranteed, unhedged, unidentifiable, unidentified, unknown, unknowns, unobservable, unplanned, unpredictability, unpredictable, unpredictably, unpredicted, unproved, unproven, unquantifiable, unquantified, unreconciled, unseasonable, unseasonably, unsettled, unspecific, unspecified, untested, unusual, unusually, unwritten, vagaries, vague, vaguely, vagueness, vaguenesses, vaguer, vaguest, variability, variable, variables, variably, variance, variances, variant, variants, variation, variations, varied, varies, vary, varying, volatile, volatilities, volatility.

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