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Abstract

We construct a new newspaper-based sentiment indicator for Spain that allows us to monitor Spanish economic activity in real-time. As opposed to the traditional survey-based confidence indicators that are released at the end of the month, our indicator can be constructed on a daily basis and updated in real-time. We compare our proposed index with the popular Economic Sentiment Indicator of the European Commission, and we show that ours performs significantly better in nowcasting the Spanish GDP. In addition, our indicator proves to be helpful in order to predict the current COVID-19 recession from an earlier date. All in all, our indicator performs similarly to or even outperforms other soft indicators, with the advantage of being updated daily. Thus, it provides a valuable option when measuring the confidence in the economy.

Keywords: nowcasting, GDP, recession, real-time, textual analysis, sentiment indicators, soft indicators.

JEL classification: E32, E37, C53, C23.

Resumen

Se propone un nuevo indicador de sentimiento basado en noticias de periódicos que permite analizar, en tiempo real, la evolución de la actividad económica en España. A diferencia de los indicadores de confianza tradicionales que se publican a fin de mes, nuestro indicador puede construirse con frecuencia diaria y actualizarse en tiempo real. Se compara el nuevo indicador con el indicador de sentimiento económico que publica la Comisión Europea, y se obtiene una mejora significativa al incluirlo en un modelo de previsión de crecimiento de corto plazo del PIB, respecto a la previsión que se obtiene cuando se utiliza el índice tradicional. Asimismo, nuestro indicador identifica la recesión económica causada por el Covid-19 con una mayor anticipación. En conjunto, el nuevo indicador tiene un desempeño similar al de otros indicadores cualitativos, o incluso los mejora, con la ventaja de que puede actualizarse diariamente. Por todo ello, el índice propuesto surge como una alternativa valiosa para medir la confianza en la evolución de la economía.

Palabras clave: previsión a corto plazo, PIB, recesión, tiempo real, análisis textual, indicadores de sentimiento, indicadores cualitativos.

Códigos JEL: E32, E37, C53, C23.

1 Introduction

Benchmark data to assess activity are normally provided by the national accounts and are available at a quarterly frequency. Nevertheless, there usually exists a significant publication lag of, typically, at least 30 days after the quarter of reference has ended. More timely data is usually published in the form of economic indicators, both covering quantitative information (so-called "hard" indicators) and qualitative information provided by agent surveys of sentiment and plans (so-called "soft" indicators). These standard leading indicators, used by practitioners and academics alike, are typically available with a short delay, and are available at a monthly frequency (see Giannone et al., 2009 or Keeney et al., 2012). Technological progress has enabled the development of other sources of data usable for monitoring real-time economic activity, in particular, indicators based on textual analysis, including news media (see Shapiro et al., 2020, Thorsrud, 2016, 2020 and many others). Following this line of research, this paper proposes a new daily economic news sentiment indicator (DENSI) based on newspaper data for Spain as an alternative measure of economic confidence, which can be constructed at daily frequencies and it is shown to better help the nowcasting of Spanish GDP growth than a widely used popular confidence indicator —i.e. the Economic Sentiment Indicator (ESI)[1] published by the European Commission (EC)—. To construct our measure we rely on Boolean searches,[2] which boils down to counting the frequencies of specific words in the text, a quite popular procedure in the recent literature: for instance, see the influential economic policy uncertainty (EPU) index by Baker et al. (2016).[3]

Our indicator, as it is the case for many other textual based indicators, could potentially be interpreted as a measure of economic confidence and, therefore, compared with other confidence indicators, which are mostly survey-based. Survey-based confidence indicators are probably among the most useful soft indicators available to make an assessment of the general economic situation. They reflect agents' perceptions regarding the present and future economic situation. Indeed, for each particular country, confidence indicators are highly correlated with GDP growth (e.g. see the ESI). However, the COVID-19 crisis has put some of these indicators' weaknesses in the spotlight.

[1] The ESI is built as a composite of five different confidence indicators using the following weights: 40% for industry, 5% for construction, 30% for services, 20% for consumers, 5% for retail.

[2] Alternatively, it would be possible to rely on natural language processes in order to extract the "sentiment" or the topics characterizing the news (e.g., Shapiro et al., 2020, Thorsrud, 2020, 2016).

[3] Following this procedure, a number of EPU indexes have been developed for many countries (e.g. Ghirelli et al., 2019 for Spain) and has been used in a number of empirical applications (e.g. Colombo, 2013, Caggiano et al., 2017, Fontaine et al., 2017, Meinen and Roehe, 2017).

First, most confidence indicators rely on surveys that are conducted during (at most) the first part of the reference month (for instance the ESIs surveys are carried out in the first three weeks of the reference month),[4] while results are released during the last week of that month. In general, this strategy would not cause any problem, but if a significant shock occurs during the second half of the month, the confidence indicators would not reflect it (Shapiro et al., 2020).

Second, as for any survey, its accuracy largely depends on the survey's responses rates and, when these are not high enough, potential sampling problems can emerge, especially during some particular situations (Ludvigson, 2004). Both of these problems have simultaneously emerged during the COVID-19 outbreak, given it started to affect most European countries during the second half of March and due to the difficulty of carrying out the surveys during the lockdown. This situation became evident in the ESI release for March 2020. For instance, the value of the ESI for March did not reflect the pandemic crisis outbreak that started in the middle of the month,[5] but instead remained at the optimistic levels reached in the previous months (see the March 2020 observation in the blue line in Figure 1). Moreover, for the case of Italy, the EC announced that no data could be collected for the month of April due to the strict confinement measures.

A third issue is that survey-based confidence indicators can show some specific bias along the business cycle. According to Gayer and Marc (2018), this could happen, for example, if business managers and consumers adapt their economic expectations to a more modest growth. Such a bias became evident at the end of the Great Recession, when average economic growth was significantly lower than that observed during the pre-crisis period but the ESI stood at similar average levels in both periods.[6] This bias is evident in Figure 1: from 2015, the ESI frequently had values in the 75–90th percentile of its own distribution, probably being over-optimistic. Figure 1 also confirms that this bias is not present in our proposed indicator. Its dynamics, instead, correctly reflect the moderate growth of the GDP during the last recovery, as opposed to that observed in the pre-crisis period. A reason for the presence of this bias in survey-based indicators may be the possibility that respondents base their perceptions of the economic situation on a cross-section comparison, i.e., ignoring the historical perspective. In contrast, when journalists write an article about the economic situation of a country, they

[4] For example, during the month of March 2020, the ESI surveys of consumers, the service sector, and the retail sector were carried out between the 2nd and the 12th of March, while the surveys of the industry sector and the construction sector were carried out between the 2nd and the 23rd of March.

[5] Spain was locked down on the 14th of March 2020.

[6] The average annual GDP growth rate between 2000 and 2007 was around 3.7% and diminished to 2.6% during the 2014–2019 period. Analyzing the same periods, the average levels for the ESI were, respectively, 105.5 and 106.3 points.

typically make an historical assessment, which may explain why our news-based indicator does not show such a bias.

Dealing with these weaknesses, our proposed indicator based on newspaper articles emerges as an alternative confidence indicator, especially since the COVID-19 pandemic crisis. Newspaper articles may be a useful data source for constructing confidence indicators to assess the current economic situation, for two main reasons: first, the press (especially financial newspapers or the economic sections of generalist newspapers) provides a daily picture of the economic developments of a country; second, since newspapers are published every day, this allows constructing real-time indicators at high (daily) frequencies. Finally, text-based sentiment measures can be developed at a very low cost relative to survey-based measures.

When proposing the new confidence indicator, we will focus on the Spanish case. Therefore, we rely on a large database of Spanish press and construct a sentiment indicator that reflects the economic tone of news articles in the short-run. In a nutshell, our indicator reflects the balance between the number of news articles that contain keywords related to upturns and downturns of the Spanish business cycle. The new proposed indicator closely follows the dynamics shown by the ESI. Nonetheless, in contrast to the ESI, in March 2020 the DENSI drops to the level of the Great Recession, which appears to be a more correct description of the economic outlook given the start of the pandemic crisis.

In order to analyze whether the DENSI could do a better job than survey-based confidence indicators regarding the assessment of the current economic situation, we perform two different—but related—exercises. First, relying on mixed-frequency bivariate vector autoregressive (MF-BiVAR) models, we show that a model including both the DENSI and GDP significantly improves the GDP forecast accuracy when compared to a model that includes the ESI and GDP as the main variables. This result suggests that the DENSI could provide a better signal for an earlier evaluation of the economic situation than the ESI. Second, we use both indicators to compute the implied probability of recessions at short-term horizons. Result show that the DENSI does better than the ESI in predicting the business cycle turning points in the short-run.

A number of papers have constructed text-based measures of economic activity. The latter are becoming increasingly popular because they are real time measures (Shapiro et al., 2020). E.g., Calomiris and Mamaysky (2019) use news articles to predict risk and return in stock markets, while Fraiberger (2016) constructs a sentiment index based on the economic news articles produced by Reuters. Nyman et al. (2018) exploit financial market text-based data to predict financial system distress. Thorsrud (2020, 2016) show that the information contained in the main Norwegian business newspapers articles improves the GDP nowcast. Our paper is closely

related to Combes et al. (2018) and Shapiro et al. (2020). The first authors, who focused on France, construct a sentiment indicator of economic activity based on news published in *Le Monde*, the main generalist French newspaper, and show that the index helps to improve the short-term GDP forecast and nowcast. In particular, their textual indicator improves forecasting compared to a simple autoregressive model and an autoregressive model augmented with the survey-based Insee Business Climate indicator.[7] Shapiro et al. (2020) develop an indicator of economic sentiment based on economic and financial newspaper articles and show that daily news sentiment is predictive of movements of survey-based measures of consumer sentiment. In particular, they estimate impulse responses of the main macroeconomic variables to shocks in economic sentiment and find that positive shocks in economic sentiment increase consumption, output, and interest rates, whereas they dampen inflation. Therefore, they claim that newspaper-based sentiment indicators provide useful signals of economic activity at a very low cost relative to survey-based measures.

We contribute to this literature by proposing a new newspaper-based sentiment indicator for Spain, which could be obtained on a daily basis at any point during the month. Moreover, we provide evidence that newspaper-based indicators can better deal with the aforementioned limitations, which are typical of survey-based confidence indicators (i.e., (i) the monthly value refers only to the first half of each month; (ii) potential sampling problems due to a lower response rate; (iii) potential bias along business cycles). Finally, in line with the previously mentioned literature, we also show that newspaper-based confidence indicators can improve classical confidence indicator measures when assessing more recent economic developments.

The rest of the paper is organized as follows. In Section 2, we describe our DENSI. Section 3 presents two empirical applications in which we compare the predictive power of the ESI and the DENSI. Section 4 offers some concluding remarks.

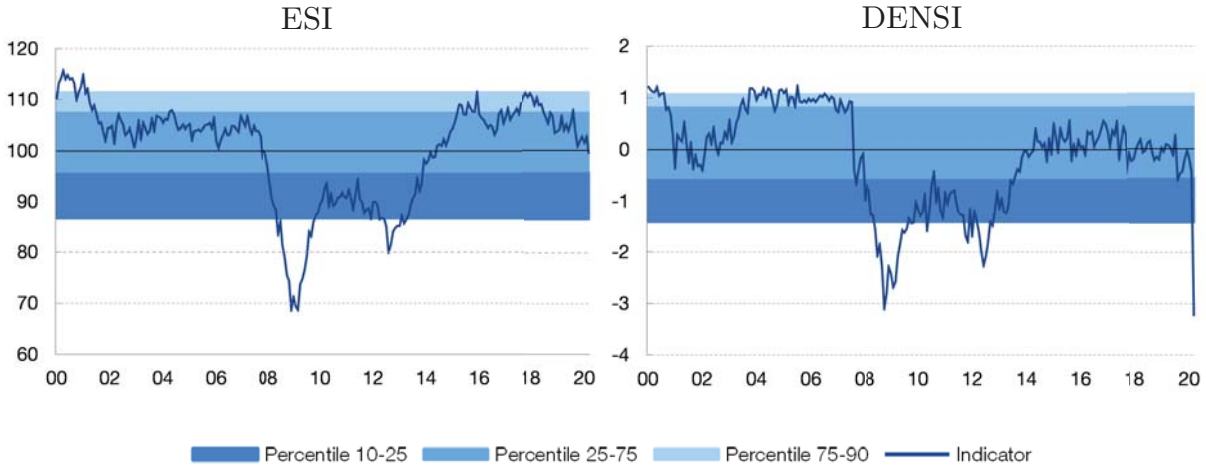
2 Description of the index

We build a sentiment indicator capturing the economic tone of news articles published in the Spanish press. In a nutshell, our indicator reflects the balance between the number of news articles that contain keywords related to upturns and downturns in the Spanish business cycle.

We consider 7 relevant Spanish national newspapers: *El País*, *El Mundo*, *La Vanguardia*, *ABC*, *Expansión*, *Cinco Días*, and *El Economista*. The first 4 newspapers are the largest and most-read generalist newspapers in Spain, while *Expansión*, *Cinco Días*, and *El Economista* are the three main Spanish business newspapers. We focus on the printed editions of these

[7] This indicator is equivalent to the ESI for France.

Figure 1: Comparison between the economic sentiment indicator (ESI) and the daily economic news sentiment indicator (DENSI)



Note: Monthly frequencies. The x-axis shows years from 2000 to 2020. The y-axis shows the unit of measurement (points) of the ESI (100 points, on average) and of the DENSI (0 points, on average).

newspapers and ignore the online versions. Our decision is supported by two arguments: first, online editions have become more widespread only in the most recent years, while we consider quite a substantial time span. Ignoring the digital press ensures homogeneity in our index. Second, printed newspapers ensure meeting standards in terms of the quality and relevance of the news since editors select the articles to be published in the printed version of the newspaper given space limitations.

Our main indicator is monthly. However, one advantage of relying on newspapers articles is that one can construct indicators at higher (daily) frequencies. All searches are carried out using the Dow Jones' Factiva service. For each newspaper, we conduct queries from the first month the newspaper is collected in the Dow Jones' Factiva database, starting from January 1997. We restrict all queries to the following articles: (i) articles in the Spanish language; (ii) articles with content related to Spain, based on Factiva's indexation; (iii) articles about corporate or industrial news, economic news, or news about commodities or financial markets, according to Factiva's indexation. We then perform three types of queries.

First, we count the number of articles that satisfy the aforementioned requirements, which provides us with a measure of economic articles. This will serve as denominator for our indicator.

Second, we count the number of articles that, in addition to satisfying the aforementioned conditions, contain upswing-related keywords. That is, the articles must contain the word *recuperacion** (recovery) or one of the following words, provided that they are preceded or followed by either *economic** (economic) or *economía* (economy) within a distance of 5 words: *aceler**

(acceleration), *crec**, *expansi** (growth), *increment**, *aument** (increase), *recuper** (recovery), *mejora** (improvement). In addition, in order to ensure that the news items are about the Spanish business cycle, we also require the article to contain the word *Españ** (Spain/Spanish).[8]

Similarly, we count the number of articles that, in addition to satisfying the aforementioned conditions, are about downswings. In particular, the articles must contain the word *recesión** (recession) or *crisis* (crisis) or one of the following words, provided that they are preceded or followed by either *economic** (economic) or *economía* (economy) within a distance of 5 words: *descen**, *disminu**, *redu** (decrease), *ralentiz**, *decrec**, *desaceler**, *contracción** (slowdown). The articles should also contain the word *Españ** (Spain/Spanish).

Then, for each newspaper, we take the difference between the upturn and downturn counts. To construct the index, we follow the procedure used by Baker et al. (2016). First, we scale the difference between upturn and downturn counts by the total number of economic articles in the same newspaper/month. Second, we standardize the monthly series of scaled counts considering the period of 1997m1–2020m2 so that the volatility of each series is comparable across newspapers. Third, we average the series across newspapers. Fourth, we rescale the resulting index to mean 0, considering the period of 1997m1–2020m2, to obtain the monthly DENSI.

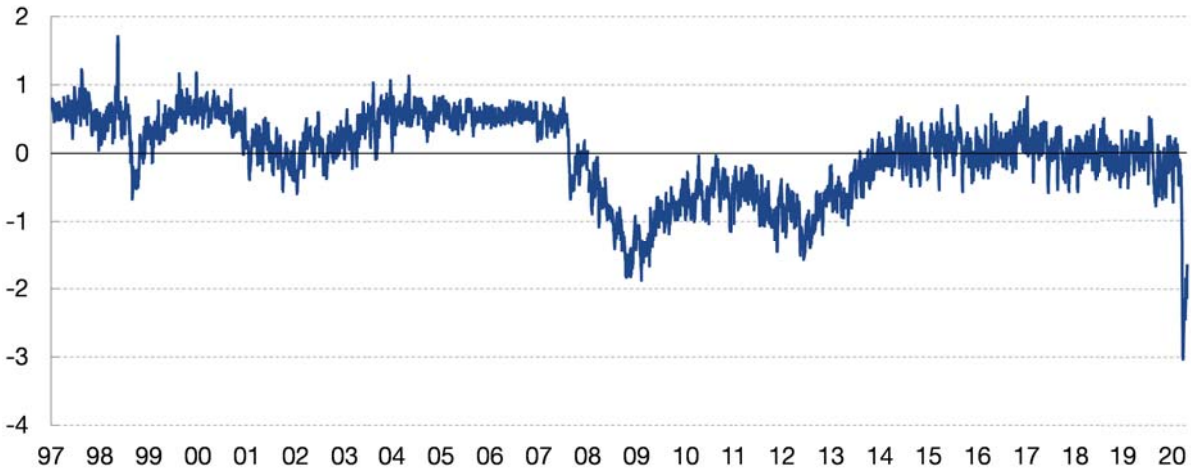
Figure A.1 in the Appendix shows our DENSI against the ESI at the monthly level. The latter is normalized so that both indexes can share the same y-axis in the graph.[9] Both indexes follow the same pattern throughout the entire time span and are highly correlated (the correlation index for the period 1997m1–2020m3 is 0.8). However, the behavior of both indexes differs dramatically in March 2020 after the COVID-19 outbreak in Spain. The DENSI signals the outbreak correctly and drops to values reached during the Great Recession, while the ESI remains at the positive levels characterizing the recent months. This is because the ESI relies on answers mostly collected in the first half of the month, which do not capture the start of the economic crisis that occurred from the lockdown implemented on March 14th to fight against the spread of COVID-19.

Finally, Figure 2 shows the 7-day moving average of the DENSI from January 1997 onwards at the daily frequency. Being able to construct daily confidence indicators is a major advantage of newspaper-based indexes compared to the traditional monthly confidence indicators. This

[8] We already require that the content of the article is related to Spain. However, the latter condition is quite loose since articles that are related to Spain do not necessarily talk about Spanish matters (e.g. they may talk about foreign matters that have implications for Spain). For this reason, we also require that the article contains the word Spain/Spanish.

[9] The ESI is constructed to have mean 100 and a standard deviation of 10 in a fixed period of time. For details, see link to Eurostat page. Between 1997m1 and 2020m3, it has mean of 101.

Figure 2: Our indicator at a daily frequency



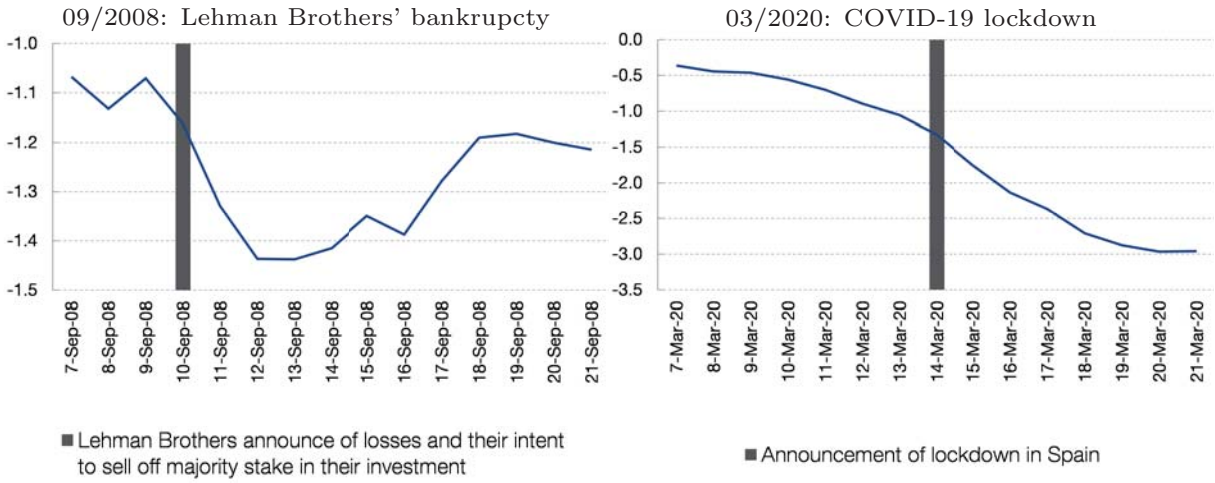
Note: The line depicts the 7-day moving average of the DENSI index.

becomes crucial when important shocks occur in the middle of the month or far from the date at which the monthly confidence indicators are released. We provide two examples of situations in which the availability of our DENSI has correctly signaled the worsening of the economic situation in real-time: at the time of the Lehman Brothers bankruptcy in September 2008 (see right panel of Figure 3) and at the time of the COVID-19 lockdown in March 2020 (see left panel of Figure 3). According to Figure 3, our indicator responds very quickly to important economic events: i.e. it drops sharply just after the Leheman Brothers' announcement of losses in September 2008 (just before their bankruptcy), and just after the announcement of the Spanish lockdown in March 2020.

3 Empirical analysis

The ESI has been shown to be helpful in predicting short-term GDP growth (e.g., see Červená and Schneider, 2014, Mazzi et al., 2014, Gajewski, 2014). In this section, we aim to go one step further by evaluating whether our proposed indicator could do better than the ESI in this sense and, consequently, we present two different but related exercises to analyze if this is the case. In the first one, we rely on the ESI and the DENSI to forecast Spanish GDP growth and we compare the forecast accuracy obtained in each case. In the second application, we set up a model to compute the implied probability of recession for Spain based on, alternatively, the ESI and the DENSI. As in the previous exercise, the main objective is to compare the predictive power of each indicator.

Figure 3: The DENSI during specific shocks



Note: The figure shows the evolution of the DENSI around the Lehman Brothers bankruptcy (left panel) and around the COVID-19 outbreak (right panel).

3.1 Forecasting GDP

GDP figures, which are probably the best measure to proxy the aggregate state of the economy, are generally released at quarterly frequencies. Of course, between each quarterly publication, many meaningful economic indicators become available that help in the assessment of the economic situation. Therefore, mixed-frequency models emerge as one way of exploiting this intra-quarter information when forecasting short-term GDP growth. Here, we rely on an MF-BiVAR model, as in Mariano and Murasawa (2010), to compare the GDP forecast accuracy of a model that alternatively includes the ESI or the DENSI as monthly variables (obviously, GDP is the quarterly variable included in both cases).

In Mariano and Murasawa's (2010) notation, the GDP quarter-on-quarter growth rate (y_t), which is observed every three periods (months), could be written in terms of a latent monthly growth rate (y_t^*) through the following arithmetic formula (see Mariano and Murasawa, 2010 for its derivation):

$$y_t = \frac{1}{3}y_t^* + \frac{2}{3}y_{t-1}^* + y_{t-2}^* + \frac{2}{3}y_{t-3}^* + \frac{1}{3}y_{t-4}^* \, . \quad (1)$$

Of course, y_t^* is never observed. By letting x_t stand for the monthly variable (the ESI or the DENSI), it is possible to define $Y_t = (y_t, x_t)'$ and $Y_t^* = (y_t^*, x_t)'$ and relate both vectors as[10]

[10] All variables are standardized to have a zero mean and a variance equal to one before estimating the model.

$$Y_t = H(L)Y_t^* \,, \tag{2}$$

where

$$H(L) = \begin{pmatrix} 1/3 & 0 \\ 0 & 1 \end{pmatrix} + \begin{pmatrix} 2/3 & 0 \\ 0 & 0 \end{pmatrix} L + \begin{pmatrix} 1 & 0 \\ 0 & 0 \end{pmatrix} L^2 + \begin{pmatrix} 2/3 & 0 \\ 0 & 0 \end{pmatrix} L^3 + \begin{pmatrix} 1/3 & 0 \\ 0 & 0 \end{pmatrix} L^4 \,,$$

where L is a lag operator. As indicated in Mariano and Murasawa (2010), a Gaussian vector autoregressive of order P (VAR(P)) model could be assumed for Y_t^* as

$$\Phi(L)Y_t^* = w_t, \tag{3}$$

where $w_t \sim IN(0, \Sigma)$. For $P \leq 5$ and defining $S_t = \left(Y_t^*, ..., Y_{t-4}^*\right)'$, the mixed-frequency VAR(P) model could then be written under the state-space representation as

$$Y_t = CS_t \,, \tag{4}$$

$$S_{t+1} = AS_t + Bz_t \,, \tag{5}$$

where $z_t \sim IN(0, I_2)$ and

$$A = \begin{pmatrix} \phi_1 & \cdots & \phi_p & 0_{2\times(5-p)2} \\ & I_8 & & 0_{8\times 2} \end{pmatrix}, \qquad B = \begin{pmatrix} \Sigma^{1/2} \\ 0_{8\times 2} \end{pmatrix}, \qquad \text{and} \qquad C = \begin{pmatrix} H_0 & \cdots & H_4 \end{pmatrix}.$$

The previously described state-space model is estimated by means of maximum likelihood estimation. Under this specification (we assume $P = 3$), we carry out the following forecasting exercise.

First, we set up a pseudo-real-time nowcasting exercise for GDP. In particular, we assume it is the last day of each month t and, for our exercise, we use the information that would have been available at that moment (we use real-time vintages for GDP). It should be noted that flash estimates for GDP are published 30 days after the end of the reference quarter. Therefore, within a quarter, we predict the one-quarter-ahead GDP growth no matter whether it is the first, second, or third month of the quarter. We start the exercise in January 2013, and for each month until December 2019, we conduct the nowcast of quarter-on-quarter GDP growth when the ESI and the DENSI are, alternatively, the monthly variable included in the model. Our target is the second release of GDP figures.

The nowcasts of both models are shown in Figure 4. The blue and red lines represent the predictions based on the Bi-VAR model with the ESI and DENSI, respectively, while the horizontal green line is the target value. As can be observed, the predictions obtained from the model that includes the ESI are, in general, above those that include the DENSI. This result could potentially be explained by the possible positive bias that survey-based confidence indi-

cators show during the period after the Great Recession. According to Gayer and Marc (2018), a possible explanation for this positive bias could be the adaptation of the agents economic expectations to a more modest growth after the 2008 crisis.

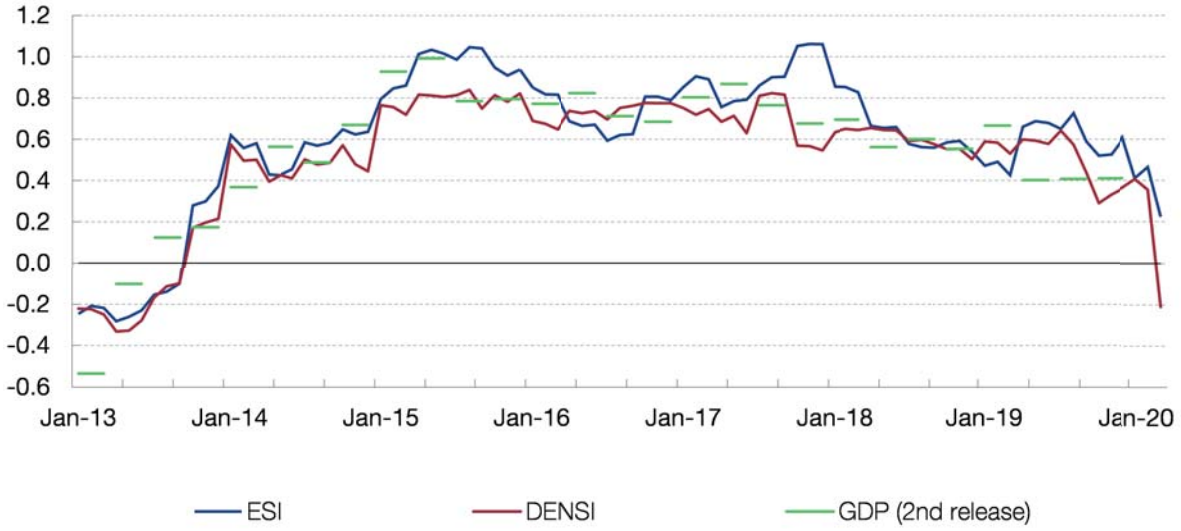
To compare the forecast accuracy of both models, we rely on the forecast root mean squared error (RMSE). Results indicate that the RMSE of the Bi-VAR model that contains the DENSI is about 20% lower than that obtained under the model that includes the ESI, the difference being significant at the 1% confidence level.[11] This indicates that the DENSI significantly improves the nowcast of GDP when compared with the ESI, meaning that it provides a potentially better signal for the evaluation of the current economic situation.

As already mentioned, one particular advantage of the DENSI is the possibility of computing it on a daily basis. In the previous section, we highlighted how the DENSI changed around the Lehman Brothers bankruptcy in September 2008 and the COVID-19 lockdown in March 2020. Taking each of those events as a case study, we have estimated how the GDP nowcast would have changed around those particular weeks.[12] In particular, on different days of the month we assume that the values of the DENSI are equal to the average value of the already-known days of that month, and for each of those particular days we compute the nowcast of the GDP. In Figure 5 (left panel), we show how each value of the DENSI would have evolved as new information would have become available. For example, only one week after the end of August 2008, the DENSI would have declined from -5.12 to -5.74, while two weeks after it would have reached a value of -6.35. Consequently, the nowcast for the third quarter of 2008 would have been reduced by almost 0.1 percentage points after 15 days. When analyzing the COVID-19 outbreak (Figure 6), the revision of the nowcast under the model is even greater as the days passed: between March 7 and March 21, the nowcast would have been revised by almost 0.7 percentage points. These results confirm the relevance of having daily real-time information in order to make a good assessment of the general economic situation.

[11] The RMSE of the model that includes the DENSI is equal to 0.137, while the one estimated for the model that contains the ESI is equal 0.172, meaning that the relative RMSE is about 0.797. To test whether the difference is significant, we rely on the Diebold and Mariano test.

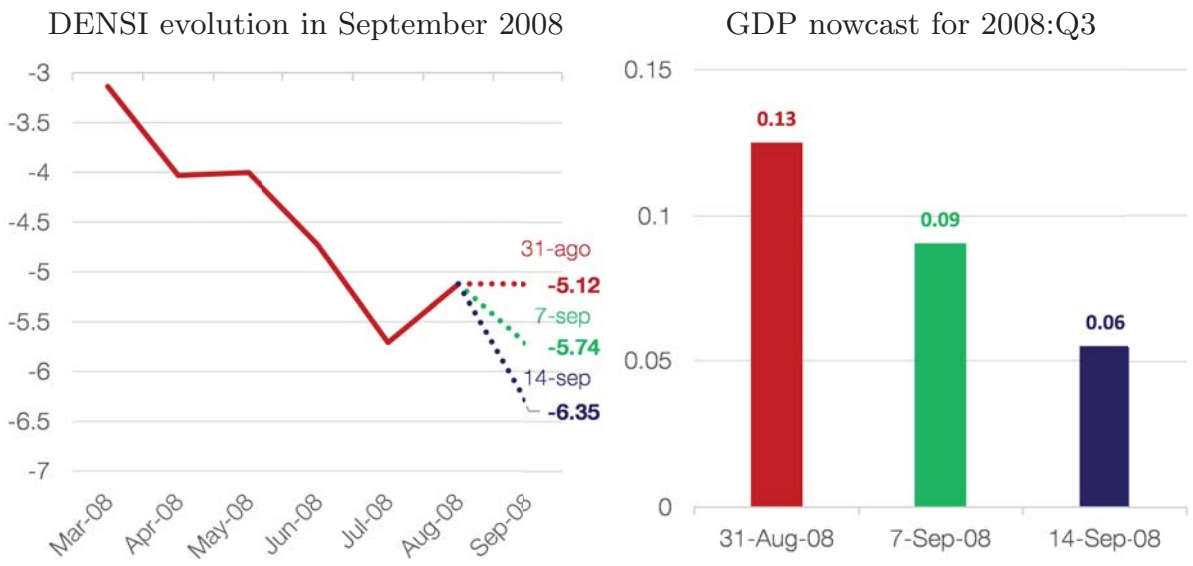
[12] Results for 2008 are mainly indicative and should be cautiously interpreted since only ten years of data are available for estimating the model prior to computing each forecast (the DENSI series starts in 1997).

Figure 4: Quarterly GDP growth nowcast



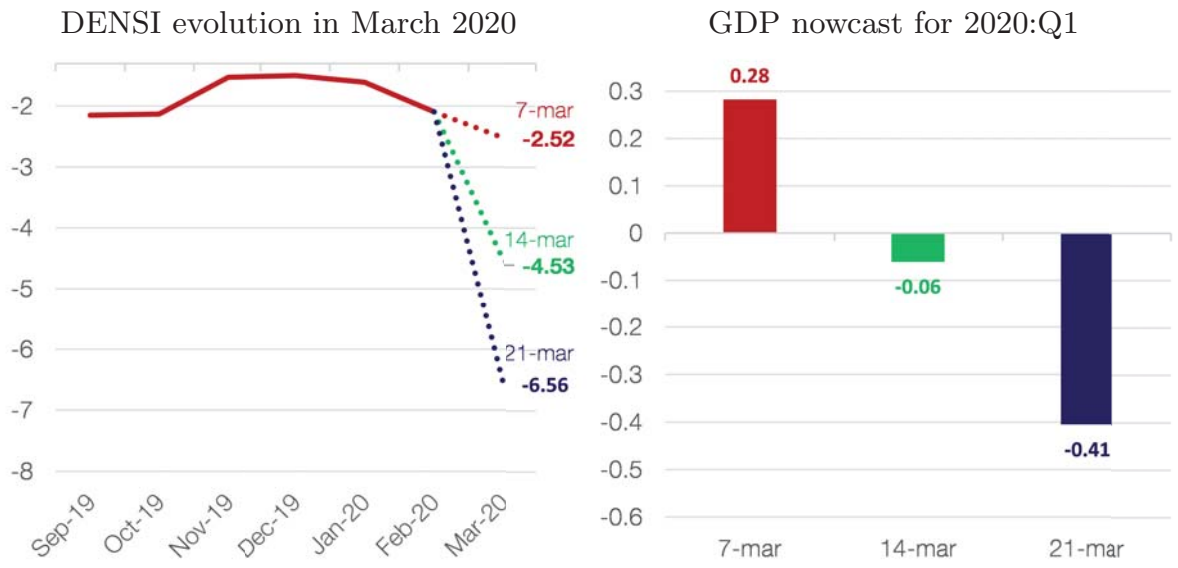
Note: The blue (red) line represents the predictions obtained from the Bi-VAR model that includes the ESI (DENSI) and the GDP. The green line depicts the target variable, i.e., the second release of GDP growth rate.

Figure 5: Nowcasts around the Lehman Brothers bankruptcy



Note: On the left plot, the dotted lines show the August 2008 monthly value of the DENSI and the values for September 2008 as they would have been computed on September 7 and September 14. On the right plot, the GDP nowcast for the third quarter of 2008 from the Bi-VAR model computed on each of those days is shown.

Figure 6: Nowcasts around the COVID-19 outbreak



Note: On the left plot, the dotted lines show monthly average values of the DENSI as it would have been computed on March 7, March 14, and March 21. On the right plot, the GDP nowcast for the first quarter of 2020 from the Bi-VAR model computed on each of those days is shown.

3.2 Predicting the probability of recession

In this section, we test whether our text-based sentiment indicator has predictive content in terms of business-cycle turning points. For this purpose, we start from a very simple model that is standard in the literature, where recession probabilities are estimated as a (probit) function of the present value of the slope of the yield curve—i.e., the difference between short-term and long-term yields (see Wright, 2006, among many others). In particular, this kind of model is described by

$$P(R)_{(t+n)} = \alpha + \beta_1 \left[yield_t^{3M} - yield_t^{10A} \right] + \epsilon_{(t+n)}, \qquad \text{(Model 1)}$$

where $P(R)_{(t+n)}$ stands for the recession probability at a future horizon $(t+n)$, $yield_t^{3M}$ and $yield_t^{10A}$ are, respectively, the three-month and 10-year Spanish treasury bill yields, and the residuals ϵ_t are assumed to be independently and normally distributed. To measure the stance of the business cycle, we rely on the recession dates given by the Spanish Business Cycle Dating Committee (Spanish Economic Association, 2015), and we assume that the recession probability is equal to one when a recession occurred and zero otherwise. Departing from this model, we check whether forecast accuracy could be improved by adding an economic sentiment indicator

(the DENSI or the ESI) as an additional regressor. Therefore, we estimate the following models, which encompass Model 1:

$$P(R)_{(t+n)}^{ESI} = \alpha^{ESI} + \beta_1^{ESI}\left[yield_t^{3M} - yield_t^{10A}\right] + \beta_2^{ESI} ESI_t + \epsilon_{(t+n)}^{ESI}, \qquad \text{(Model 2)}$$

$$P(R)_{(t+n)}^{DENSI} = \alpha^{DENSI} + \beta_1^{DENSI}\left[yield_t^{3M} - yield_t^{10A}\right] + \beta_2^{DENSI} DENSI_t + \epsilon_{(t+n)}^{DENSI}. \qquad \text{(Model 3)}$$

Finally, we compute the recession probabilities when the slope of the yield curve is omitted from the model:

$$P(R)_{(t+n)}^{ESI^*} = \alpha^{ESI^*} + \beta_2^{ESI^*} ESI_t + \epsilon_{(t+n)}^{ESI^*}, \qquad \text{(Model 4)}$$

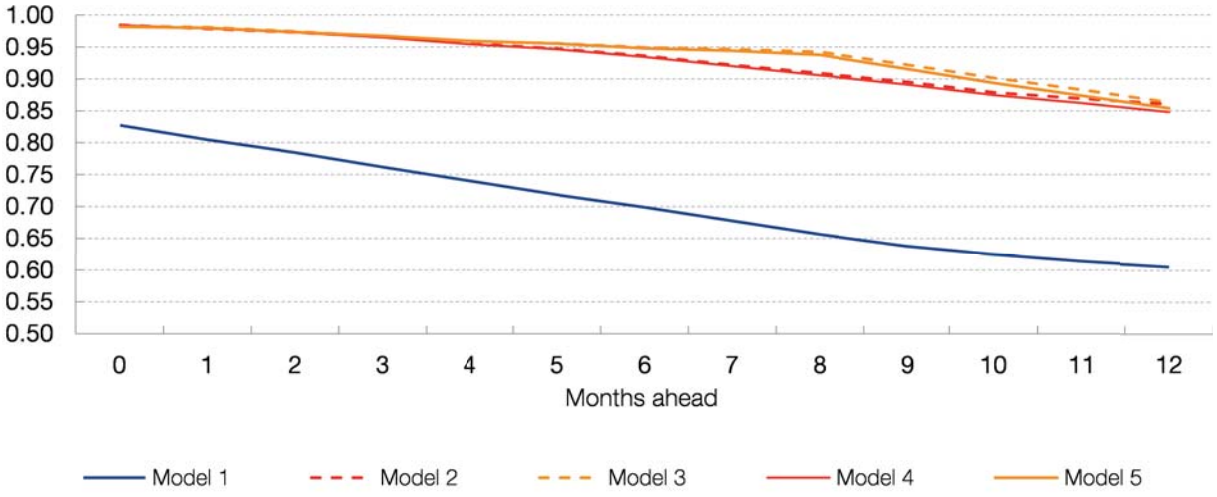
$$P(R)_{(t+n)}^{DENSI^*} = \alpha^{DENSI^*} + \beta_2^{DENSI^*} DENSI_t + \epsilon_{(t+n)}^{DENSI^*}. \qquad \text{(Model 5)}$$

Each of the five models are estimated for $n = 0, 1, ..., 12$ (i.e., up to a 12-month horizon) using a sample period from January 1997 until February 2020. To evaluate the goodness-of-fit of the different models, we calculate the receiver operating characteristic (ROC) curve. Intuitively, the ROC curve defines the ability of the model to correctly classify an observation as a recession by weighting the true positive rate, i.e., how many times the model predicts a recession when there is a recession, and the false positive rate, i.e., how many times the model predicts a recession when this did not occur. The area under the ROC curve is a metric that summarizes the diagnostic ability of a model. It ranges between 0.5, which corresponds to a model with no ability to classify recessions, and 1, which corresponds to a model with perfect discrimination. We use this metric to compare the diagnostic ability of our models.

Figure 7 shows the ROC curve under each particular model. Three points are worth noting. First, in the case of Spain, the standard model (Model 1) is outperformed by all of the other four selected models at all horizons (the blue line is always below the other lines). The low performance of the slope of the yield curve as a predictor of recession could potentially be explained by the key role played by the European Central Bank since the 2012 financial crisis.[13] In particular, conventional and unconventional monetary policies such as forward guidance, asset purchase, and enhanced credit support may have flattened the slope of the yield curve associated with national bonds, curbing the predictive power of the indicator. Second, the models that

[13] Based on the period before the Great Recession, Alonso et al. (1997) and Martínez Serna and Navarro (2005) show that the inclusion of the Spanish yield curve provides relevant information to predict Spanish output slowdowns or expected economic growth, respectively.

Figure 7: Comparing the diagnostic ability of different models

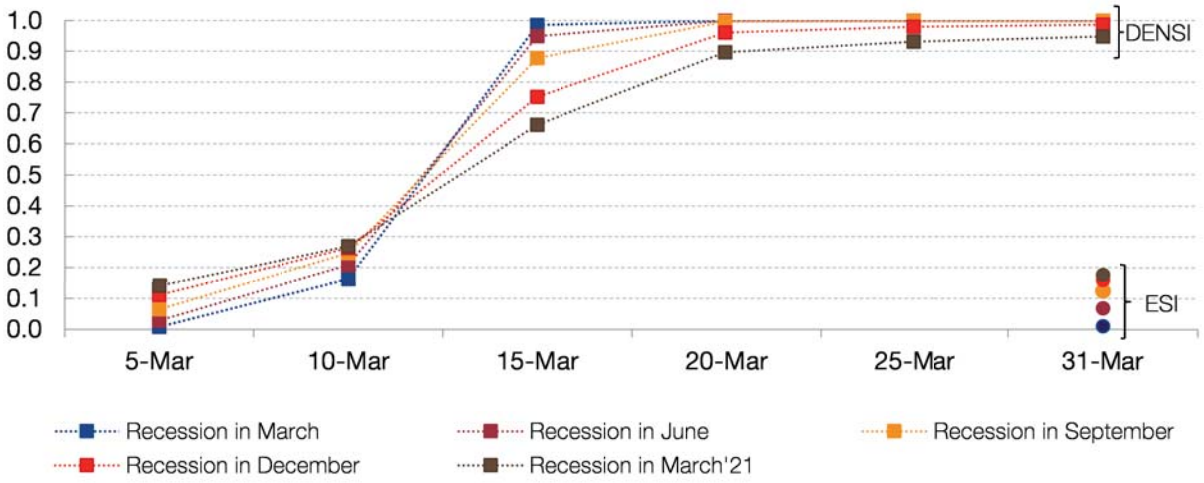


Note: Each line represents the receiver operating characteristic (ROC) curve of each model. A value of 1 represents a perfect ability to discriminate between two alternative statuses (recession or not), whereas a value of 0.5 represents no ability of discrimination. Model 1: slope of the yield curve; Model 2: slope of the yield curve and ESI; Model 3: slope of the yield curve and DENSI; Model 4: ESI; Model 5: DENSI.

include either the ESI or the DENSI show a great fit in terms of ROC, being over 0.9 at any horizon, with the DENSI having slightly better diagnostic ability at longer horizons. Third, once any of the confidence indicators is included in the model, adding the yield curve as a regressor does not improve the results.

Nonetheless, as already mentioned, one advantage of the DENSI is that it can be computed on any day of the month, making it possible to estimate recession probabilities at daily frequencies. Therefore, the DENSI becomes very useful for providing timely predictions of recession probabilities, such as during the recent episode of the COVID-19 outbreak. In this sense, Figure 8 shows weekly probabilities of recession (estimated at different points in time during March 2020) from March 2020 up to one year ahead. Specifically, we estimate the model using either the DENSI or the ESI to compute the probability of recession from the current month (March 2020) to 3, 6, 9, and 12 months ahead. To show the importance of having real-time updates of the DENSI, we evaluate the model using the information available on the 5th, 10th, 15th, 20th, 25th, and 31st of March. On each particular date, we assume that the value of the DENSI for March would be equal to the average value of the already known days of the month. Therefore, the value computed on the 31st of March will match the monthly value of the DENSI, while the values computed on earlier dates are considered as approximations of that monthly value. Of course, in the case of the ESI, there is only one date available at the end of the month.

Figure 8: Weekly recession probabilities during the COVID-19 outbreak



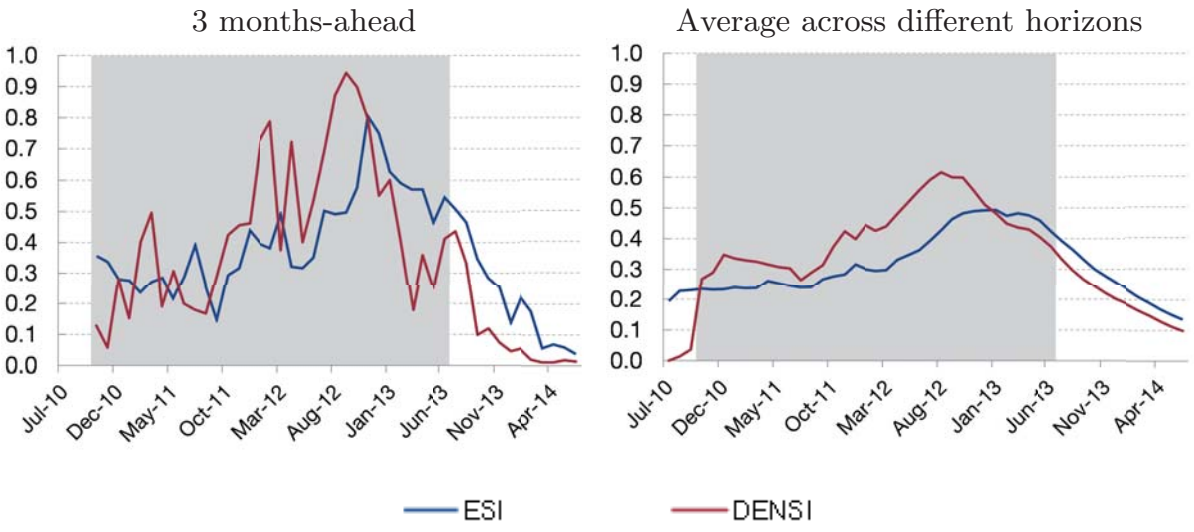
Note: Each date on the x-axis represents the moment during March 2020 at which we compute the probability of recession at different horizons based on the model with the DENSI: in March 2020 (blue squares), in June 2020 (3 months ahead, purple squares), in September 2020 (6 months ahead, yellow squares), in December 2020 (9 months ahead, red squares), and in March 2021 (1 year ahead, brown squares). The model with the ESI allows us to compute such probabilities only on the date of the ESI release, i.e., at the end of the month. Such probabilities are represented by the circles, with different colors corresponding to the different horizons.

The figure clearly shows how the estimations based on the DENSI adjust correctly to the rapid economic developments due to the COVID-19 outbreak. By March 14th, when the Spanish government declared a state of alarm and the country was immediately locked down,[14] the probability of recession increased by a factor of two at least at any horizon and reached values near 1 during the second half of the month. Given that most of the ESI's surveys took place before the implementation of the state of alarm, it is not surprising that the recession probability for March based on the ESI (see the lower-right corner of Figure 8) remains very low. These results indicate that in the presence of big events, the DENSI would be able to capture their impact earlier than the ESI.

Aiming to compare the information content of other high-frequency indicators, in Figure A.2 of the Appendix we also compare, for March 2020, the prediction of recession probabilities by a model that includes the slope of the yield curve as an explanatory variable with those obtained by Model 5, in which the DENSI is the only regressor. The very low recession probabilities of the former model are consistent with the lack of reaction of the sovereign markets to the

[14] According to Article 116.2 of the Spanish Constitution, a state of alarm can be declared "in all or part of the national territory, when there are health crises that involve serious alterations to normality." The state of alarm was approved by decree on Saturday the 14th of March and, as a consequence, the country was immediately locked down.

Figure 9: Probability of recession estimated at different horizons



Note: The gray area represents the recession period according to the dates specified by the Spanish Business Cycle Dating Committee. The blue (red) line represents the probability of recession obtained from the model with the ESI (DENSI). In the left panel, these probabilities are estimated 3 months before each date shown on the x-axis. In the right panel, each point represents the average across the probabilities of recession computed for a given date on the x-axis at different horizons.

COVID-19 outbreak in March (unlike the stock markets), as a consequence of monetary policy intervention with the announcement of a new temporary asset-purchasing program (i.e., the Pandemic Emergency Purchase Programme, on the 18th of March).

3.2.1 Predicting the probability of recession in pseudo-real-time

As an additional application, we run a pseudo-real-time exercise to evaluate the estimated recession probability based on the DENSI and the ESI, alternatively, during the 2012 recession. This exercise allows us to compare the predicting capacity of both models in terms of (i) anticipating the crisis, (ii) measuring the increase in the probability of recession during the crisis, and (iii) foreseeing the end of the crisis. For this exercise, we estimate Model 4 and Model 5 using data from January 1997 until June 2010 and then compute the recession probabilities at different horizons (from the current month to 12 months ahead) for the subsequent period. Results for both models are presented in Figure 9: the left panel shows the estimated recession probabilities at a specific horizon (3 months), while the right panel shows the probability of recession in a given month computed as the average probability across all horizons.

Focusing on the left panel of the figure, three points are worth noting. First, both models were delayed in predicting the beginning of the crisis. Second, during the crisis, the model with

the DENSI (red line) showed higher probabilities of recession compared to the model with the ESI (blue line). Third, the model with the DENSI is better able to anticipate the end of the crisis, as the probability of recession drops sharply by the summer of 2013.

The right panel of the figure confirms that, on average, the DENSI performs better than the ESI in the three aforementioned aspects: (i) it anticipates better the start of the crisis (it jumps from 0 to 0.3 during the first month of the crisis), (ii) it displays, on average, a higher probability of recession throughout the crisis, and (iii) it drops faster at the end of the crisis.

4 Conclusions

For any policymaker, a prompt assessment of the current economic situation is of key importance. Since most macroeconomic variables are feasible only after some lag, having meaningful up-to-date indicators of the state of the economy becomes a priority. Therefore, we have proposed a new indicator of economic sentiment based on newspaper articles that allows assessing real-time economic activity in Spain. Our proposed indicator has three major advantages with respect to the very popular ESI, which is provided by the European Commission: 1) it can be constructed on a daily basis; 2) it does not suffer from bias along business cycles; and 3) it is very flexible with respect to the topic of interest (one can easily develop new indicators focused on specific issues by selecting specific keywords of interest and constructing the indicators backwards, whereas with survey-based data, new topics need the development of new questions in the survey).

In the empirical part of the paper, we set up two exercises to show that the DENSI is a better indicator than the ESI for the case of Spain. In a first exercise, we set up mixed-frequency bivariate VAR models and let the ESI and the DENSI compete in nowcasting the GDP growth rate. The DENSI provides significantly more precise predictions from January 2013 to December 2019. In addition, we showed two examples in which a major shock occurred in the middle of the month (in September 2008, with the Lehman Brothers bankruptcy, and in March 2020 with the COVID-19 lockdown): on both occasions, real-time updates of the DENSI proved to be very useful in revising downwards the nowcast of economic activity.

In a second exercise, we focused on predicting the COVID-19 economic crisis and computed the probability of recession at different horizons from March 2020. Our results showed that the DENSI provides better results compared to the ESI. The probability of recession in March 2020 jumped to about 100% on the 14th March 2020, i.e., the day Spain was locked down. In the second half of the month, the probability of recession reached values between 90% and 100% at any horizon. By contrast, the ESI indicator, which in March 2020 provided a poor signal of the economic situation, yielded a very small probability of recession in the subsequent months.

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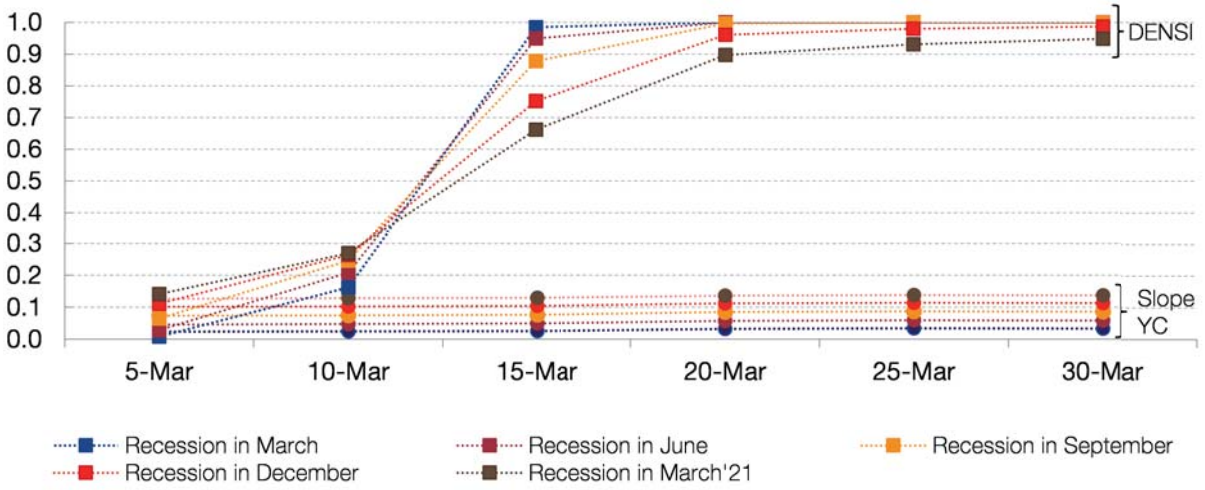
Appendix

A Additional figures

Figure A.1: Comparison between the ESI and the DENSI

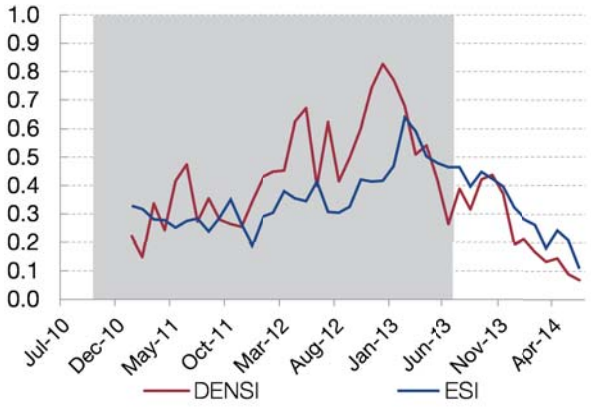
Note: The gray area represents the recession period according to the dates specified by the Spanish Business Cycle Dating Committee. The ESI has been normalized (0 mean and 1 standard deviation) in order to have the same range as the DENSI index.

Figure A.2: Weekly recession probabilities during the COVID-19 outbreak: yield curve vs. the DENSI



Note: Each date on the x-axis represents the moment during March 2020 at which we compute the probability of recession at different horizons: in March 2020 (blue symbols), in June 2020 (3 months ahead, purple symbols), in September 2020 (6 months ahead, yellow symbols), in December 2020 (9 months ahead, red symbols), and in March 2021 (1 year ahead, brown symbols). The results obtained from the model based on the DENSI are depicted by squares, while the results obtained by the model based on the yield curve are represented by circles.

Figure A.3: Probability of recession 6 months ahead



Note: The gray area represents the recession period according to the dates specified by the Spanish Business Cycle Dating Committee. The blue (red) line represents the probability of recession obtained from the model with the ESI (DENSI). Probabilities are estimated 6 months before each date shown on the x-axis.

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