

Anxiety for the pandemic and trust in financial markets*

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Abstract

The COVID-19 pandemic has generated disruptive changes in many fields. Here we focus on the relationship between the anxiety felt by people during the pandemic and the trust in the future performance of financial markets. Precisely, we move from the idea that the volume of Google searches about “coronavirus” can be considered as a proxy of the anxiety and, jointly with the stock index prices, can be used to produce mood indicators – in terms of pessimism and optimism – at country level. We analyse the “very high human developed countries” according to the Human Development Index plus China and their respective main stock market indexes. Namely, we propose both a temporal and a global measure of pessimism and optimism and provide accordingly a classification of indexes and countries.

The results show the existence of different clusters of countries and markets in terms of pessimism and optimism. Moreover, specific regimes along the time emerge, with an increasing optimism spreading during the mid of June 2020. Furthermore, countries with different government responses to the pandemic have experienced different levels of mood indicators, so that countries with less strict lockdown had a higher level of optimism.

Keywords: COVID-19; coronavirus; Google Trends; Financial Stock Index; Mood.

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1 Introduction

The world is experiencing the rapid and dramatic widespread of COVID-19 [14, 22] – a pandemic generated by a coronavirus – with millions of infected and a large number of deaths. Beyond the sanitary aspects of such an infectious disease, one of the main concerns experienced by the community regards the economic impact of the measures taken for contrasting the virus.

The individuals' behaviours are at the core of the interest of many scientific studies given that, those behaviours are the critical variables to understand the perspective of many economic activities. Several businesses require the physical interactions among the involved actors – and such interactions have been reduced by the lockdown policies and by the natural attitude of people avoiding possible sources of contagion – while virtual connections allow another set of economic relevant activities, such as investing in financial markets. Interestingly, [9] provides a brief discussion on the reactions of the financial markets to rare catastrophic events of non-financial nature. The author points the attention of the readers to the plausible parallelisms between pandemics and natural disasters, terrorist attacks and even nuclear conflict. Less recently, [13] elaborate on how aviation disasters can generate a decline in stock market prices. In general, empirical evidence prove that prices collapse in concomitance to rare and unexpected disasters (see, e.g. [2, 7, 10]). On the same line, but in a broader perspective, several authoritative studies highlight that anxiety and negative mood might increase investors' risk aversion, hence leading to the collapse of stock prices (see, e.g. [1, 11, 12, 4]).

Therefore, the financial distress we are observing in the international stock markets can be reasonably interpreted through the anxiety of people, whose worries for the pandemic disease affect the expectation of financial markets future performance.

This paper enters this debate. Specifically, it explores how the anxiety for COVID-19 mirrors the strategies of investing/disinvesting money in financial markets. In particular, we discuss the relationship between anxiety for COVID-19 and the view of financial markets, with the particular aim of investigating optimism and pessimism. The analysis is carried out by dealing with the country-level moods. We explore the relationship mentioned above for a large set of countries, to derive the different behaviours of the populations. [6] and [3] are remarkably relevant for contextualizing our study. The authors discuss the economic anxiety stemmed from coronavirus. [3] conducts a survey study of over 500 US consumers and shows that the serious concern about coronavirus implications leads to pessimistic expectations about macroeconomic turnaround via deterioration of the economic fundamentals. [6] complement [3]'s perspective by including also the time dimension and the causal effect of the pandemic on the increased economic anxiety. The methodological ground of [6] lies on the meaningfulness of Google Trends data, which are assumed

to give in-depth information on the development of the anxiety in the specific context of the economic outcomes. We adopt [6]’s view and hypothesize that anxiety for COVID-19 is proxied by the irrepressible persistence of related Google searches. In so doing, we also follow [15], where a survey study over a large number of respondents confirms that media exposure and online searches are good predictors of the increasing fear of coronavirus (in this, see also the review paper by [8]).

In details, we collect and compare two different datasets over the same reference period which goes from January 6th, 2020 to the June 19th, 2020. By one side, we consider the daily Google Trends data. Specifically, we examine for the searches volumes of the word “*coronavirus*” along with its translations for different countries and respective most spoken languages. Data retrieved at a country level allows for sounding out similarities and discrepancies in the searching for information practised by users in need of awareness. In our approach, such a compulsive searching is intended as a proxy for the anxiety generated by the pandemic. On the other side, we consider the daily levels of the main stock indexes, which include companies related to the considered countries. The source of financial data is Datastream. In order to have a reliable and consistent dataset, countries are chosen by using the Human Development Index (HDI) embraced by the United Nations Development Programme (UNDP) in the Human Development Report Office to rank countries on the basis of their human development. Specifically, we select the areas having an HDI index greater than 0.8 calculated with the 2018 information. The choice of 0.8 as a threshold is appropriate because all the countries having at least that level can be considered as “very high human developed countries”. It ensures a good enough level of connections between socio-financial entities within the countries, namely it guarantees the incorporation of the necessary links between citizens’ cognitions of the problems, ability to get informed about them and financial strategies designer presence. To such a list of nations, we add China, which is ranked below the 0.8 thresholds – specifically, 0.75. We reasonably do so because China is central in the phenomenon under investigation. Moreover, the countries without data on stock exchanges in our source – which is Datastream – have been obviously excluded from the list.

We move our steps from [6] in two main respects: first, the quoted paper deals with topics in Google Trends, and we deal with one crucial word. In so doing, we have a translation task to face – as also acknowledged by [6]. Nevertheless, the use of one word allows to obtain intuitive results and is far from being restrictive in our context. Indeed, a preliminary inspection of the Google Trends data shows that the considered word is the most relevant trend related to the current pandemic; second, the quoted paper derives information about economic anxiety directly by Google Trends. Differently, we here start from the idea that the anxiety is manifested through the Google searches of the word “*coronavirus*” (and its translations), but then we move to the real performance of the financial markets, to assess the links with the trust on them.

Some distance measures between time series have been suitably introduced to offer a wide perspective on the connections between the considered data. We consider concepts of distance focusing on specific dates and offering global information on the entire reference period. All the proposed measures range in the unitary interval $[0, 1]$, hence letting the comparative analysis of different countries be possible.

Several interesting results emerge. Countries and markets can be properly clustered in terms of their mood during the pandemic period. Regularities and deviations at individual week level can be also identified. Moreover, the analysis of the daily variations of the levels of anxiety and trust in financial markets gives insights on countries behaviors in the overall period. A general trend of pessimism is concentrated in early and mid March, when the lockdown have been adopted by many countries and the international community started to reckon the severity of the problem. A focus on some noticeable cases of hard and weak lockdown policies has been also presented. In this respect, countries with a stricter lockdown have a more persistent and higher level of pessimism.

The rest of the paper is organized as follows. Section 2 presents the employed dataset, by providing also details on the data collection procedure. Section 3 illustrates the methodological devices used for the study. Section 4 outlines and discusses the results of the analysis. Last section concludes.

2 Data

We now present the employed data. As we will see in detail below, the considered dataset is associated with the Google Trends and to the financial markets at country level. As a premise, we have to say that data on financial markets are not always available; moreover, the access to the web is not a reliable issue in some realities. Thus, we focus on a set of countries whose data are unbiased and reliable. At this aim – and for providing a consistent analysis – we have used the Human Development Index (HDI) adopted by United Nations Development Programme (UNDP)'s Human Development Report Office. HDI is a composite index made of factors like life expectancy, education, per capita income indicators and other relevant factors whose details are recollected in [17] by Mahbub ul Haq, one of the two designers of the index. HDI is used to rank countries on the basis of human development. We take all the countries defined as “very high human developed countries”, namely those having an HDI index greater than 0.8. The selection is based on data from 2018, Table 1 of [18]. China is added to the considered countries – even if the HDI of China is 0.75 – because of its centrality in the COVID-19 propagation; the first known human infections were in China.

The respective most used language is associated with each of these countries. Then, by means

of Google Translate, the word “*coronavirus*” is translated from English to each of those languages. In so doing, we obtain the translations reported in Table 1.

The translated terms are employed to download the web searches indicator from Google Trends. Namely, for each country, one looks for the searches of the respective “*coronavirus*” translations. In this way, the magnitude of the searches by country is obtained employing the words translated in the country most common language. The period investigated goes from January 6th, 2020 to June 19th, 2020.

At the end of this process, one gets a matrix of time series regarding 63 countries. In our analysis, we are interested in examining the time series of the searches from the first day in which a relevant volume of researches is recorded in each country – i.e., in the first day in which Google Trends offers a nonnull value – for the respective translated terms. See columns one, two and three of Table 1 and Figure 1 to have an idea of the main trends in the data. The most evident point regards the high volume of searches occurred during the same days around mid-March 2020.

We associate at least one stock market index with each country of the list mentioned above. Per each index, the closing prices are downloaded from Thomson Reuters Datastream. The time span is defined by the same criterion adopted in collecting the Google Trends data (see Table 2 and Figure 2), so that one has the same time span. Andorra, Bahamas, Barbados, Belarus, Brunei, Liechtenstein, Palau, Seychelles and Uruguay do not have a stock market index of reference in our data source, so we exclude them. The final list of considered countries contains 54 elements. Furthermore, we align the Google Trends data and the financial data so that, for each day in which prices are recorded, the volume of web searches can be used in the analysis. Consequently, because the financial markets are closed during non-trading days, Google Trends data is reduced accordingly. As a reference for the number of observation, one can look at column “N. Obs.” in Table 2.

3 Methodology

To face the problem, we design indicators able to capture the connection between anxiety for the pandemic and expectations on the future outcomes of financial markets. The underling idea relates to the synchronicity between increments and decrements of Google searches and of stock index levels, so that, increasing (decreasing) volumes of searches and decreasing (increasing) prices are associate to pessimistic (optimistic) moods.

To describe the employed methodology, some notation is needed.

We denote the number of considered countries by J – and J is 54 for us, see Section 2 – and

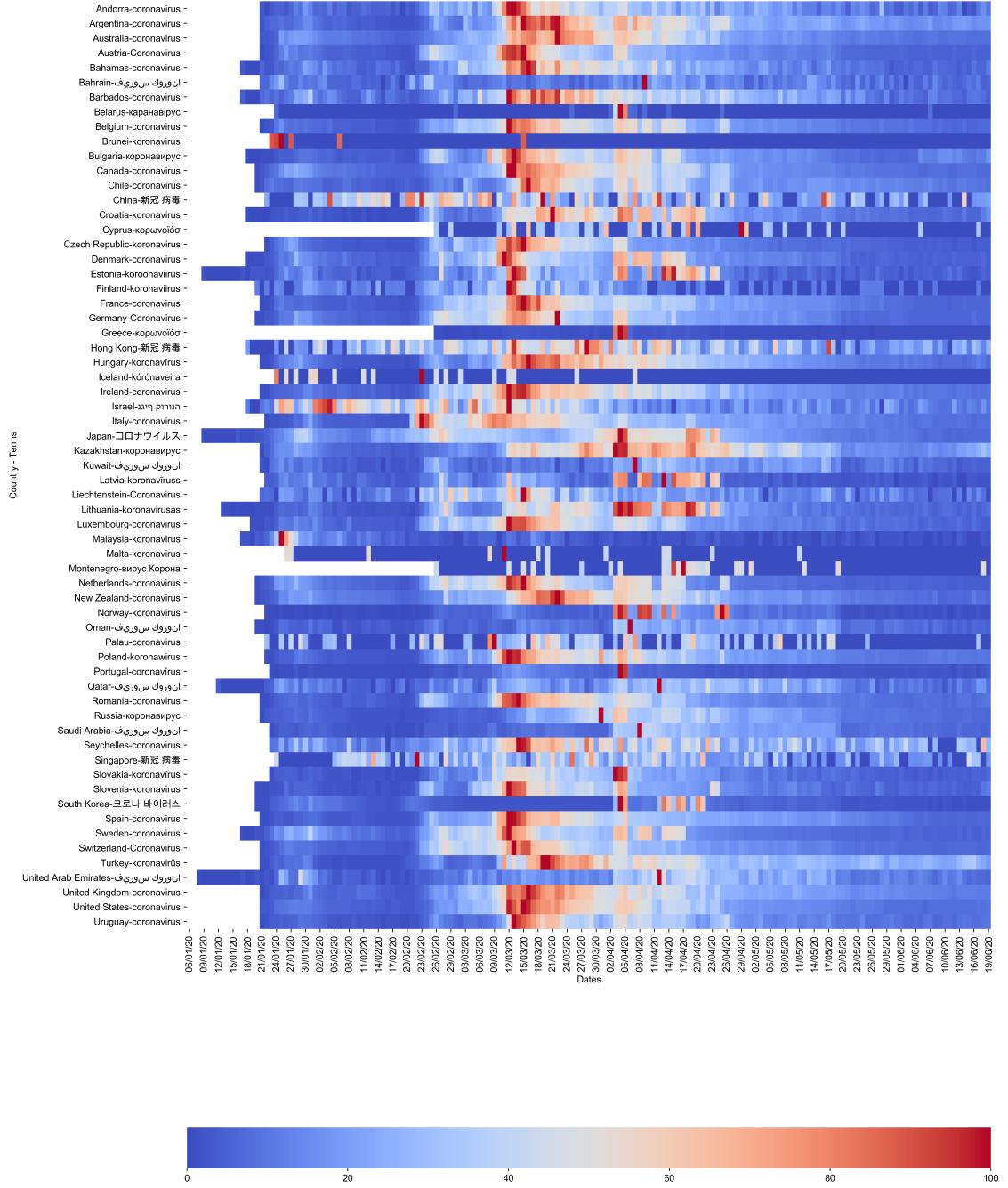


Figure 1: Heatmap representation of the Google search indicators of the word “*coronavirus*” and its translations in the respective most spoken language for each country. The indents give a clear view of the beginning of the interest in COVID-19 for each country.

label the generic country by $j = 1, \dots, J$. Each country hosts K financial markets. The number of financial markets depends on the selected country, so that one should write $K = K(j)$. Such a dependence will be omitted when not necessary. Often, $K > 1$ – i.e. the most part of the considered countries is associated to more than one financial market. However, there are cases of countries with $K = 1$. The generic financial market is $k = 1, \dots, K$.

As already discussed in Section 2, we have daily data on prices and Google searches of the word “*coronavirus*” (and its translations) in a common reference period of T days. For country j , we denote the available time series of the prices of the stock index k by $\mathbf{p}_k^j = (p_k^j(1), \dots, p_k^j(T))$. Analogously, the sample of the Google searches for country j is $\mathbf{w}^j = (w^j(1), \dots, w^j(T))$.

Notice that the range of variation of the components of \mathbf{p}_k^j and \mathbf{w}^j are different. Indeed, \mathbf{p}_k^j has nonnegative components, while the components of \mathbf{w}^j are integer numbers ranging in $[0, 100]$, and there exists \bar{t} such that $w^j(\bar{t}) = 100$. Time \bar{t} represents the day with the maximum level of searches over the period $[1, T]$, and depends naturally on j . Also such a dependence will be conveniently omitted. The minimum value of the elements of \mathbf{w}^j is not necessarily null. Indeed, null search means absence of interest for the considered word in country j – i.e., null amount of Google searches; such an occurrence does not necessarily appear over the period $[1, T]$. Assigning value 100 to the highest daily flow of Google searches over $[1, T]$ and null value to null searches allows the easy normalization – implemented directly by the Google Trends algorithm – of the Google search data in the range $[0, 100]$.

For better comparisons, we impose the variation range $[0, 100]$ also to the series \mathbf{p}_k^j for each j and k through a simple normalization procedure. We denote the normalized series of the prices by $\bar{\mathbf{p}}_k^j$.

First of all, we identify $\bar{t} \in \{1, \dots, T\}$ such that $p_k^j(\bar{t}) = \max\{p_k^j(t) : t = 1, \dots, T\}$. Then, we set $\bar{p}_k^j(\bar{t}) = 100$. Null price is associated to zero value for the normalized series, so that we set $\bar{p}_k^j(t) = 0$ when $p_k^j(t) = 0$. Evidently, one can have $p_k^j(t) > 0$ for each $t = 1, \dots, T$, so that one has $\bar{p}_k^j(t) > 0$ for each t .

The entire series can be derived as follows

$$\bar{p}_k^j(t) = \left[100 \times \frac{p_k^j(t)}{p_k^j(\bar{t})} \right], \quad \forall t = 1, \dots, T, \quad (1)$$

where $[\bullet]$ is the integer part of the real number \bullet .

The exploration and comparison of financial data and Google Trends will proceed at country level; it will be implemented by conceptualizing suitable distance measures, under different perspectives. In so doing, we provide several insights on countries regularities and discrepancies.

3.1 Time-dependent distance measures

We first build a distance measures based on the comparison between the time-dependent normalized accumulations of prices and Google searches. We consider $t_1, t_2 \in \{1, \dots, T\}$ with $t_1 \leq t_2$ and define

$$A_j([t_1, t_2]; k) = \frac{1}{2} \cdot \sum_{s=t_1}^{t_2} \left[\frac{\bar{p}_k^j(s)}{\bar{P}_k^j} - \frac{w^j(s)}{W^j} \right] + \frac{1}{2}, \quad (2)$$

where

$$W^j = \sum_{t=1}^T w^j(t), \quad \bar{P}_k^j = \sum_{t=1}^T \bar{p}_k^j(t).$$

By construction, it results $A_j([t_1, t_2]; k) \in [0, 1]$. A high value of $A_j([t_1, t_2]; k)$ means that $[t_1, t_2]$ is a time period with a high percentage of price of market k and a low percentage of Google searches – where percentages have to be intended in terms of the total amount on the overall period. Thus, $A_j([t_1, t_2]; k)$ close to one means that $[t_1, t_2]$ is an optimistic period. Differently, $A_j([t_1, t_2]; k)$ is close to zero when prices are relatively low and Google searches of the word “coronavirus” are relatively high. In this case, $[t_1, t_2]$ is a time interval where country j has experienced anxiety about COVID-19 and lack of trust in market k .

Notice that the case $t_1 = 1$ and $t_2 = T$ is trivial and not interesting, being $A_j([1, T]; k) = 1/2$ for each j and k – i.e., in the middle (fair) situation between optimism and pessimism. Indeed, $[1, T]$ is the entire period, hence being associated to full percentage of prices and Google searches. More reasonably, the proper selection of t_1 and t_2 allows to explore elements of the considered sample in relevant subperiods.

At a country level, we can average the A_j ’s in (2) with respect to the markets. In particular, we define

$$A_j([t_1, t_2]) = \frac{1}{K(j)} \sum_{k=1}^{K(j)} A_j([t_1, t_2]; k). \quad (3)$$

We observe that $A_j([t_1, t_2]) \in [0, 1]$, and all the comments reported above remain valid for the indicator presented in (3).

3.2 Global distance measures

We here compare the considered series on the basis of the signs of their daily variations. Specifically, we assess how often an increase (a decrease) of the Google searches is associated to a decrease (an increase) of the prices of the financial markets. The entity of the daily variation is also taken into account.

Consistently with our framework, we refer hereafter to a generic series $\mathbf{x} = (x(1), \dots, x(T))$, whose components range in $[0, 100]$.

Thus, given a threshold $\zeta \in [0, 100]$ and $t = 1, \dots, T - 1$, we define the sign variation of the series \mathbf{x} between t and $t + 1$ at the threshold ζ as follows:

$$\delta_t^{(\zeta)}(\mathbf{x}) = \begin{cases} 1, & \text{if } x(t+1) - x(t) > \zeta; \\ 0, & \text{if } -\zeta \leq x(t+1) - x(t) \leq \zeta; \\ -1, & \text{if } x(t+1) - x(t) < -\zeta. \end{cases} \quad (4)$$

The parameter ζ is fixed a-priori; it represents the entity of the daily variation to be crossed for stating that the series have an increase (or a decrease, by taking the variation with negative sign) from time $t - 1$ to time t . Evidently, the case $\zeta = 0$ leads to $\delta_t^{(0)}(\mathbf{x}) = 1$ when $x(t+1) > x(t)$, $\delta_t^{(0)}(\mathbf{x}) = -1$ when $x(t+1) < x(t)$ and $\delta_t^{(0)}(\mathbf{x}) = 0$ when $x(t+1) = x(t)$.

The comparison between the behaviors of the Google searches and of the financial markets can be performed at country level by means of the δ 's defined in (4).

For each $j = 1, \dots, J$, we compare the series \mathbf{w}^j with $\bar{\mathbf{p}}_k^j$, for each $k = 1, \dots, K(j)$.

We define

$$\Delta^{(\zeta)}(t, j, k) = \delta_t^{(\zeta)}(\mathbf{w}^j) - \delta_t^{(\zeta)}(\bar{\mathbf{p}}_k^j). \quad (5)$$

By definition, the Δ 's in (5) can take values in $\{-2, -1, 0, 1, 2\}$. Such values have specific meanings and deserve an interpretation.

When $\Delta^{(\zeta)}(t, j, k) = -2$, then we observe a decrease of the Google searches related to “*coronavirus*” and an increase of the price of the financial market k . This case has a clear interpretation in terms of optimism. Indeed, people show a decreasing anxiety for the pandemic disease – they weaken the amount of searches on the Google – and, simultaneously, exhibit an increasing interest in investing in the financial market. The value -1 is associated to constant Google searches and increase of the price or decreasing level of Google searches and invariant price. The value 0 is related to the cases of identical behavior between Google searches and price, so that they can be invariant between date t and $t + 1$ or both of them can increase/decrease. The value +1 relies to increasing level of Google searches and invariant price or, alternatively, a constant level of Google searches and decreasing price. The value +2 describes the situation in which Google searches grow and price decrease. This is the other corner case, in which anxiety and sadness for the spread of the disease – mirroring in the growth of Google searches – is associated to decreasing amount of investments in the financial market.

In general, the positive values of the Δ 's describe situations of pessimism, captured by anxiety for the disease and decrease of investments in the financial markets. Conversely, the cases of negative Δ 's are related to optimism, with decreasing interest for COVID-19 and growing attention for the future evolutions of financial markets.

Some distance measures with high information content can be derived by (5).

We measure the aggregated connection between the considered trend in Google and the price of market k in country j over the considered period by defining

$$H_j^{(\zeta)}(k) = \frac{1}{4(T-1)} \left[\sum_{t=1}^{T-1} \Delta^{(\zeta)}(t, j, k) + 2(T-1) \right]. \quad (6)$$

By construction, $H_j^{(\zeta)}(k) \in [0, 1]$. If such an indicator approaches zero, then people in country j tend to the highest level of optimism – in the sense expressed when discussed the case of -2 as value of the Δ 's – when analyzing the Google searches of the considered word and its connections with the price of financial market k . The converse situation appears when $H_j^{(\zeta)}(k)$ is close to one, where we are in presence of a high level of pessimism and anxiety.

By averaging the H_j 's in (6) with respect to k we obtain an indicator describing the reality at country level, for all the connections between the considered word and the prices of financial markets, as follows:

$$H_j^{(\zeta)} = \frac{1}{K(j)} \sum_{k=1}^{K(j)} H_j^{(\zeta)}(k). \quad (7)$$

Clearly, $H_j^{(\zeta)} \in [0, 1]$ and the arguments above – opportunely rephrased at country level – remain valid.

We now provide a measure of how a specific country has experienced optimism versus pessimism over the considered period. At this aim, we consider a ratio indicator as follows:

$$R_j^{(\zeta)}(k) = \frac{1}{2(T-1)} \left[\sum_{t=1}^{T-1} \mathbf{1}(\Delta^{(\zeta)}(t, j, k) = 2) - \sum_{t=1}^{T-1} \mathbf{1}(\Delta^{(\zeta)}(t, j, k) = -2) + T - 1 \right]. \quad (8)$$

where

$$\mathbf{1}(\bullet) = \begin{cases} 1, & \text{if } \bullet \text{ is true;} \\ 0, & \text{otherwise.} \end{cases}$$

By construction, $R_j^{(\zeta)}(k) \in [0, 1]$. For country j and when referring to market k , there is a high percentage of optimistic days with respect to pessimistic ones as the value of such indicator approaches zero, while we are in a substantial context of pessimism when the indicator in (8) is close to one. The corner cases have a clear interpretation: when $R_j^{(\zeta)}(k) = 0$, then all the days in the considered period present a decreasing anxiety for COVID-19 coupled with an increasing trust in market k ; differently, $R_j^{(\zeta)}(k) = 1$ is associated to an entire period of increasing need of awareness on COVID-19 and decreasing price of market k .

Also in this case, we can focus on country j by averaging the R_j 's over the markets:

$$R_j^{(\zeta)} = \frac{1}{K(j)} \sum_{k=1}^{K(j)} R_j^{(\zeta)}(k). \quad (9)$$

Evidently, $R_j^{(\zeta)} \in [0, 1]$ and the discussion reported above applies also in this more general case.

The global distance measures presented above capture two different aspects of the phenomenon under analysis. $H_j^{(\zeta)}$ and $H_j^{(\zeta)}(k)$ provide information on the mood as an average of the Δ 's over all the days of the considered sample. Differently, $R_j^{(\zeta)}(k)$ and $R_j^{(\zeta)}$ focus only on the dates where the daily variations of searches volumes and stock index levels have had discordant behaviors. Namely, the indicators R 's offer more details on the ratio between fully optimistic days and fully pessimistic ones, i.e. on the proportion of the days in which the Google searches have decreased and the indexes prices have increased and those with an increase of searches and a decrease of the prices.

4 Results and discussion

The normalised time series of the stock indexes prices are obtained via Eq. (1). The outcome of such a normalisation is presented in Figure 2 and the main statistical indicators of both the original and the normalised time series are showed in Table 2. The visual inspection of this Figure allows the reader to confirm the general trends of the markets, with a decline induced by incorporation of the pandemic effects. Figure 1 and Table 1 show the increased Google searches of the translated “coronavirus” in different countries. The searching activities started at a different time and with a general delay with respect to the decline recorded in the financial markets.

As a preliminary comment, we notice that the Moreover, the A_j 's in Eq. (2) and (3) compare the normalised values of Google searches and prices, while the H_j 's in Eq. (6) and (7) and the R_j 's in Eq. (8) and (9) compare their daily increments and decrements. Thus, the A_j 's offer a view of the snapshots of anxiety for COVID-19 and trust in financial markets; differently, the H_j 's and the R_j 's propose an evolutive perspective on the daily variations of the Google search and the stock market data.

In computing the index $A_j([t_1, t_2]; k)$ in Eq. (2), we take $t_2 - t_1$ constantly equal to five days, hence studying the weekly behaviour of the index. The outcomes per each index are summarized in Figure 4 and Table 3. Moreover, the results of $A_j([t_1, t_2])$ across the stock indexes of each country – namely, those in Eq. (3) – are reported in Figure 5 and Table 4. From this view, some facts emerge:

- The paths have drastically changed between the 7th and the 8th weeks of the year, namely between 17/02/2020 and 01/03/2020. This is the period during which the international community started to take the situation seriously despite the controversial statements of national governments' heads. On 11/03/2020, WHO's Director declared “WHO has been assessing this outbreak around the clock and we are deeply concerned both by the alarming levels of spread and severity, and by the alarming levels of inaction. We have therefore made

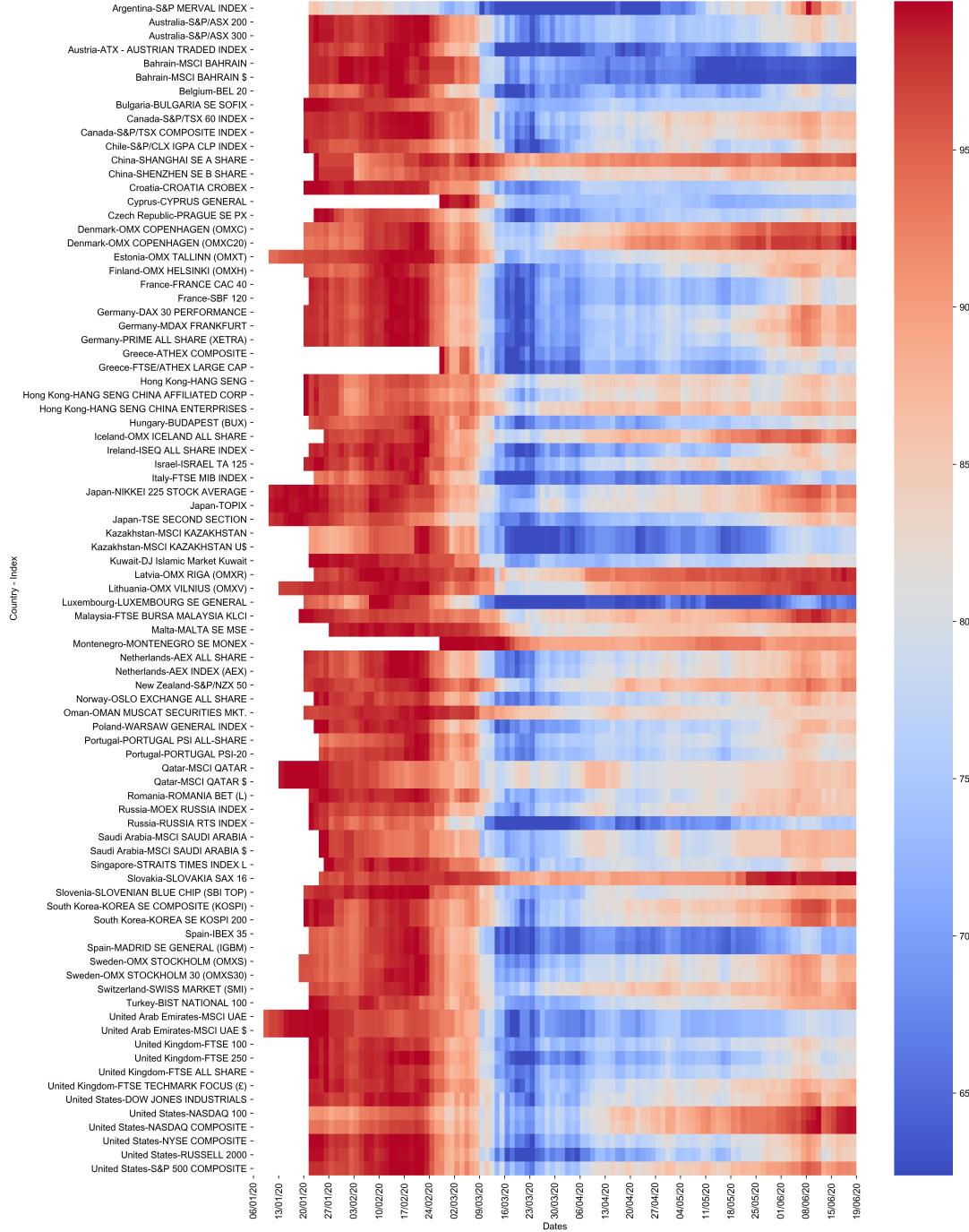


Figure 2: Heatmap representation of the normalised prices recorded for each stock market index (see, Eq. 1). The time series starting points are different because the prices are stored from the first day in which relevant volumes of Google searches in that country are recorded.

the assessment that COVID-19 can be characterised as a pandemic.” [19].

- Greece and South Korea have spent more than 90% of the analysed weeks in a quite positive mood, namely reporting an $A_j([t_1, t_2]) > 0.5$.
- Cyprus and Iceland have experienced mild pessimism on a quite large number of weeks. They present $A_j([t_1, t_2]) < 0.5$ at least 40% of the times in the studied period.
- Weeks 10 and 11 are characterized by the lowest average of $A_j([t_1, t_2])$. Their means across the countries are respectively 0.485 and 0.483.
- The highest number of countries experiencing a $A_j([t_1, t_2]) < 0.5$ is met on week 11. During the period 16/03/2020 - 20/03/2020, 81% of the analysed countries experienced a high volume of Google searches and a low level of normalised prices. Therefore, a high level of anxiety/pessimism. On the other hands, the tails (weeks 1-4 and 20-24) present a higher level of the index, with an increased presence of positivism in most of the countries during the most recent weeks.

In Table 5 the considered countries are week-wise ranked by using $A_j([t_1, t_2])$. Montenegro holds the first position for five weeks. Similarly, we observe that Greece, Iceland and Malta seat on the firsts four positions most of the times. This outcome suggests that these countries experienced waves of optimism and pessimism; interestingly, for the quoted countries, consecutive weeks may have a large discrepancy in the ranking positions. Thus, one can say that the waves are of impulsive and compulsive nature – perhaps, they are driven by news on the pandemic or statements of the Governments – and this leads to sudden changing of the people’s behaviour in searching on Google and taking positions in the market.

We also propose a focus of weekly rankings of some paradigmatic cases: Sweden, Iceland and South Korea – the countries with an easy lockdown, see [20, 21, 16] – and Italy, UK, USA and China – which are countries having or having had a harder lockdown. By inspecting Figure 6, one can appreciate that the countries having experienced an easier lockdown have spent more optimistic moods during the recent weeks.

The results show some regularities in the behavior across countries and indexes, as Figures 4 and 5 clearly testify. An initial phase of optimism was probably induced by skeptic statements from national governments and media agencies; in fact, the emergence has been underestimated by a large number of people at its inception, see [5]. Then, once the situation has escalated, Google searches have drastically increased (see Figure 3) and the markets have simultaneously reacted, plausibly also in the light of the lockdown policies implemented all over the world. The raised pessimism is represented in Figure 4 and 5 by the blue bands in weeks 10-15. A general relief

came in after that. In a few cases, the anxiety boosted from the very beginning. This is clearly the case for Iceland, Malaysia, Malta and more mildly for Singapore, see Figure 5 and Table 5. Considering week 24th, the stock indexes and so the countries reporting the highest level of A_j in (3) are Greece, Iceland and Malta, with values 0.527, 0.524, 0.523, respectively. On the other hand, those having the lowest values are Montenegro, Bahrain and Singapore with 0.508, 0.507 and 0.504, respectively.

Figure 6 offers a comparison of the weekly rank of the countries – on the basis of $A_j([t_1, t_2])$ – having experienced an easy (upper panel) and hard (lower panel) lockdown. In general, countries with a stricter lockdown seem to show globally a more pervasive pessimistic moods than those with a weaker lockdown. In particular, one can notice the presence of common waves of optimism (low rank) and pessimism (high rank) over the considered period. Importantly, there is an evident countertendency among some countries, with opposite moods in peculiar subperiods. Indeed, Iceland, South Korea and Sweden show pessimism at the beginning of the pandemic and optimism for the rest of the period, with a spike of pessimism around week 15-16. For China, UK, Italy and USA the situation is more scattered, but there is optimism at the beginning for UK, Italy and USA, a substantial pessimism of all the considered countries in the last part of the period. China and Italy seem to follow analogous patterns in the late part of the period; a possible explanation can be found in the strict collaboration between such countries during the lockdown, which can be seen as the driver of a common mood.

Eqs. (6) and (8) allows getting the global distance measures considering different levels of ζ , which is the threshold used to capture the variations of the observed series on a daily basis. Specifically, we use $\zeta = 0, 1, \dots, 50$.

The results for $H_j^{(\zeta)}(k)$ (see Eq. 6) are reported in Figure 7 and Table 6.

Financial markets show quite similar behaviours in their links with the Google Trends, mainly in the maximum values of $H_j^{(\zeta)}(k)$. Indeed, the variation range in the maxima is 0.502-0.530, with Bahrain's stock indexes being outliers with 0.551 and 0.567. However, there are noticeable differences in the minimum values of the $H_j^{(\zeta)}(k)$, with a variation range 0.400-0.498. Notice the differences appearing also within the same country, like for the minima of the $H_j^{(\zeta)}(k)$ for the US – with NYSE COMPOSITE at 0.468 and NASDAQ 100 and NASDAQ COMPOSITE at 0.403.

The averaged results at country level of Eq. (7) are shown in Figure 8 and Table 7.

Some cases are particularly interesting and can be noticed by visual inspecting the results:

- Latvia, Montenegro, Norway, Denmark and Canada have a vast majority of $H_j^{(\zeta)} > 0.5$ manifesting a high average level of simultaneous Google searches growths and stock indexes declines. Across the ζ s used in calculating $H_j^{(\zeta)}(k)$, such an occurrence appears at least in

the 90% of the cases.

- Malta have 92% of $H_j^{(\zeta)} < 0.5$, representing an average low level of decreasing Google searches and stock indexes increments at the same time.
- The highest value of $H_j^{(\zeta)}$ occurs in Bahrain, with 0.559, for $\zeta = 0$. This finding is in agreement with those discussed already for $H_j^{(\zeta)}(k)$ above.
- The smallest value of $H_j^{(\zeta)}$ occurs in Italy, with 0.400, for $\zeta = 0$.

The $R_j^{(\zeta)}(k)$ in Eq. (8) are reported in Figure 9 and Table 8.

The variation range in the maxima for the case of $R_j^{(\zeta)}(k)$ is $0.5 - 0.565$, with Bahrain's stock indexes having the highest values. Differences in the minimum values are noticeable as well, and the variation range goes from 0.421 to 0.5. The lowest value is associated with Italy's index once again. Remarkable differences appear for the markets within the same country, in the specific case of $R_j^{(\zeta)}(k)$; the USA is again one of the most remarkable examples of a wide variation range at a stock market level.

The results at country level are presented in Figure 10 and Table 9; they have been calculated through Eq. (9). The most relevant facts are listed below:

- Qatar has the highest percentage of ζ s such that $R_j^{(\zeta)} > 0.5$, namely 19.6%; therefore, it is the country having contemporaneous increases in Google searches and decreases in stock index prices for a large number of thresholds ζ s. Belgium, Spain and France follow, with 17.6% of the ζ s leading to $R_j^{(\zeta)}$ in the range $(0.5,1]$.
- Greece, Malaysia, Argentina and New Zealand have the highest percentages of ζ s such that $R_j^{(\zeta)} < 0.5$, with the first two countries having 11.8% of the observations falling within $[0,0.5)$ and the latest two ones having a proportion of 9.8%.
- The lowest value of $R_j^{(\zeta)}$ occurs in Italy, with 0.421, for $\zeta = 0$.
- The highest value of $R_j^{(\zeta)}$ occurs in Bahrain, with 0.565, for $\zeta = 0$.

By looking at the global distances measures, the case of $\zeta = 0$ is the most relevant to be commented for the information carried out. In such a case, the proposed indexes are sensible to the smallest daily variation. Bahrain, Malta, Israel, Cyprus, United Arab Emirates, Singapore, Oman and Japan have $H_j^{(\zeta=0)} > 0.5$. Thus, these countries have experienced on average a great level of anxiety for COVID-19 and a small trust in the financial markets future performances. Differently, Italy, Canada, Lithuania, Germany, United Kingdom and Spain have the lowest positions, with $H_j^{(\zeta=0)} < 0.5$. In such countries, an optimistic mood seems to be preponderant, on average. Notice

that such a list of “optimistic moods” contains highly developed countries with a noticeable spread of the pandemic. Reasonably, optimism is linked to the confidence of the citizens of the most developed countries either in finance as well as in the health care infrastructures, in the light of solving a so pervasive problem like a widespread pandemic.

For the case of $R_j^{(\zeta=0)} < 0.5$, the lowest positions are held by Russia, Switzerland, Lithuania, Romania, Germany and Italy. So, these countries that have experienced a large number of days of contemporaneous decreases in Google searches and increases in stock index prices. Bahrain, Israel, Japan, Singapore, Oman, Malta and Iceland are the countries with $R_j^{(\zeta=0)} > 0.5$. Of course, results for $H_j^{(\zeta=0)}$ and $R_j^{(\zeta=0)}$ are often overlapping, and some countries confirm their general mood when the comparison between fully optimistic days and fully pessimistic ones is performed. Interestingly, we find that in places where the pandemic has been managed quite brightly, the general feelings have been more pessimistic than optimistic (see e.g. the case of Israel).

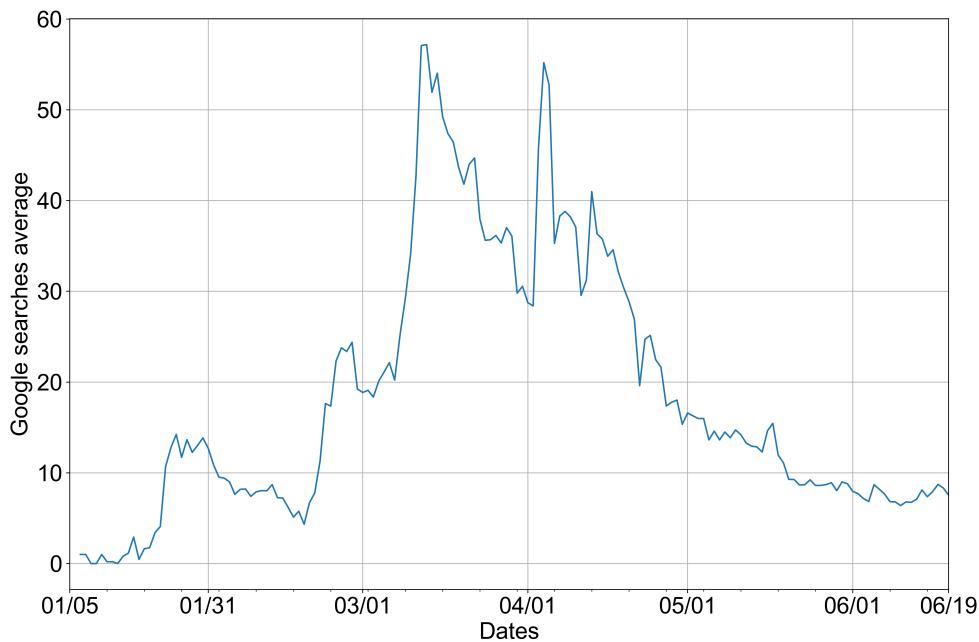


Figure 3: Averaged Google searches of “coronavirus” – along with its translations in the different languages – across countries with $HDI > 0.8$ plus China, on time-basis.

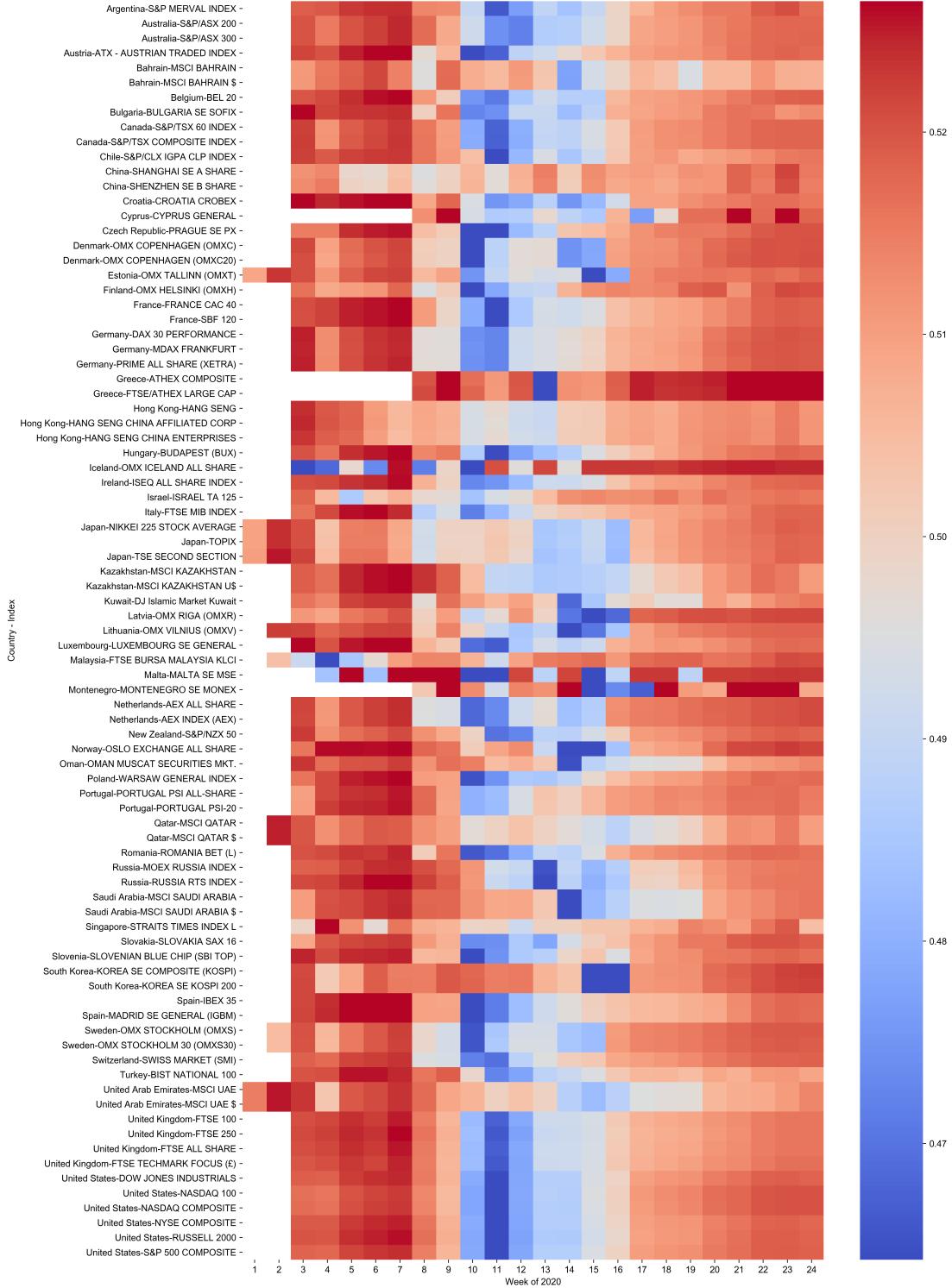


Figure 4: Heatmap representation of $A_j([t_1, t_2]; k)$ in Eq. (2), at stock index level. Indents represent the differences in the starting date of the related Google Trends data – i.e., the first date with a nonnull Google search volume.

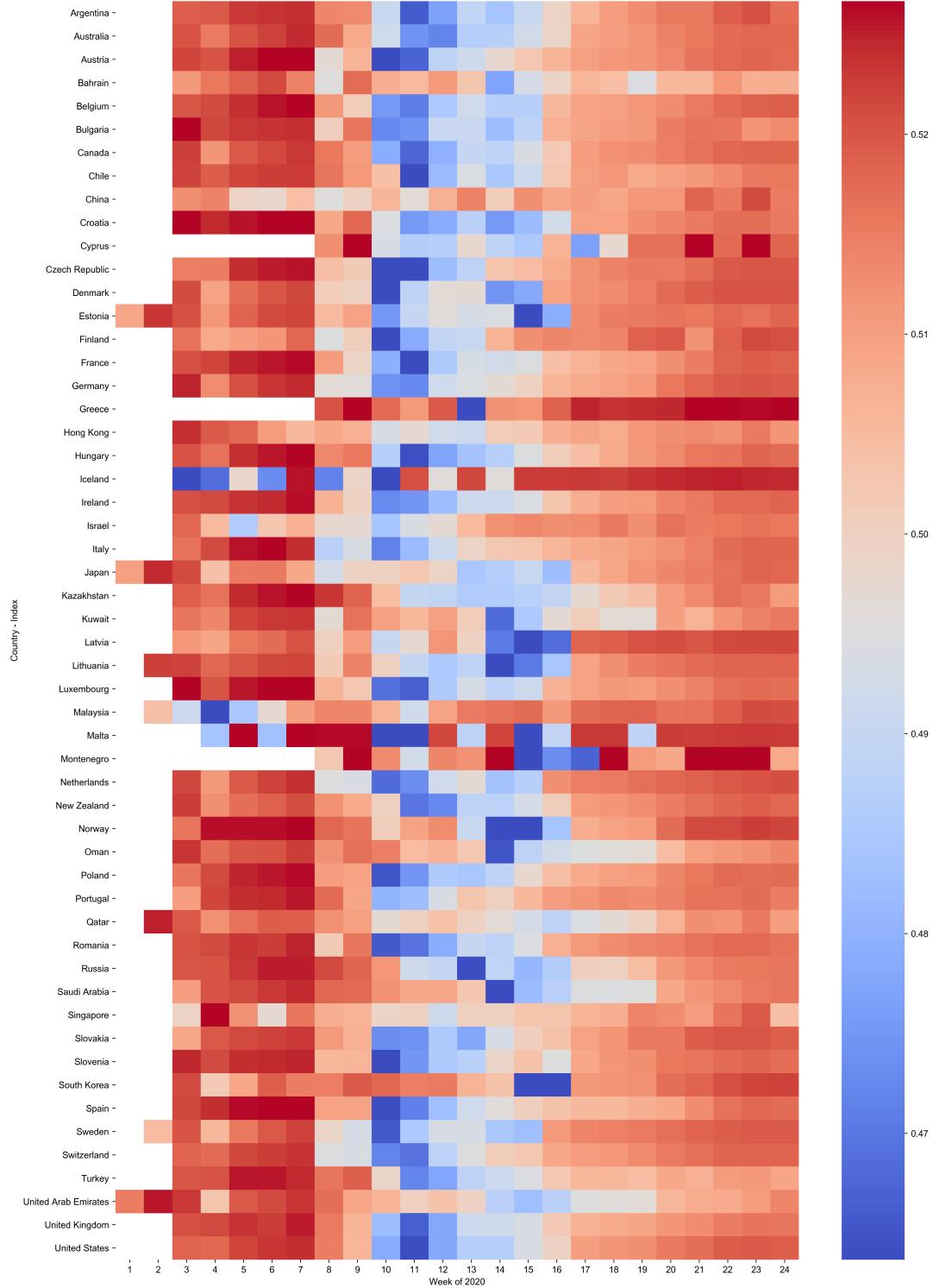


Figure 5: Heatmap representation of $A_j([t_1, t_2])$ in Eq. (3), at country level. Also in this case, indents represent the differences in the starting date of the Google Trends data at country level.

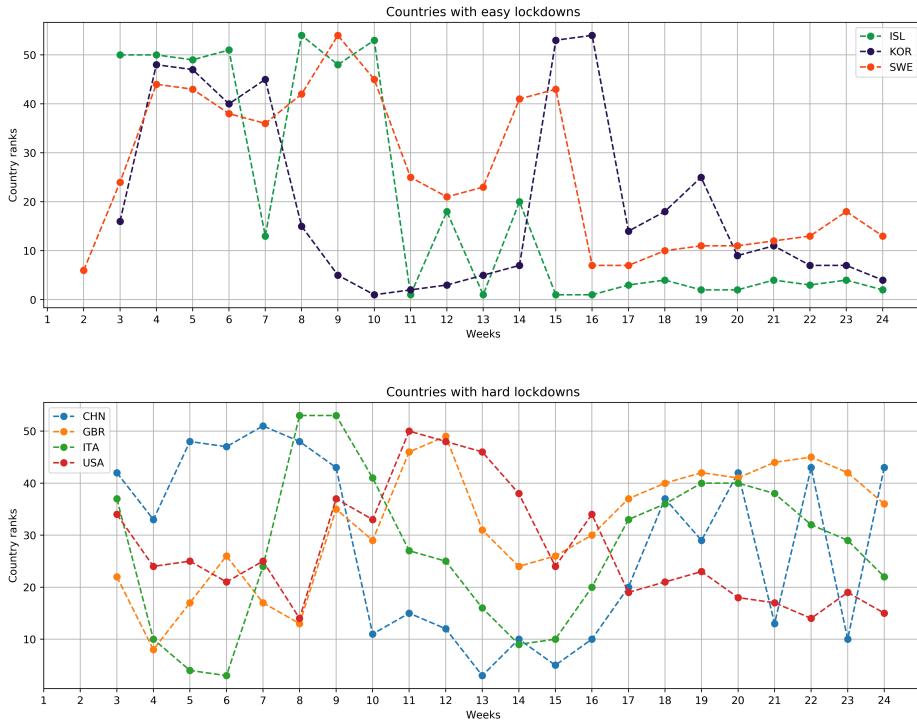


Figure 6: A comparison of the weekly mood of the countries – on the basis of the ranks of $A_j([t_1, t_2])$ – having experienced an easy/hard lockdown. The lower is the rank, the higher is the optimism experienced in that week by the respective country.

5 Conclusions

The study investigates the relationship between the Google search volumes of “*coronavirus*” and the stock index prices of different markets. The analysis is carried out at country level; thus, the word “*coronavirus*” has been opportunely translated, when needed. Such analysis allows for mapping interrelationships between COVID-19 anxiety in nations and lack of trust in stock markets future performance. These aspects are related to the uncertainty surrounding the evolution of the pandemic and expectations about its effects. In our framework, we follow [6] and hypothesize that anxiety is manifested via the intensity of the searches run on Google related to the virus.

The proposed indicators allow to capture changes in moods along the time – for the case of the A_j 's in (2) and (3) – and permit also classification of markets and countries under a more global perspective on the overall period – see the H_j 's in (6) and (7) and the R_j 's in (8) and (9). Moreover, the A_j 's compare the values of Google searches and prices, while the H_j 's and the R_j 's compare the daily increments/decrements of such quantities.

For a fair treatment of the considered dataset, we have taken only “very high human developed

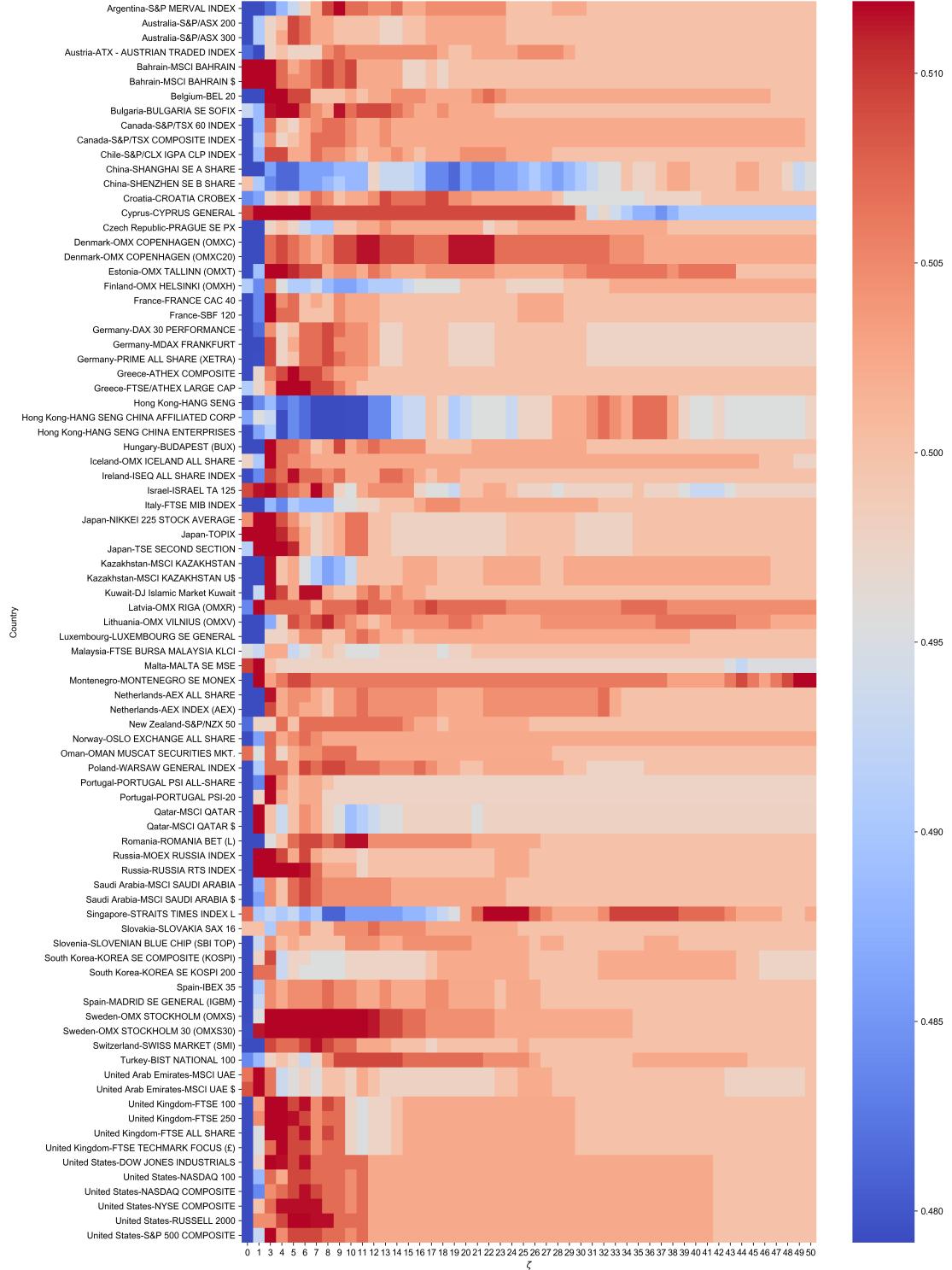


Figure 7: Heatmap representation of $H_j^{(\zeta)}(k)$ in Eq. (6), at stock index level and on the basis of the thresholds ζ s.

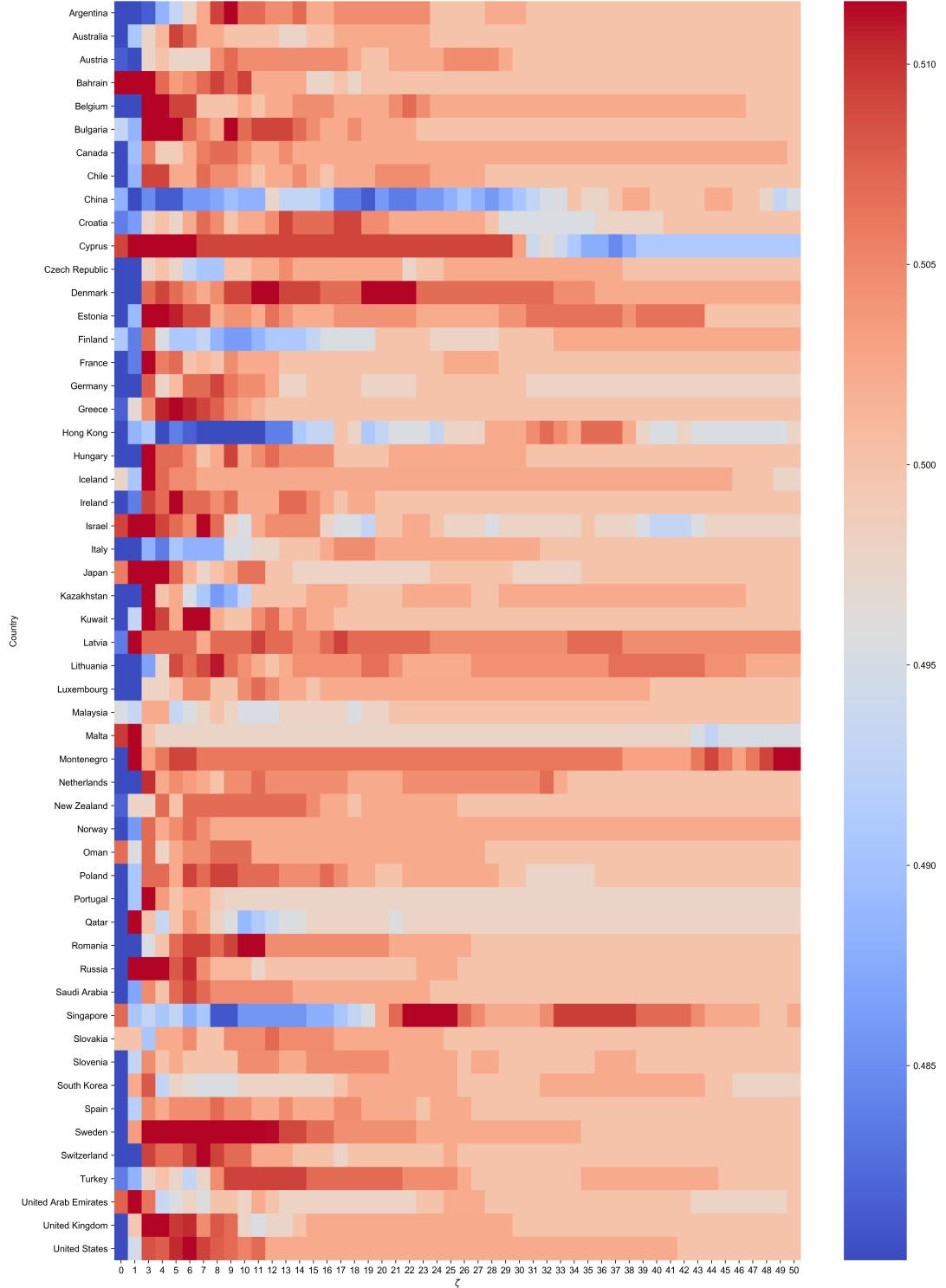


Figure 8: Heatmap representation of $H_j^{(\zeta)}$ in Eq. (7), at country level and on the basis of the thresholds ζ s.

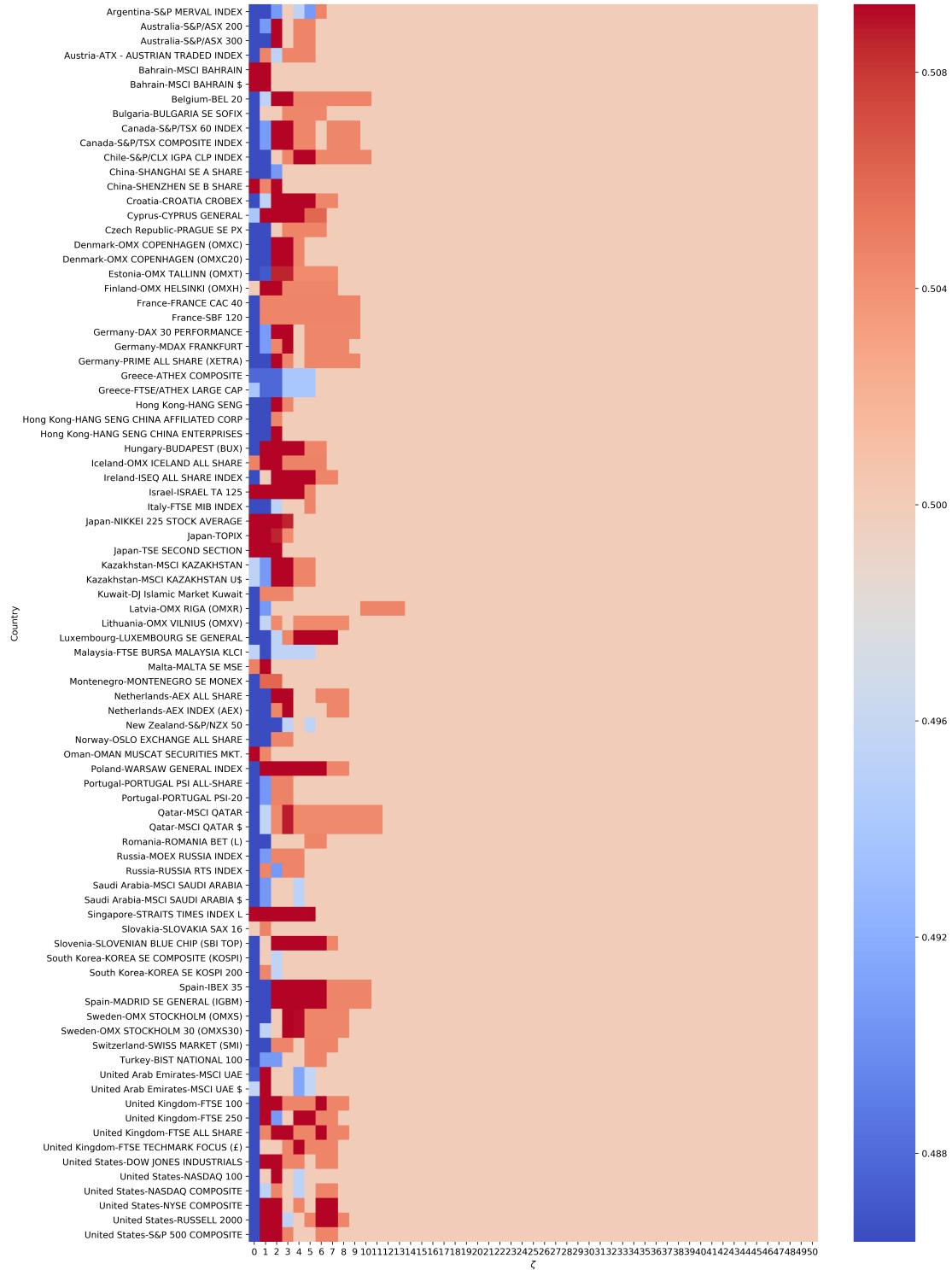


Figure 9: Heatmap representation of $R_j^{(\zeta)}(k)$ in Eq. (8), at stock index level and on the basis of the thresholds ζ s.

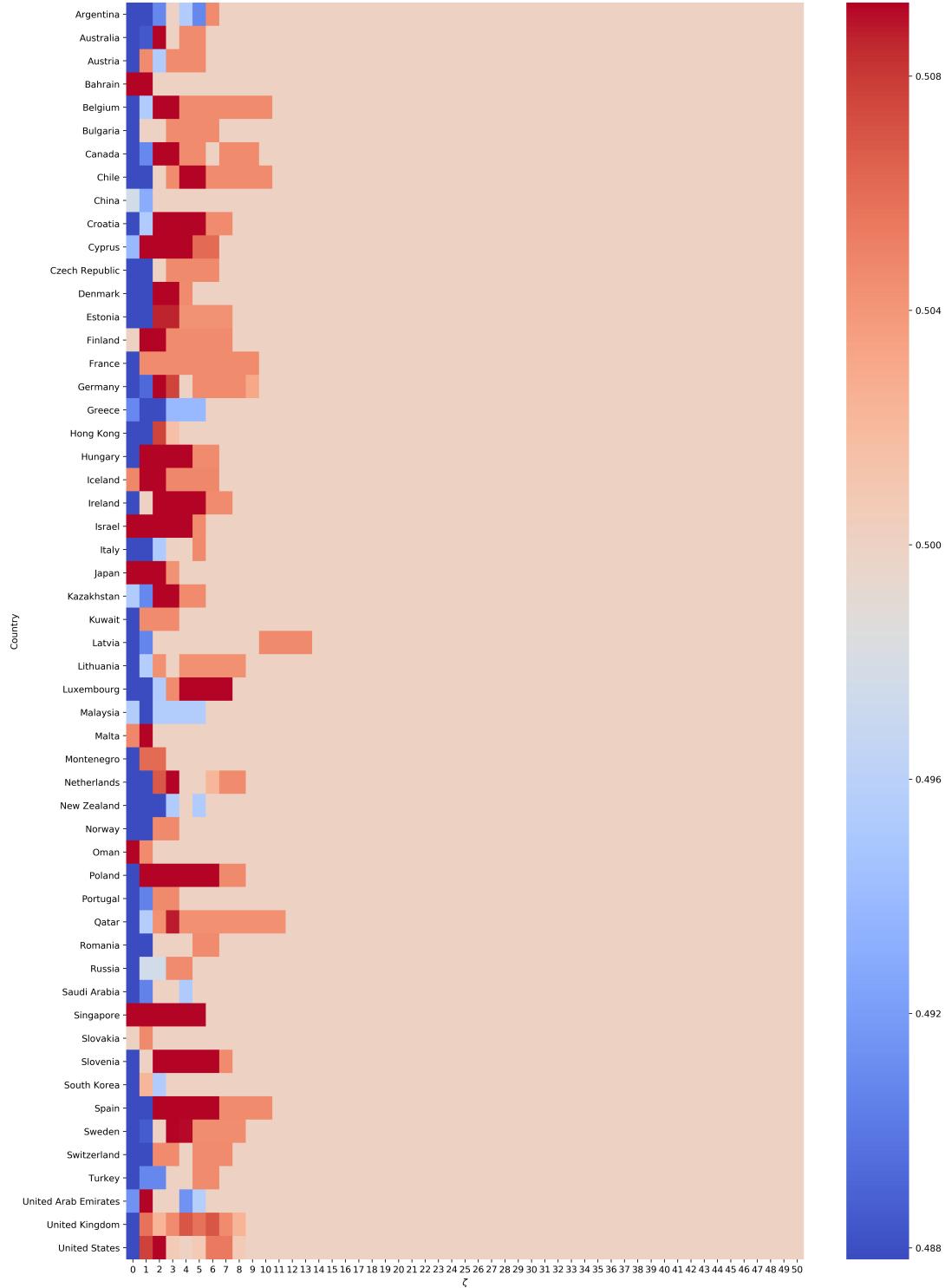


Figure 10: Heatmap representation of $R_j^{(\zeta)}$ in Eq. (9), at country level and on the basis of the thresholds ζ s.

countries” – i.e., those with an HDI greater than 0.8 – and have reasonably added China. Some countries with HDI greater than 0.8 but without a stock exchange have been removed from the list.

The study allows having a panoramic view of the evolution of the pandemic, its effects on the behaviour of people and its impact on financial markets. Furthermore, the country-level approach gives insights on similarities and discrepancies of the different populations in respect of the link between the anxiety for COVID-19 and the expectations about stock markets performance.

Country	terms	N. Obs.	μ	σ	Skew	Kurt	μ/σ
Andorra	coronavirus	151	21.993	19.640	1.794	3.867	1.120
Argentina	coronavirus	151	29.079	24.462	1.206	0.609	1.189
Australia	coronavirus	151	26.735	22.690	1.207	0.306	1.178
Austria	Coronavirus	151	20.430	20.572	1.928	3.838	0.993
Bahamas	coronavirus	155	22.303	20.927	1.528	2.039	1.066
Bahrain	فیروس کرونا	151	11.768	9.360	5.880	51.919	1.257
Barbados	coronavirus	155	26.800	22.471	1.293	1.209	1.193
Belarus	каранавірус	148	1.973	11.097	7.449	58.031	0.178
Belgium	coronavirus	151	23.669	21.221	1.243	0.912	1.115
Brunei	koronavirus	149	3.651	17.847	4.746	20.878	0.205
Bulgaria	коронавирус	154	22.786	21.561	1.341	1.104	1.057
Canada	coronavirus	152	25.039	22.082	1.398	1.268	1.134
Chile	coronavirus	152	21.914	19.096	1.625	2.406	1.148
China	新冠 病毒	150	30.513	24.353	0.677	-0.032	1.253
Croatia	koronavirus	154	22.539	23.752	1.169	0.157	0.949
Cyprus	κορωνοϊός	115	13.322	21.840	1.587	2.013	0.610
Czech Republic	koronavirus	150	18.880	20.863	1.877	3.188	0.905
Denmark	coronavirus	154	20.994	20.459	1.595	2.090	1.026
Estonia	koroonavirüs	163	17.773	22.791	2.068	3.554	0.780
Finland	koronavirus	152	12.974	15.485	2.597	10.577	0.838
France	coronavirus	151	23.060	21.109	1.465	2.102	1.092
Germany	Coronavirus	152	22.296	19.562	1.411	1.765	1.140
Greece	κορινοϊός	115	3.774	14.466	6.049	35.634	0.261
Hong Kong	新冠 病毒	154	32.175	20.736	0.780	0.649	1.552
Hungary	koronavírus	151	26.543	24.531	1.189	0.361	1.082
Iceland	kórónaveira	148	6.128	17.692	2.926	8.299	0.346
Ireland	coronavirus	151	27.245	23.121	1.114	0.584	1.178
Israel	כovid-19	154	29.182	21.834	1.166	0.811	1.337
Italy	coronavirus	150	25.960	22.112	1.130	0.554	1.174
Japan	コロナウイルス	163	25.540	19.700	1.113	1.137	1.296
Kazakhstan	коронавирус	151	32.086	24.145	0.727	-0.504	1.329
Kuwait	فیروس کرونا	151	12.695	10.626	3.974	29.089	1.195
Latvia	koronavīrus	150	15.533	22.113	2.207	3.816	0.702
Liechtenstein	Coronavirus	151	19.927	15.596	1.817	5.039	1.278
Lithuania	coronavirusas	159	23.572	26.291	1.369	0.775	0.897
Luxembourg	coronavirus	153	22.529	21.246	1.482	1.884	1.060
Malaysia	koronavirus	155	5.884	11.544	5.493	36.443	0.510
Malta	koronavirus	146	4.192	14.699	3.795	15.588	0.285
Montenegro	вирус Корона	115	10.765	21.945	1.909	2.946	0.491
Netherlands	coronavirus	152	23.072	22.431	1.236	0.857	1.029
New Zealand	coronavirus	152	26.013	22.373	1.360	1.025	1.163
Norway	koronavirus	150	11.373	22.099	3.053	8.220	0.515
Oman	فیروس کرونا	152	11.776	10.691	4.038	29.401	1.102
Palau	coronavirus	150	17.420	21.531	1.012	0.542	0.809
Poland	koronawirus	150	23.940	22.218	1.448	1.644	1.078
Portugal	coronavirus	149	5.383	11.303	7.275	57.320	0.476
Qatar	فیروس کرونا	160	16.350	12.382	2.138	11.681	1.321
Romania	coronavirus	151	22.338	22.240	1.513	1.619	1.004
Russia	коронавирус	151	16.762	15.348	1.776	5.187	1.092
Saudi Arabia	فیروس کرونا	149	12.409	12.271	2.984	16.307	1.011
Seychelles	coronavirus	149	31.342	20.223	0.993	0.979	1.550
Singapore	新冠 病毒	148	23.757	18.333	0.892	1.760	1.296
Slovakia	koronavírus	149	16.201	18.168	2.181	5.867	0.892
Slovenia	koronavirus	152	18.901	20.257	1.743	2.969	0.933
South Korea	코로나 바이러스	152	8.967	16.827	3.654	13.159	0.533
Spain	coronavirus	151	22.490	21.035	1.601	2.516	1.069
Sweden	coronavirus	155	22.271	20.375	1.306	1.197	1.093
Switzerland	Coronavirus	151	22.093	20.035	1.472	2.050	1.103
Turkey	koronavírus	151	28.934	22.757	0.923	0.533	1.271
United Arab Emirates	فیروس کرونا	164	15.878	13.302	2.037	8.827	1.194
United Kingdom	coronavirus	151	27.576	23.148	1.238	0.748	1.191
United States	coronavirus	151	25.397	23.879	1.329	0.896	1.064
Uruguay	coronavirus	151	19.570	20.028	1.809	3.270	0.977

Table 1: Google Trends data. The table contains country name, translation of “coronavirus” from English to the most used language in the respective country and statistical summary of the related time series. The different number of observations depends on the first date in which a positive value for the search volumes is recorded.

Country	Index	μ	σ	Skew	Kurt	μ/σ
Argentina	S&P Merval INDEX	0.507	0.016	-1.075	0.147	31.047
Australia	S&P/ASX 200	0.507	0.015	-1.018	-0.112	33.143
Austria	ATX - AUSTRIAN TRADED INDEX	0.507	0.018	-1.405	1.891	28.855
Bahrain	MSCI BAHRAIN	0.506	0.010	-1.064	2.100	52.517
	MSCI BAHRAIN \$	0.506	0.010	-1.032	2.024	52.041
Belgium	BEL 20	0.507	0.016	-0.837	-0.387	31.297
Bulgaria	BULGARIA SE SOFIX	0.507	0.016	-0.849	-0.382	31.820
Canada	S&P/TSX 60 INDEX	0.507	0.016	-1.150	0.231	32.262
	S&P/TSX COMPOSITE INDEX	0.507	0.016	-1.138	0.201	32.048
Chile	S&P/CLX IGPA CLP INDEX	0.507	0.015	-1.561	2.619	32.734
China	SHANGHAI SE A SHARE	0.508	0.007	-0.291	-0.900	69.022
	SHENZHEN SE B SHARE	0.508	0.007	-0.224	-0.917	73.086
Croatia	CROATIA CROBEX	0.507	0.017	-0.703	-0.895	29.432
Cyprus	CYPRUS GENERAL	0.506	0.018	0.139	-1.095	28.743
Czech Republic	PRAGUE SE PX	0.507	0.018	-1.595	2.014	27.678
Denmark	OMX COPENHAGEN (OMXC)	0.506	0.017	-1.314	1.049	29.865
	OMX COPENHAGEN (OMXC20)	0.506	0.017	-1.327	1.093	30.002
Estonia	OMX TALLINN (OMXT)	0.506	0.017	-1.601	2.413	29.180
Finland	OMX HELSINKI (OMXH)	0.506	0.017	-2.163	5.441	29.680
France	FRANCE CAC 40	0.507	0.016	-1.062	0.903	31.220
	SBF 120	0.507	0.016	-1.064	0.905	31.176
Germany	DAX 30 PERFORMANCE	0.507	0.015	-0.906	0.235	34.239
	MDAX FRANKFURT	0.507	0.015	-0.896	0.160	34.282
	PRIME ALL SHARE (XETRA)	0.507	0.015	-0.895	0.212	34.235
Greece	ATHEX COMPOSITE	0.516	0.023	-3.681	14.420	22.250
	FTSE/ATHEX LARGE CAP	0.516	0.023	-3.673	14.390	22.210
	HANG SENG	0.508	0.008	-0.370	-0.183	60.783
Hong Kong	HANG SENG CHINA AFFILIATED CORP	0.508	0.009	-0.393	-0.195	58.726
	HANG SENG CHINA ENTERPRISES	0.508	0.008	-0.418	-0.269	61.537
Hungary	BUDAPEST (BUX)	0.506	0.017	-1.029	0.254	30.412
Iceland	OMX ICELAND ALL SHARE	0.505	0.025	-1.059	-0.222	20.333
Ireland	ISEQ ALL SHARE INDEX	0.507	0.016	-0.824	-0.299	32.556
Israel	ISRAEL TA 125	0.507	0.010	-0.959	-0.123	50.712
Italy	FTSE MIB INDEX	0.507	0.014	-0.803	0.127	35.194
	NIKKEI 225 STOCK AVERAGE	0.506	0.012	-0.537	-0.722	43.446
Japan	TOPIX	0.506	0.011	-0.538	-0.722	44.073
	TSE SECOND SECTION	0.506	0.012	-0.516	-0.663	42.277
Kazakhstan	MSCI KAZAKHSTAN	0.507	0.014	-0.252	-1.378	36.482
	MSCI KAZAKHSTAN US	0.507	0.014	-0.252	-1.378	36.482
Kuwait	DJ Islamic Market Kuwait	0.506	0.013	-1.209	2.126	39.475
Latvia	OMX RIGA (OMXR)	0.506	0.020	-1.713	2.434	25.431
Lithuania	OMX VILNIUS (OMXV)	0.506	0.017	-1.185	0.339	29.350
Luxembourg	LUXEMBOURG SE GENERAL	0.507	0.017	-0.934	0.297	29.277
Malaysia	FTSE BURSA MALAYSIA KLCI	0.507	0.017	-2.683	8.680	29.648
Malta	MALTA SE MSE	0.504	0.028	-1.119	-0.072	18.248
Montenegro	MONTENEGRO SE MONEX	0.505	0.033	-2.264	6.125	15.321
Netherlands	AEX ALL SHARE	0.507	0.017	-0.961	-0.322	30.288
	AEX INDEX (AEX)	0.507	0.017	-0.970	-0.293	30.392
New Zealand	S&P/NZX 50	0.507	0.015	-1.291	0.794	33.972
Norway	OSLO EXCHANGE ALL SHARE	0.508	0.023	-2.237	5.170	21.625
Oman	OMAN MUSCAT SECURITIES MKT.	0.507	0.013	-1.375	2.646	37.753
Poland	WARSAW GENERAL INDEX	0.507	0.016	-1.093	0.449	30.770
Portugal	PORTUGAL PSI ALL-SHARE	0.510	0.012	-1.266	1.360	43.377
	PORTUGAL PSI-20	0.510	0.012	-1.202	1.268	42.707
Qatar	MSCI QATAR	0.507	0.010	-0.075	-1.102	51.130
	MSCI QATAR \$	0.507	0.010	-0.074	-1.102	51.130
Romania	ROMANIA BET (L)	0.507	0.017	-1.189	0.333	29.378
Russia	MOEX RUSSIA INDEX	0.507	0.016	-1.033	0.462	32.642
	RUSSIA RTS INDEX	0.507	0.017	-0.888	0.119	29.871
Saudi Arabia	MSCI SAUDI ARABIA	0.507	0.016	-1.609	3.124	32.374
	MSCI SAUDI ARABIA \$	0.507	0.016	-1.607	3.117	32.346
Singapore	STRAITS TIMES INDEX L	0.507	0.008	0.491	0.214	61.183
Slovakia	SLOVAKIA SAX 16	0.507	0.016	-1.096	-0.001	32.341
Slovenia	SLOVENIAN BLUE CHIP (SBI TOP)	0.507	0.017	-1.300	1.403	29.858
South Korea	KOREA SE COMPOSITE (KOSPI)	0.507	0.026	-3.395	12.267	19.488
	KOREA SE KOSPI 200	0.507	0.026	-3.395	12.262	19.467
Spain	IBEX 35	0.507	0.017	-1.066	0.902	30.213
	MADRID SE GENERAL (IGBM)	0.507	0.017	-1.052	0.872	30.194
Sweden	OMX STOCKHOLM (OMXS)	0.506	0.015	-1.008	0.216	33.044
	OMX STOCKHOLM 30 (OMXS30)	0.506	0.015	-1.026	0.291	33.372
Switzerland	SWISS MARKET (SMI)	0.507	0.015	-1.188	0.720	33.293
Turkey	BIST NATIONAL 100	0.506	0.014	-0.759	0.214	35.367
United Arab Emirates	MSCI UAE	0.507	0.012	-0.223	-0.665	43.329
	MSCI UAE \$	0.507	0.012	-0.223	-0.665	43.329
United Kingdom	FTSE 100	0.506	0.015	-1.009	0.359	32.823
	FTSE 250	0.506	0.016	-0.971	0.350	31.828
	FTSE ALL SHARE	0.506	0.016	-1.003	0.360	32.642
	FTSE TECHMARK FOCUS (E)	0.506	0.015	-1.097	0.529	32.673
	DOW JONES INDUSTRIALS	0.506	0.017	-1.095	0.172	30.084
	NASDAQ 100	0.506	0.017	-1.151	0.227	30.388
	NASDAQ COMPOSITE	0.506	0.017	-1.139	0.193	30.092
	NYSE COMPOSITE	0.506	0.017	-1.070	0.116	29.925
	RUSSELL 2000	0.506	0.018	-1.030	-0.002	28.860
	S&P 500 COMPOSITE	0.506	0.017	-1.116	0.175	30.276

Table 3: Main statistical indicators of $A_j([t_1, t_2]; k)$ from Eq. (2) at stock index level.

Country	μ	σ	Skew	Kurt	μ/σ
Argentina	0.507	0.016	-1.075	0.147	31.047
Australia	0.507	0.015	-1.018	-0.112	33.115
Austria	0.507	0.018	-1.405	1.891	28.855
Bahrain	0.506	0.010	-1.048	2.062	52.279
Belgium	0.507	0.016	-0.837	-0.387	31.297
Bulgaria	0.507	0.016	-0.849	-0.382	31.820
Canada	0.507	0.016	-1.144	0.216	32.155
Chile	0.507	0.015	-1.561	2.619	32.734
China	0.508	0.007	-0.262	-0.908	71.104
Croatia	0.507	0.017	-0.703	-0.895	29.432
Cyprus	0.506	0.018	0.139	-1.095	28.743
Czech Republic	0.507	0.018	-1.595	2.014	27.678
Denmark	0.506	0.017	-1.321	1.071	29.935
Estonia	0.506	0.017	-1.601	2.413	29.180
Finland	0.506	0.017	-2.163	5.441	29.680
France	0.507	0.016	-1.063	0.904	31.198
Germany	0.507	0.015	-0.900	0.203	34.254
Greece	0.516	0.023	-3.678	14.411	22.232
Hong Kong	0.508	0.008	-0.394	-0.215	60.339
Hungary	0.506	0.017	-1.029	0.254	30.412
Iceland	0.505	0.025	-1.059	-0.222	20.333
Ireland	0.507	0.016	-0.824	-0.299	32.556
Israel	0.507	0.010	-0.959	-0.123	50.712
Italy	0.507	0.014	-0.803	0.127	35.194
Japan	0.506	0.012	-0.532	-0.702	43.270
Kazakhstan	0.507	0.014	-0.252	-1.378	36.482
Kuwait	0.506	0.013	-1.209	2.126	39.475
Latvia	0.506	0.020	-1.713	2.434	25.431
Lithuania	0.506	0.017	-1.185	0.339	29.350
Luxembourg	0.507	0.017	-0.934	0.297	29.277
Malaysia	0.507	0.017	-2.683	8.680	29.648
Malta	0.504	0.028	-1.119	-0.072	18.248
Montenegro	0.505	0.033	-2.264	6.125	15.321
Netherlands	0.507	0.017	-0.966	-0.308	30.340
New Zealand	0.507	0.015	-1.291	0.794	33.972
Norway	0.508	0.023	-2.237	5.170	21.625
Oman	0.507	0.013	-1.375	2.646	37.753
Poland	0.507	0.016	-1.093	0.449	30.770
Portugal	0.510	0.012	-1.235	1.314	43.045
Qatar	0.507	0.010	-0.075	-1.102	51.130
Romania	0.507	0.017	-1.189	0.333	29.378
Russia	0.507	0.016	-0.959	0.280	31.207
Saudi Arabia	0.507	0.016	-1.608	3.120	32.360
Singapore	0.507	0.008	0.491	0.214	61.183
Slovakia	0.507	0.016	-1.096	-0.001	32.341
Slovenia	0.507	0.017	-1.300	1.403	29.858
South Korea	0.507	0.026	-3.395	12.265	19.478
Spain	0.507	0.017	-1.059	0.887	30.203
Sweden	0.506	0.015	-1.017	0.253	33.208
Switzerland	0.507	0.015	-1.188	0.720	33.293
Turkey	0.506	0.014	-0.759	0.214	35.367
United Arab Emirates	0.507	0.012	-0.223	-0.665	43.329
United Kingdom	0.506	0.016	-1.021	0.399	32.497
United States	0.506	0.017	-1.107	0.152	29.962

Table 4: Main statistical indicators of $A_j([t_1, t_2])$ in Eq. (3) at country level.

Country	max	ζ_{\max}	min	ζ_{\min}	μ	σ	Skew	Kurt	μ/σ
Argentina	0.514	9	0.465	1	0.500	0.008	-2.744	9.300	61.631
Australia	0.509	5	0.440	0	0.499	0.009	-6.300	42.784	56.684
Austria	0.507	9	0.477	1	0.501	0.005	-3.228	13.247	100.479
Bahrain	0.559	0	0.498	15 16 18	0.503	0.010	4.523	23.068	51.964
Belgium	0.521	3	0.440	0	0.501	0.011	-4.304	22.483	46.232
Bulgaria	0.516	4	0.489	1	0.502	0.005	0.652	1.995	105.606
Canada	0.507	8 9	0.427	0	0.501	0.011	-6.609	45.353	46.197
Chile	0.509	3 4	0.452	0	0.501	0.008	-5.474	34.981	66.096
China	0.502	38 39 44 45	0.480	1	0.492	0.007	0.074	-1.293	73.282
Croatia	0.509	13 17 18	0.484	0	0.500	0.005	-0.822	2.309	102.002
Cyprus	0.527	1	0.485	37	0.502	0.010	-0.134	-1.083	49.747
Czech Republic	0.505	13	0.465	0	0.499	0.007	-3.918	17.128	76.321
Denmark	0.511	11 12 [19-22]	0.454	0	0.504	0.010	-4.145	18.072	48.899
Estonia	0.515	3 4	0.453	0	0.503	0.008	-4.721	28.766	61.084
Finland	0.507	3	0.484	1	0.498	0.005	-0.791	-0.380	91.540
France	0.517	3	0.451	0	0.500	0.008	-4.761	30.006	63.821
Germany	0.509	8	0.443	0	0.498	0.009	-4.787	27.922	55.327
Greece	0.517	5	0.482	0	0.501	0.005	-0.106	9.170	111.827
Hong Kong	0.507	32 35 36 37	0.472	0	0.494	0.009	-0.702	-0.172	55.112
Hungary	0.514	3	0.438	0	0.500	0.010	-5.290	32.563	50.278
Iceland	0.512	3	0.490	1	0.502	0.003	-0.849	10.345	190.485
Ireland	0.512	5	0.468	0	0.501	0.006	-3.413	17.699	81.892
Israel	0.516	3	0.493	19 40 41 42	0.500	0.005	1.244	1.194	94.872
Italy	0.505	17 18 19	0.400	0	0.496	0.017	-4.751	24.584	29.866
Japan	0.524	3	0.498	7 [14-23] [30-34]	0.501	0.005	3.091	10.265	97.770
Kazakhstan	0.512	3	0.449	1	0.499	0.009	-4.280	22.439	57.636
Kuwait	0.512	3 6 7	0.479	0	0.501	0.005	-1.317	10.495	109.350
Latvia	0.514	1	0.484	0	0.506	0.004	-4.249	27.331	139.940
Lithuania	0.511	8	0.428	0	0.502	0.012	-5.380	32.209	42.485
Luxembourg	0.507	11	0.461	0	0.500	0.007	-4.539	21.268	68.256
Malaysia	0.502	3 4	0.493	1 5	0.499	0.002	-1.188	0.897	243.889
Malta	0.514	1	0.493	44	0.498	0.003	3.985	18.747	158.192
Montenegro	0.512	1 49 50	0.466	0	0.505	0.006	-5.740	38.116	85.054
Netherlands	0.510	3	0.443	0	0.501	0.011	-4.583	21.763	46.811
New Zealand	0.507	4 [6-14]	0.482	0	0.501	0.004	-2.059	11.283	126.313
Norway	0.507	3 6	0.472	0	0.502	0.005	-5.071	27.999	101.428
Oman	0.507	0 3 8 9 10	0.495	1	0.502	0.002	0.690	1.077	212.642
Poland	0.509	6 8 9	0.472	0	0.501	0.006	-2.889	14.892	90.044
Portugal	0.515	3	0.467	0	0.498	0.005	-3.255	25.052	94.406
Qatar	0.513	1	0.463	0	0.497	0.006	-3.840	25.296	85.521
Romania	0.512	10 11	0.438	0	0.501	0.011	-4.731	26.581	47.579
Russia	0.519	3	0.477	0	0.501	0.005	-0.407	10.179	92.818
Saudi Arabia	0.509	6	0.472	0	0.501	0.005	-3.806	20.311	96.753
Singapore	0.512	[22-25]	0.481	8 9	0.500	0.009	-0.489	-1.109	53.898
Slovakia	0.507	12	0.491	3	0.501	0.002	-0.924	5.984	203.538
Slovenia	0.505	3 10 11 12 [15-20]	0.454	0	0.500	0.007	-6.068	40.443	71.938
South Korea	0.508	3	0.450	0	0.499	0.008	-5.714	37.367	65.922
Spain	0.507	8	0.435	0	0.500	0.010	-6.430	43.834	52.273
Sweden	0.528	3	0.477	0	0.505	0.008	0.246	4.104	66.680
Switzerland	0.512	7	0.438	0	0.500	0.011	-4.758	26.526	48.007
Turkey	0.509	[9-14]	0.484	0	0.502	0.005	-1.214	3.323	101.176
United Arab Emirates	0.528	1	0.494	4	0.500	0.005	4.686	27.527	109.050
United Kingdom	0.516	4	0.436	0	0.501	0.010	-5.343	35.349	50.233
United States	0.512	6	0.439	0	0.502	0.010	-5.949	39.841	53.236

Table 7: Main statistical indicators of $H_j^{(\zeta)}$ in Eq. (7), at country level. Also in this case, the values of the reference thresholds ζ s are illustrated.

Country	max	ζ_{max}	min	ζ_{min}	μ	σ	Skew	Kurt	μ/σ
Argentina	0.505	6	0.468	0 1	0.498	0.007	-4.252	18.219	76.251
Australia	0.514	2	0.454	0	0.499	0.007	-5.499	36.750	71.468
Austria	0.505	1 3 4 5	0.472	0	0.500	0.004	-5.806	39.154	120.645
Bahrain	0.551	0	0.500	[2-50]	0.501	0.008	5.654	33.120	64.042
Belgium	0.523	2	0.463	0	0.501	0.007	-2.665	22.162	75.245
Bulgaria	0.505	[3-6]	0.477	0	0.500	0.003	-5.628	38.402	144.571
Canada	0.514	2	0.443	0	0.500	0.009	-5.815	39.342	58.322
Chile	0.509	4 5	0.454	0	0.500	0.008	-4.796	26.899	66.081
China	0.500	[2-50]	0.493	1	0.500	0.001	-6.273	41.026	490.895
Croatia	0.518	2 3	0.486	0	0.501	0.005	1.844	7.965	105.528
Cyprus	0.524	1	0.494	0	0.501	0.005	3.362	13.220	109.736
Czech Republic	0.505	[3-6]	0.453	0	0.499	0.007	-6.031	39.432	72.275
Denmark	0.514	2	0.459	0	0.499	0.007	-4.427	25.467	72.761
Estonia	0.509	2 3	0.453	0	0.499	0.007	-5.644	36.742	69.621
Finland	0.518	1	0.500	0 [8-50]	0.501	0.003	4.229	20.731	163.965
France	0.505	[1-9]	0.456	0	0.500	0.007	-6.293	43.293	77.413
Germany	0.512	2	0.427	0	0.499	0.011	-6.375	43.869	46.941
Greece	0.500	[6-50]	0.488	1 2	0.499	0.003	-2.933	7.776	169.887
Hong Kong	0.508	2	0.463	0	0.499	0.006	-5.076	27.686	83.566
Hungary	0.519	2 3	0.458	0	0.501	0.007	-3.121	22.725	68.434
Iceland	0.514	1 2	0.500	[7-50]	0.501	0.003	3.546	13.001	165.438
Ireland	0.514	2 3 4	0.463	0	0.500	0.006	-3.489	24.217	78.581
Israel	0.523	0	0.500	[6-50]	0.501	0.004	3.920	17.515	126.334
Italy	0.505	5	0.421	0	0.498	0.012	-5.911	36.715	41.962
Japan	0.520	0 1	0.500	[4-50]	0.501	0.004	4.058	15.910	119.395
Kazakhstan	0.509	2 3	0.491	1	0.500	0.003	0.822	9.432	200.434
Kuwait	0.505	1 2 3	0.472	0	0.500	0.004	-6.271	43.554	123.714
Latvia	0.505	[10-13]	0.463	0	0.499	0.006	-6.000	39.837	90.399
Lithuania	0.504	2 [4-8]	0.439	0	0.499	0.009	-6.777	47.575	57.276
Luxembourg	0.509	[4-7]	0.459	0	0.499	0.007	-4.185	22.310	70.029
Malaysia	0.500	[6-50]	0.486	1	0.499	0.002	-4.174	20.378	219.740
Malta	0.510	1	0.500	[2-50]	0.500	0.001	5.654	33.118	338.369
Montenegro	0.506	1 2	0.482	0	0.500	0.003	-4.926	34.715	176.675
Netherlands	0.514	3	0.447	0	0.499	0.009	-4.779	26.089	57.020
New Zealand	0.500	4 [6-50]	0.472	0	0.499	0.005	-4.201	18.213	101.422
Norway	0.505	2 3	0.467	0	0.499	0.006	-4.876	24.372	88.643
Oman	0.509	0	0.500	[2-50]	0.500	0.001	5.654	33.120	354.632
Poland	0.519	3	0.463	0	0.501	0.007	-2.761	19.523	72.977
Portugal	0.505	2 3	0.462	0	0.499	0.006	-6.268	42.134	91.164
Qatar	0.509	3	0.469	0	0.500	0.005	-4.997	32.597	102.766
Romania	0.505	5 6	0.431	0	0.499	0.010	-6.669	46.032	50.601
Russia	0.505	3 4	0.442	0	0.499	0.008	-6.959	49.302	61.592
Saudi Arabia	0.500	2 3 [5-50]	0.458	0	0.499	0.006	-6.584	44.984	82.818
Singapore	0.510	[0-5]	0.500	[6-50]	0.501	0.003	2.446	4.144	163.309
Slovakia	0.505	1	0.500	0 [2-50]	0.500	0.001	7.141	51.000	764.662
Slovenia	0.514	2 3	0.477	0	0.501	0.005	-1.308	13.235	105.358
South Korea	0.502	1	0.456	0	0.499	0.006	-6.994	49.508	82.115
Spain	0.514	2	0.449	0	0.500	0.008	-4.789	30.210	61.181
Sweden	0.514	3	0.486	0	0.500	0.004	-0.416	9.080	138.936
Switzerland	0.505	2 3 5 6 7	0.440	0	0.499	0.010	-5.331	29.966	52.025
Turkey	0.505	5 6	0.486	0	0.500	0.003	-3.281	13.267	179.107
United Arab Emirates	0.513	1	0.491	0 4	0.500	0.003	1.175	17.126	197.300
United Kingdom	0.507	4 6	0.455	0	0.500	0.007	-6.185	42.517	75.195
United States	0.509	2	0.456	0	0.500	0.007	-6.095	42.091	77.219

Table 9: Main statistical indicator of $R_j^{(\zeta)}$ in Eq. (9), at country level. Also in this case, the reference thresholds ζ s are reported.

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