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The Role of Economic News in Predicting Suicides

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Abstract

In this paper we explore the role of media and language used to comment on economic news in nowcasting and forecasting suicides in England and Wales. This is an interesting question, given the large delay in the release of official statistics on suicides. We use a large data set of over 200,000 news articles published in six major UK newspapers from 2001 to 2015 and carry sentiment analysis of the language used to comment on economic news. We extract daily indicators measuring a set of negative emotions that are often associated with poor mental health and use them to explain and forecast national daily suicide figures. We find that highly negative comments on the economic situation in newspaper articles are predictors of higher suicide numbers, especially when using words conveying stronger emotions of fear and despair. Our results suggest that media language carrying very strong, negative feelings is an early signal of a deterioration in a population's mental health.

Keywords: Suicide, health outcomes, text analysis, emotions extraction, forecasting.
JEL codes: I14, I15

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1 Introduction

Suicide was the fourth most common cause of death at ages 15-29 in 2019, with about 700,000 people taking their own life (World Health Organization (2021)). A report by the Office of National Statistics (2019) states that there were 5,691 suicides in England and Wales in 2019 - an increase by 321 compared with the year before. Suicide is also the biggest killer of young people within the United Kingdom and Republic of Ireland, as 759 young people took their own lives in 2018. Suicide has an enormous negative rippling effect across families and communities and harms society. People with severe mental illness have an increased risk of premature mortality, as they die on average 15-20 years earlier than the general population. Urgent action is required to prevent and alleviate the socio-economic burden of these mental health problems. Given the significant loss of lives to suicide, the Government has recently launched an initiative aimed at reducing suicide rates in England within the next five years (Strategy 2023-2028) (Department of Health and Social Care (2023)). This initiative not only aims to decrease the suicide rate over the next five years, with initial reductions anticipated within half this timeframe or sooner, but also commits to enhancing support for individuals who have self-harmed and for those bereaved by suicide. However, a key challenge to the design and implementation of targeted interventions to reduce suicide rates is the delay in the availability of suicide data. Data on suicides are typically released by the Office for National Statistics with a lag of 2-3 years, and even after this period, updates may occur as new information on past deaths emerges. Therefore, there appears to be a significant discrepancy between the timing of when these statistics are released and the need for up-to-date evidence to design and implement evidence-based policy interventions effectively.

Numerous factors contribute to mental health distress. Among them is the adverse influence of economic downturns, often linked to sharp rises in unemployment due to inadequate social and work protection programs. Periods of economic downturn and recession may lead to increases in debt, job losses, house repossession, strains on relationships and reductions in public spending, which in turn adversely affect mental health.

There exists an ample body of literature attempting at understanding whether and to what extent mental health distress is associated with economic factors. These studies usually take as indicators of economic fluctuations variables compiled by national statistical agencies such as unemployment rate or growth rate in real Gross Domestic Product and regress them against measures of mental health. Ruhm (2000) investigated how health and mental health status fluctuate with state macroeconomic conditions in the United States. The author found a that high unemployment rates are associated with lower mortality for several types of mortality. However, the author also estimated a positive relationship between unemployment and suicide rates, a result that has been corroborated by subsequent studies conducted by Ruhm (2003) and Ruhm (2015). Coope et al. (2014) argued that suicide rates among men aged 35-44 rose significantly during the Great Recession. A similar association has been found in Spain and Greece, where Lopez Bernal et al. (2013) and Branas et al. (2015) used an interrupted time series approach to show that suicides increased during economic downturns. Antonakakis and Collins (2014) studied the link between fiscal austerity and suicides in five Eurozone peripheral countries, namely Greece, Ireland, Italy, Portugal and Spain, over the period 1968–2012. The authors observed that fiscal austerity has short, medium, and long–run suicide increasing effects on the male population in the 65–89 age group. Bunnings et al. (2015) found that job insecurity has adverse effects not only on individuals but also their spouses and other family

members. Di Novi et al. (2023) found that mental-health distress following job disruptions depends on the level of Employment Protection Legislation, with significantly higher distress in countries in which legislation is more binding, where a stronger employment protection may discourage job creation and have longer unemployment spells.
A number of studies indicate minimal, null, or occasionally even beneficial impacts of economic downturns on mental health issues. For example, Harper and Bruckner (2017) and Harper et al. (2015) only found mild evidence of a link between recessions and suicides, while other studies, such as those by Gerdtham and Ruhm (2006) and Atalay et al. (2021), found no deterioration in suicide trends. In a recent study on the causal impact of macroeconomic shocks on suicide for England and Wales, Lepori et al. (2024) found insignificant effect of shocks to GDP and unemployment growth on suicide numbers. Some works find a positive effect of economic recessions on mental health. Notably, Neumayer (2004) documented that various mortality rates, including suicides, are lower during recessions, using German data. Carrying an analysis of suicide rates at worldwide level, Claveria (2022) pointed at the positive correlation between economic growth and suicide, particularly strong in middle-income countries. A similar result was observed by Antonakakis and Collins (2018), who found that in high-income countries further income increases seemed to be associated with net negative mental health spillover effects. One explanation for the potentially beneficial impact of economic downturns on mental health is that tighter budget constraints might discourage individuals from engaging in high-risk behaviors such as excessive drug or alcohol consumption. Conversely, during economic upturns, job-related stress tends to escalate, prompting individuals to potentially turn to increased tobacco use, alcohol, medication, and drugs as coping mechanisms to manage the stress associated with economic expansions (Freeman (1999), Neumayer (2004)). According to Claveria (2022), rapid economic growth may also be accompanied by social instabilities that may in turn increase suicide risk.

While previous research primarily focuses on how ”objective” economic indicators, such as unemployment rate or GDP growth rate, predict mental health, this paper explores whether subjective measures, such as the way the (written) media depict the economy, can also forecast suicide patterns. Specifically, we examine the role of media and the language used to discuss economic news to predict suicides in England and Wales. Leveraging news to predict suicide rates could be very useful because news-based indicators are both frequent and easily accessible. Unlike traditional economic indicators, which are often released on a monthly or quarterly basis, news is generated and disseminated daily. Such high frequency allows for more timely and responsive analysis. Additionally, the accessibility of news means that a wide range of information is readily available for analysis, providing a rich dataset for identifying potential correlations between economic sentiment in the media and suicide rates.
In addition to other contextual and personal factors, people are likely to partly form beliefs and expectations about their economic situation based on what they hear from the media, such as newspapers, TV and social media. Different reporting on the same economic event may be associated with varying emotional states, depending on their interpretation of events and situations, inducing different reactions, thus leading to different decisions. Studies in psychology and behavioral economics have demonstrated that emotional and personality aspects play a crucial role in shaping economic behavior and decision-making across various contexts (Loewenstein et al. (2001)). Building on this evidence, we posit that the psychological distress (e.g., anxiety, depression, frustration) caused by negative economic news can make individuals more prone to committing suicides. Affective states

such as anxiety, fear, sadness and despair extracted from the language used in economic news may capture elements linked to human perception and mood that influence suicide behaviour and individual decision-making.
To test this hypothesis we exploit a very large data set of over 200,000 economic news collected from six major newspapers in the United Kingdom (UK) over the period from January 2001 until December 2015. We calculate a number of indicators of negative emotions from economic news and investigate their role in explaining and anticipating suicide numbers in the England and Wales. These measures can serve as real-time indicators of the health of the economy and of the mood of the general public towards the current economic situation, providing valuable insights that may not always be available through official statistics. We first explore how the emotion indicators are related to the economic situation of a country. Then, we adopt a regression framework to assess the impact of emotions on suicides in England, ultimately showing the forecasting ability of our model. In our regression model we control for a number of variables that are recognised by existing literature as important determinants of suicide rates, including Gross Domestic Product (GDP) growth, unemployment, maximum temperature registered during the day and extreme temperature episodes. To calculate our emotion indicators we adopt the WordNet-Affect dictionary by Strapparava et al. (2004) and Strapparava and Valitutti (2004): this allows us to extrapolate the emotional content of economic news and measure the presence of specific emotions in the selected economic news and use them as predictors of suicide numbers. We focus on four emotions capturing the negative affective states of fear, anxiety, sadness and despair. These negative emotions have been linked by the psychology literature to facial expressions that can be considered as universal, i.e., observable basic emotional expressions across different cultures (Ekman (1993)). We explore whether the new information provided by the emotion indicators may help in better predicting and forecasting suicide rates relative to traditional determinants of suicides. To this end, we carry both an in-sample analysis and an out-of-sample exercise. Our results indicate that augmenting regression with selected daily news-related emotions improves significantly the in-sample prediction of the suicide numbers relative to the benchmark model for England and Wales. We also find that highly negative emotions improve the forecasting power of suicide numbers for a forecasting horizon of between one week and three months. Our findings add to existing studies on the relationship between economic conditions and suicide.

Our study has a number of important evidence-based implications. Empirical findings point at emotion indicators extracted from news as useful tools for policy makers to track and anticipate variations in mental health needs. This seems particularly important in light of the recent suicide prevention strategy for England implemented by the Government, and noting the disconnection between the timing of the release of suicide statistics and the necessity for up-to-date information on mental health needs when designing evidence-based policy interventions. Therefore, the development and maintenance of sentiment-based indicators may allow central governments to better track mental health needs and anticipate changes, thus helping estimating more accurately the allocation of health budget to mental health. Overall, extracting sentiment and emotions from economic news to predict suicides stands as an important example of how non-traditional data sources may help central decision makers in allocating resources for health and mental health care more swiftly and efficiently.

The remainder of the paper is structured as follows. Section 2 presents the data, while Section 3 is devoted to the construction of our emotion indicators. Section 4 discusses the results and Section

5 concludes.

2 Data

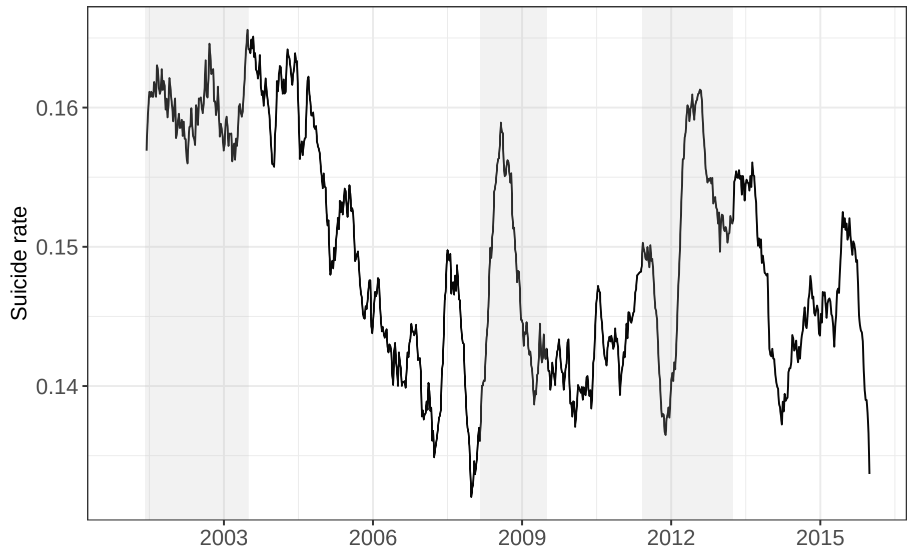
2.1 Suicide data

We use daily data on the total number of suicides in England and Wales, for the period from the 1st of January 2001 up to the 31st of December 2015. These data have been provided by the Office for National Statistics (ONS) following a data request. Ideally, our study would benefit from using suicide data at a fine level of aggregation, such as regional, local authority, or neighborhood levels. This granularity would allow us to exploit cross-sectional variation and potentially identify causal relationships. However, to protect the identity of individuals in areas with a small number of suicide, these data have been provided with no further breakdown by geographic area. Suicide data are released by the ONS with a 2-3 year lag, given that coroners' reports often take time while circumstances leading to death are examined. Even after this lag, data on suicides are often updated as new information on some past deaths may become available.

A substantial body of literature on seasonal and temporal effects on suicides documents a consistent increase in suicides and suicide attempts during spring and early summer, as well as on specific days of the week. Several studies have identified a higher frequency of suicide peaks on Monday, declining over the course of the week, a phenomenon commonly referred to as "Blue Monday (Cavanagh et al. (2016)), while other studies have noted an increase in admissions for suicide attempts during weekends (Valtonen et al. (2006)). To reduce intra-year seasonal patterns, we aggregated the variable "number of suicides" at weekly level. Further, we divided the total number of suicides by total population, and expressed suicide rates in 100,000 population. Figure 1 shows the temporal evolution in weekly suicide numbers per 100,000 population. The shaded grey area indicates the timing of the recessions, as reported by the OECD recession indicator for the Euro Area. From the graph, we can clearly see that suicide rate rises in the periods covering the recessions.
We observe a peak in the suicide rate in the year 2013. While the UK was not in recession in those years, several European countries experienced high economic instability due to the sovereign debt crisis that followed the 2008 Great Recession. Through contagion in business failure, this may have influenced both the economic situation and suicide numbers in the UK. We also observe that in July 2013 there has been very hot dry spell with temperatures exceeding 30°C for 7 consecutive days, with this judged to be the most significant UK heat wave since July 2006.[1] Such rise in temperature could be associated to the growth in suicide numbers observed in the same period.

[1] Please see https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/interesting/2013/hot-dry-spell-july-2013—met-office.pdf

Figure 1: Temporal evolution of weekly suicide rate per 100,000 population in the England and Wales



Notes: The shaded gray areas indicate the OECD based Recession Indicator. Suicide figures in this and following graphs are reported as 6-month rolling means.

2.2 News data

We extracted news articles from Dow Jones from six major UK newspapers, namely: the Guardian, the Daily Mirror, Evening Standard, the Observer, the Sunday Times and the Times. We picked these newspapers because they are generalist national newspapers amongst those with highest weekly use in the country (Newman et al. (2019)) [2]. We focused on a sub-group of articles that are categorised by Dow Jones as discussing economic topics. Such selection has lead to a total of 201,807 news articles published over the period 01-01-2001 until 31-12-2015.

Figure 2 reports the temporal evolution in the total number of words (expressed in 1,000s) of the selected articles calculated on a weekly basis. It is interesting to observe a sharp increase in the number of words over time, in the years up to 2010, indicating that the economic crisis generated by the 2008 global financial collapse attracted a lot of media attention that persisted after the end of the crisis. After the end of 2010 we observe a reduction in the number of words extracted from the articles, followed by another sharp rise in 2015.

[2] See also https://yougov.co.uk/ratings/entertainment/popularity/newspaper/all

Figure 2: Total number of words from UK economic news over time (expressed in 1,000s of words)

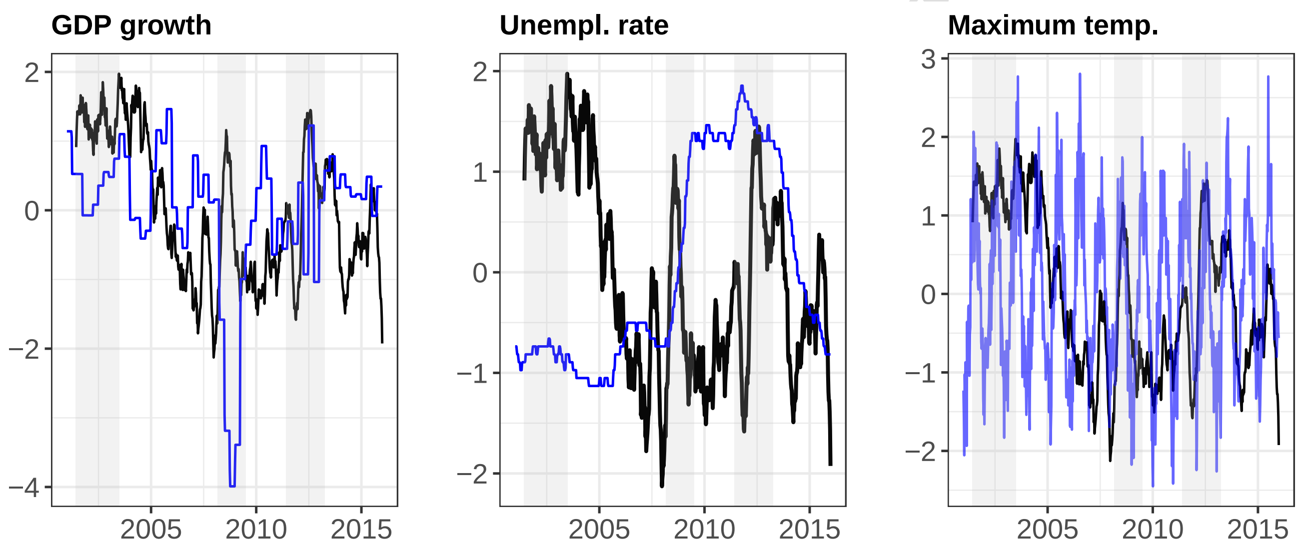
Notes: The shaded gray areas indicate the OECD based Recession Indicator.

2.3 Other determinants of suicide

To identify the relationship between sentiment from economic news and suicide rates, the ideal regression would use suicide data at the regional level and indicators extracted from local news. These indicators would include not only sentiment but also the intensity of news consumption, such as the number of page visits to specific news articles, and the prominence of the news, such as whether it appears on the front page. However, due to data constraints, we do not have access to this detailed information. To better identify the relationship between economic news sentiment and suicide rates, we have collected a number of control variables to be included in our regression equation, that are often pointed as important determinants of mental health.

First, we gathered monthly data on unemployment rate and quarterly data on Real Gross Domestic Product expressed in 1 quarter growth from the Office of National Statistics. These variables are often used as proxies for economic hardships and lifetime earnings, and are often incorporated as determinants of suicide numbers. Higher unemployment and lower economic growth implies less economic opportunity, lowering an individual's expected income, and might be associated with depressive episodes, anxiety, and loss of self-confidence that often leads to suicide (Andrés and Halicioglu (2010)). Further, we collected data on the daily maximum temperature from the MET Office. In fact, recent literature has found evidence that hotter weather increases both suicide rates (see, for example, the paper by Burke et al. (2018)). We have used the daily temperature series to calculate the occurrence of extreme weather episodes, which are likely to affect mental health status. Specifically, we define an indicator of extreme weather taking value of 1 if the maximum temperature registered on that day is 10 degrees or above the average maximum temperature registered for that day in the last 144 years. By doing this, we find a total of 266 extreme deviations from average maximum temperature, particularly concentrated in the years 2003, 2006 and 2011

Figure 3: Temporal evolution of suicide rate (in 100,000s pop) (black) versus GDP growth, unemployment rate and maximum temperature (blue)



Notes: The shaded gray areas indicate the OECD based Recession Indicator. For comparability reasons, data have been rescaled.

when over a third of the episodes occur.
Figure 3 summarises the temporal evolution of GDP growth, unemployment rate and maximum temperature against suicide rate variable.

3 Sentiment and emotion extraction from news

Emotions are an important element of human nature and have been widely studied in psychology and behavioral sciences. Emotions differ in whether they express a positive or negative overall tone, or valence, as well as on the intensity of the emotional response. From the literature in psychology, higher intensity messages affect the comprehension and memorization of readers since they are often remembered better than neutral ones (see Megalakaki et al. (2019) for a review).
To assess the emotional content of news, we have adopted the WordNet-Affect emotions classification developed by Strapparava et al. (2004) and Strapparava and Valitutti (2004). The WordNet-Affect emotions classification scheme is based on Ekman (1993)'s List of Basic Emotions (i.e. *Anger, Disgust, Fear, Happiness, Sadness, Surprise*) further refined into a set of 32 classes by exploiting the emotional model and categorization proposed by Elliott (1992). It is a dictionary-based approach that consists of counting the number of terms capturing particular categories of text.
Specifically, Strapparava et al. (2004) have manually produced an initial list of 1,903 terms directly or indirectly referring to emotional states (core affective states). They have exploited the lexical English database known as WordNet to extend such a list of terms to obtain a total of 4,787 terms linked to different emotional states. One advantage of using this dictionary is that the various moods have been extracted for each specific domain (for example, politics, economics, etc.) exploiting the

WordNet Domains classification by Magnini and Cavaglià (2000).

In this paper we focus on negative emotions that are often associated to mental health problems and depression. Specifically, we consider four key emotions: *Sadness*, *Fear*, *Despair*, and *Anxiety*. Under the WordNet-Affect classification, these emotions differ in intensity (also known as arousal), and dominance, namely, the controlling and dominant nature of the emotion. For example, Under the WordNet-Affect classification, Fear is a high-arousal emotion eliciting feelings of strong worry and fright, while Anxiety is associated to words that express worry, concern, uneasiness about some present or future situation, having a relatively lower intensity (low arousal). Sadness is a low arousal emotion characterized by feelings of disadvantage, loss, grief and sorrow. Finally, the emotion of Despair expresses in our news a negative or depressed affective state of hopelessness, in which an undesirable outcome is anticipated from a given situation.
The rationale for considering these emotions is that we wish to capture the negative affective states of individuals, linked to distress, fear and hopelessness when the economy does not perform as expected (Taffler (2018)). We also remark that these four emotions belong to the core set of emotions identified by the psychological literature as universal across different cultures and directly linked to different facial expressions (Ekman (1993)).

Table 1 shows some examples of sentences that are highly rated according to our four emotion indicators.[3] The table reports a set of "secondary" emotions attached to each primary feeling of Anxiety, Fear, Sadness and Despair, representing alternative paths to the same emotion. It is interesting to observe that the various sentences demonstrate large differences in intensity and excitement that we thus expect that different feelings and reactions are triggered. Anxiety is an emotion characterized by feelings of pessimism and negativity. The second and the fourth emotion, namely Fear and Despair, have excitement in common, while Sadness is characterised by a feeling of depression, discomfort and reduced energy.

[3] The first sentence, related to Anxiety, is taken form https://www.theguardian.com/world/2017/jul/14/globalisation-the-rise-and-fall-of-an-idea-that-swept-the-world, while the second, related to Fear, from https://www.theguardian.com/commentisfree/2022/nov/02/the-uk-economy-is-about-to-be-thrown-into-a-black-hole-by-its-own-government; the third is taken from https://www.theguardian.com/business/blog/live/2019/oct/02/manufacturing-slump-heightens-global-economic-gloom-business-live?page=with:block-5d94608e8f081108db9c0a71, the fourth from https://www.theguardian.com/politics/2019/jan/15/theresa-may-suffers-historic-defeat-as-tories-turn-against-her.

Table 1: Example of sentences conveying the 4 emotions

Primary Emotion	Secondary Emotion	Example Sentence
Anxiety	Apprehension, Worry, Uneasiness, Concern Negative suspense	Opinion polls registered their strong levels of anxiety and insecurity, and the political effects were becoming more visible.
Fear	Alarm, Fright Shock, Scare, Terror, Horror,	The Central Bank was considering raising interest rates because it feared inflation: the real threat was of a monster recession.
Sadness	Depressing, Gloomy, Heartbreaking, Regret Discomfort	Adding to the economic gloom sparked by yesterday's dismal manufacturing numbers in the US and elsewhere, Germany's leading economic institutes have slashed their growth forecasts.
Despair	Pessimism, Frustration, Hopelessness, Disheartened Negative suspense	On a day of extraordinary drama at Westminster, the House of Commons delivered a devastating verdict on the prime minister's deal.

For each week in the sample, we calculated the total number of words that carry negative emotions Anxiety, Fear, Sadness and Despair appearing in the selected articles published in that week. Subsequently, for each emotion we calculated a moving average with a rolling window of 24 weeks (i.e., 6 months). In particular, we set:

$$Emotion_t = \frac{1}{24} \sum_{s=t-23}^{t} \frac{WC_{emotion,s}}{WC_s}, \tag{1}$$

where $WC_{emotion,s}$ is the words count of a specific emotion in the selected articles published in the UK at time s according to the Wordnet-Affect lexicon, while WC_s in the total word count for that week. By taking a 24 week rolling window, we assume that readers remember and are affected by news released at most 6 months before. [4] Finally, to facilitate the interpretation of regression results, we have rescaled our emotion variables in the regression analysis so that they have zero mean and unit variance.

We can now include the news indicators in a regression model, to explain variation in suicide rates. Specifically, the emotion-augmented statistical model for death rate by suicide at the weekly level is:

$$SR_{t+h} = \sum_{j=0}^{p} \rho_j SR_{t-j} + \beta Emotion_t + \gamma X_t + \varepsilon_{t+h} \tag{2}$$

where SR_t is the weekly number of suicides observed in week t divided by total population and expressed in 100,000s, $Emotion_t$ is our emotion indicator measured in week t, X_t is a set of controls and ε_t is the error term.
In the forecasting exercise, we set the forecasting horizon, h, such that $h > 0$, while in the nowcasting exercise we set $h = 0$ and exclude SR_t from the right hand side of equation (2).

[4] We have tried varying the rolling window between 12 and 24 weeks are results from the regression analysis are similar.

Suicide is seasonal, which is why trends across the same calendar months are often similar in different years, regardless of suicide levels. For example, there is an increase in suicides in spring compared to winter (see Rock and Hallmayer (2003)). To account for possible seasonal patterns in suicide numbers, we also included monthly dummies in the regression. Further, to account for changes in the mood during bank holidays, we have included dummies that indicate if bank holidays are present in the reference week.

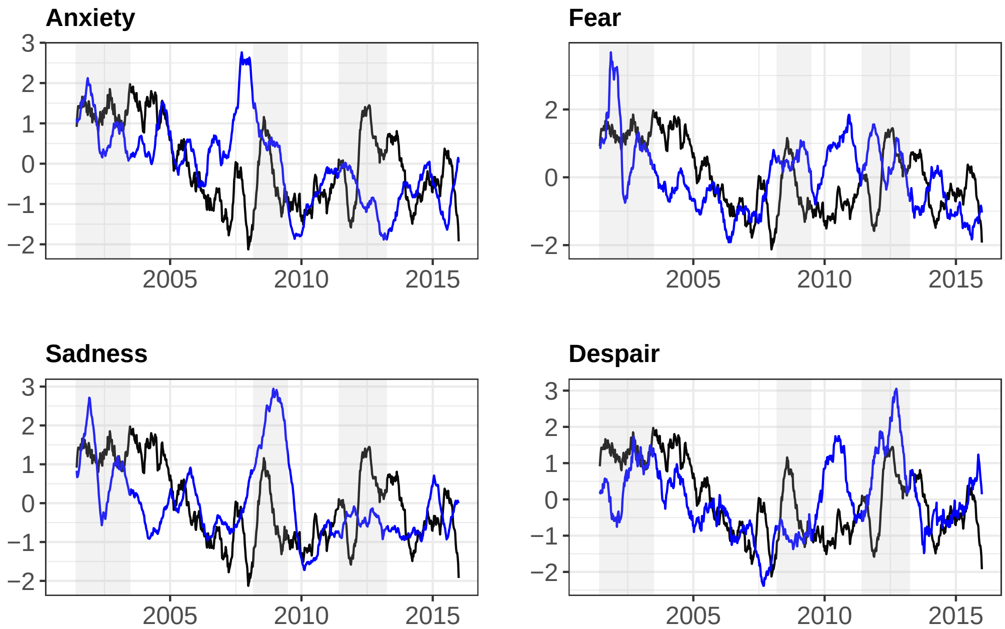
Factors that affect suicide rates, such as unemployment, persist over time. For these reasons, suicides demonstrate time dependency. In the above equation, the lagged values of suicide rates are incorporated in the regression to account for such time dependency, where the maximum lag, p is selected using the AIC information criterion.

As controls, in the X vector we included the previous period GDP growth and monthly unemployment rate, the maximum temperature registered in the week, and the number of extreme episodes registered in the week. GDP growth and monthly unemployment rate are lagged by one period to account for the fact that there exists some time lag before one can observe economic variables. Equation (2) with $h = 0$ is adopted for the in-sample analysis, aimed at estimating the impact of emotion indicators on suicide rates. When carrying the out-of-sample analysis, we set h, our forecasting horizon, varying between 1 and 24 weeks (i.e. 6 months). In the above model, we use information available at time t to predict suicide numbers observed at week $t + h$. We estimate equation (2) using the full sample for the nowcasting exercise, and subsequently adopting a rolling-windows approach. Specifically, we re-estimate the unknown parameters in Equation (2) every week over a 6-year rolling window. Accordingly, our out-of-sample period is the period from 29/05/2007 to 31/12/2015. For each rolling window, we calculate the h-step ahead forecast and associated forecast error. To evaluate the forecasting performance of models, we calculated the Root Mean Square Error (RMSE) associated to the h-step ahead forecast, and computed the Diebold and Mariano (DM) statistic over rolling out-of sample windows. In calculating the Diebold and Mariano statistic we have used as benchmark a model that only contains traditional determinants of suicide, i.e., equation (2) with $\beta = 0$.

4 Regression results

Figure 4 shows the evolution of suicide numbers against our emotion indicators over the sample period. The temporal evolution of suicide changes seem to be similar to that of Anxiety and Fear in the first part of the sample, up to 2012. Sadness demonstrated a steep increase during the 2008 Great Recession, but does not seem to be closely related to suicide afterwards. Despair appears closer to changes in suicide in the last part of the sample, from 2010 onward. Overall, from these graphs it emerges that temporal variations in our mental health indicator seem to be linked to the evolution in Anxiety and Fear in the first part of the sample and that in Despair in the second part of the sample, perhaps pointing to the use of increasingly negative, emotionally arousing language in news over time.

Figure 4: Temporal evolution of suicide rate (in 100,000s pop) (black) versus negative emotion indicators (blue).



Notes: The shaded gray areas indicate the OECD based Recession Indicator. For comparability reasons, data have been rescaled.

4.1 Nowcasting

Table 2 presents results of the estimation of equation (2) when $h = 0$. Column 1-4 displays the size and significance of the estimated coefficients attached to our indicators (Anxiety, Fear, Sadness, Despair). We observe that we include these variables in separate regressions as they are highly correlated with each other. As a benchmark, we also report results for a model that only contains traditional determinants of suicide (Column 5). It is interesting to observe that the emotion indicators, except for Anxiety, are all positive and statistically significant, with sizeable effects. On average, for Fear, Sadness and Despair, one standard deviation increase in one of the emotion indicators is associated to a rise of 200-300 in the excess number of persons committing suicide. This result seems to indicate that news are important in anticipating variations in suicides. The temporal lags in number of suicides have statistically significant coefficients. The statistically significant coefficient of the lagged variable indicates the persistence of variables that affect suicides (such as economic factors), as well as the seasonal patterns that generally occur every year, meaning that the decrease in suicides in springtime will be repeated. When focusing on traditional determinants of suicides, coefficients attached to GDP growth and unemployment rate are both statistically insignificant in most regressions. We observe however, that GDP growth has a positive and statistically significant coefficient in regression reported in Column (3), while unemployment rate has a negative and significant coefficient in regression reported in Column (2) and (4). Overall, our regressions offer limited evidence suggesting that, at least in the short-term, mental health status may decline as

macroeconomic conditions improve.
This outcome is coherent with the notion of a pro-cyclical suicide rate, a conclusion drawn by Neumayer (2004) and by Ruhm (2015) for various health indicators, although not for suicide rates. Further, it is consistent with the study by Antonakakis and Collins (2018) and Claveria (2022) who pointed at that the positive correlation between economic growth and suicide, at least for middle and high income countries. As for the weather condition variables, the maximum temperature has a strong positive impact on suicide rates, thus confirming previous results on the relevance of this variable for the mental health status (see, among others, Burke et al. (2018)). Once controlled for this variable, we find an insignificant effect of extreme weather episodes on the dependent variable. Finally, we observe an adjusted R^2 varying between 0.144 and 0.161, depending on which sentiment is included in the regression. We do observe an improvement in the adjusted R^2 when accounting for our emotions indicators, and in particular, in the case of Fear and Despair.

Table 2: The impact of news emotions on suicide rate

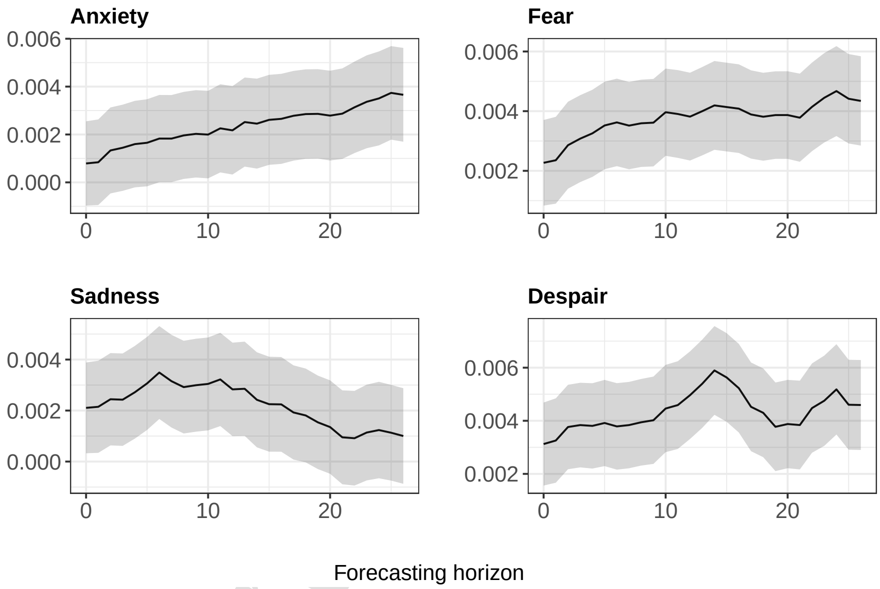
	Dependent variable: SR_t				
	(1)	(2)	(3)	(4)	(5)
Anxiety$_t$	0.001				
	(0.001)				
Fear$_t$		0.002***			
		(0.001)			
Sadness$_t$			0.002**		
			(0.001)		
Despair$_t$				0.003***	
				(0.001)	
GDP growth$_t$	0.001	0.001	0.003**	−0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Un. rate$_t$	−0.0002	−0.001*	0.0001	−0.002***	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Temp$_t$	0.001***	0.001***	0.001***	0.001***	0.001***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Extreme$_t$	0.001	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
SR_{t-1}	0.085**	0.072*	0.078**	0.061*	0.085**
	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)
SR_{t-2}	0.114***	0.102***	0.108***	0.091**	0.115***
	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
SR_{t-3}	0.048	0.037	0.042	0.026	0.048
	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
SR_{t-4}	0.141***	0.130***	0.136***	0.119***	0.142***
	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
SR_{t-5}	0.119***	0.109***	0.114***	0.097***	0.120***
	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
Adjusted R^2	0.143	0.154	0.149	0.161	0.144
F Statistic	6.780***	7.269***	7.021***	7.620***	7.077***

Note: *p<0.1; **p<0.05; ***p<0.01. In the regression specification we have included monthly dummies and a bank holiday dummy. Further, 5 lags of the dependent variables have been included in all regressions. In this table we use classical OLS standard errors.

4.2 Forecasting

We now turn to the out-of-sample prediction exercise, and estimation of equation (2) with $h > 0$ over rolling windows. Figure 5 reports the estimated coefficients of β in equation (2) and associated confidence bands, when varying h between 1 and 26 weeks (i.e., around 6 months). We observe a rise in the parameters associated to Anxiety and Fear as the time horizon increases, especially at longer horizons ($h > 10$). In other words, observing a more negative language expressing fear and anxiety in economic news at a point in time seems to be associated with a deterioration in mental health and consequent rise in the number suicides in the following 3-6 months. The t-stats associated to Despair and Anxiety are always statistically significant with h up to 20 weeks. On the contrary, the effect of Sadness seems to be weak and vanishing over time.

Figure 5: Estimated parameters $\hat{\beta}$ and associated confidence bands from equation 2 for varying forecasting horizon, h.



Notes: The black lines report estimated coefficients, while the shaded gray areas indicate the 95 per cent confidence bands.

Table 3 shows the results of the out-of-sample forecast exercise to test whether predictive performance of our news-augmented model is significantly better relative to that of the benchmark model containing only traditional determinants. To this end, we compare the RMSE of model (2) with that of model (2) with $\beta = 0$. For the comparison we use the Diebold and Mariano statistic (Diebold and Mariano (1995)) for different forecasting horizons, h. Overall, the Despair indicator shows some forecasting power. In particular, Despair has a statistically significant DM at forecasting horizons from 1 week to up to 4 month, while the other emotion indicators do not seem to have any forecasting power.

From these findings it seems that only the more extreme emotion of Despair are able to anticipate variations in suicide numbers. These results also suggest that the use by media of a language carrying very negative feelings, such as alarm, frustration and extreme discomfort, to comment on economics facts could be used as a early signal of a deterioration in the mental health status of a population.

Table 3: Diebold and Mariano tests at different forecasting horizons

Horizon	Anxiety	Fear	Sadness	Despair
1 week	1.664	-0.139	1.063	-1.713**
2 weeks	2.100	-0.580	0.877	-1.750**
3 weeks	1.809	-0.659	0.646	-2.137**
1 month	1.478	-0.456	0.808	-2.282**
3 months	0.814	-0.543	0.157	-1.467*
4 months	0.077	-0.811	0.069	-1.330*
6 months	-0.854	-0.840	-0.241	-0.442

Note: *p<0.1; **p<0.05; ***p<0.01

5 Concluding remarks

This paper exploited emotions extracted from economic news to explain and, to a certain extent forecast, national daily suicide figures in England and Wales in the years between 2001 and 2015. We have considered a set of negative emotions that are often associated with poor mental health and depression. We find that there is a significant association between the way in which the economic situation is commented in newspapers and suicide figures: after controlling for economic and weather variables, as well as a number of seasonal components and past suicide numbers, the more negatively people view their prospects, the higher the likelihood of suicide.
Further, during economic downturns, we find that both negative emotions and suicide numbers increase significantly. The indicator of Despair extracted from news is the negative emotion that appears to better forecast suicide numbers. This is particularly interesting, as suicides have been included in the so-called 'deaths of despair' (Case and Deaton (2017)). One interesting extension of this study would be to carry the analysis by considering the weekly suicide rate split by age classes. According to previous literature, younger people seem to be more vulnerable to the influence of the media in terms of on suicidal behavior, although limited evidence also shows an impact on elderly people (Hawton (2002)).

A limitation of the study is that we do not have information on individual circumstances that may lead to suicide, such as post-traumatic stress (Conner et al. (2014)), bereavement (Pitman et al. (2014)), separation (Wyder et al. (2009), divorce (Yip et al. (2015)) or bullying (Mueller et al. (2015)). We also do not have any details regarding socioeconomic characteristics, such as income, education etc. Such detailed information is generally not released, especially at the daily level, in order to protect the identity of individuals. Furthermore, as is always the case when analysing mortality data, some suicides might be mis-classified as accidents. A further limitation of this paper is that, due to privacy issues, suicide data are only available at an aggregate level, with no further breakdown by geographical area. Conducting a regional analysis, with regional-level suicide rates and indicators extracted from local news, would have significantly enhanced our analysis. Finally, we observe that the selected newspapers for building emotion indicators are predominantly generalist. It would be of great interest to explore the predictive power of sentiment towards some specific sectors. For example, using newspapers in the area of finance could enable a deeper exploration of the correlation between financial news and incidences of suicide. This could be the object of a separate study.

In the light of our results we argue that governments could assess the mental health needs of the population not only relying on traditional economic indications as proxies of such needs but also exploiting information entailed in non-traditional sources such as economic news. Using economic news as a proxy measure of individuals' mental health could be advantageous because it can provide daily updates and fill the gap of time typically required to produce national statistics. By monitoring economic news, policymakers could gain insights into the economic conditions that affect people's well-being and use this information to inform policy decisions related to mental health. Overall, combining traditional economic indicators with non-traditional sources of information, such as economic news, could provide a more complete understanding of individuals' mental health needs and help policymakers develop more effective policies to address these needs. As many suicides are impulsive and may happen at a moment of crisis (Zouk et al. (2006); Miller and Hemenway (2008)), designing preventive interventions is of great importance. For example, restricting access to means (Lewiecki and Miller (2012)), or providing digital support (Torok et al. (2020)) can save lives.

Appendix A: Brief overview of the WordNet-Affect

A synset is a group of data elements that are considered semantically equivalent for the purposes of information retrieval. WordNet-Affect is an extension of WordNet Domains (see Magnini and Cavaglià (2000)), that includes a set of synsets suitable to represent affective concepts representing moods, situations eliciting emotions, or emotional responses. The authors specifically initially identified a set of words that directly refer to emotional states (e.g. fear, cheerful, sad). Then, they expanded this initial set by implementing an unsupervised algorithm that exploited a mechanism of semantic similarity to automatically acquire from a large corpus of texts (100 millions of words). The final data set includes 1641 terms characterising 28 different emotions. Further information on the approach are available at the web link https://wndomains.fbk.eu/wnaffect.html.

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We study how language used in economic news can predict suicides in England and Wales

We extract daily indicators measuring a set of negative emotions from economic news

We find that negative comments in newspaper articles are predictors of suicide numbers

Monitoring media sentiment can help decision makers in anticipating trends in suicides

The authors declare non conflict of interests.