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Dynamics of survey responses before and during the pandemic: entropy and dissimilarity measures applied to business tendency survey data

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Abstract

This article is set within the framework of studies focusing on the impact of the SARS-CoV-2 virus on the dynamics of economic activity. For the purposes of the analysis of the expectations expressed in business tendency surveys, the paper aims to verify whether the pandemic of 2020-2022 can be seen as just another contraction phase. Entropy and dissimilarity measures are employed to study the characteristics of the expectations and assessments expressed in the business tendency survey of Polish manufacturing companies. The empirical results show that the dynamics of the manufacturing sector data, particularly as far as general economic conditions are concerned, set the pandemic period apart. The economic consequences of the COVID-19 pandemic expressed in business tendency surveys tend to be unfavourable, but the statistical properties or the degree of the concentration of respondents' answers do not correspond closely either to the expansion or contraction phases of the business cycle.

Key words: business cycles, survey data, expectations, manufacturing industry, COVID-19 pandemic.

1. Introduction

The COVID-19 pandemic is an ongoing global pandemic of coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). As of April 2022, there have been more than 504 million registered cases and 6.2 million deaths due to the virus (Worldometer, 2022). There is a consensus that the potential economic consequences of the recent world-wide pandemic will be significant. The World Bank estimates that the world economy has shrunk by 4.3% in 2020 (Boianovsky, Erreygers 2021). Substantial downward revisions in enterprises and households' economic sentiments have been noted in recent literature (see Bartik et al. 2020; van der Wielen, Barrios 2021; Meyer et al. 2022). However, the scale and range of

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negative effects of COVID-19 pandemic are far from obvious or uniform across countries and economic variables. Long-term consequences were found to depend on the region; for example, Teresiene et al. (2021) note that in the case of the Eurozone, the spread of COVID-19 pandemic did not affect the consumer-confidence index as much as in the US and China.

Similar ambiguities are noted with respect to response of the Polish economy to the pandemic. The World Bank points out that Poland has survived the pandemic relatively unscathed and may attain 3.3 percent growth in 2021 (The World Bank, 2021). Results of the RIED (Research Institute for Economic Development of SGH Warsaw School of Economics) survey in manufacturing sector show that in February 2022, enterprises evaluate their future prospects as favourable: with respect to 2021, manufacturing activity and industrial confidence indicators increase, inflation slows down, and the main survey balances (in production, orders, employment, and financial situation) reflect optimism of respondents (Adamowicz, Walczyk 2022). Generally, manufacturing sector enterprises express confidence as far as their own prospects are concerned even though their assessment of the general economic situation in Poland remains pessimistic. Also, the official aggregated statistics of Statistics Poland paint a darker picture. In March 2022, monthly general business climate indicator in manufacturing remains lower as compared to the corresponding month of the previous year: down 6.6 points for non-seasonally adjusted indicator and 7.2 points for seasonally adjusted one (GUS 2022, p. 9). To conclude, the jury is still out as far as the size of the pandemic's negative effects for the economy, as well as its long-term consequences, are concerned.

For these reasons, up-to-date analysis of the dynamics of economic phenomena during recent turbulent times poses a very current important research problem for applied economists. One of the key topics concerns behaviour of expectations which, in turn, substantially affects decisions of economic agents. Yet, results of tests performed so far on aggregated macroeconomic data proved to be inconclusive and in high degree dependent on many factors, including the phase of a business cycle. Observed changes reported by respondents constitute a unique in its timelines data source on the current state of the economy. Additionally, the use of entropy and dissimilarity measures in the field of expectation analyses has been relatively rare so far. These two factors combined – unexpected arrival of the pandemic, and lack of unequivocal results on behaviour of economic expectations in critical times – has motivated this study. It aims to verify whether behaviour of business survey expectations and observed changes allows for classification of the pandemic phase as another contraction phase, similar in this respect to other downturns in Polish economy.

The remaining part of the paper is organized as follows. In Section 2, the dataset (i.e. the RIED database on business tendency surveys in manufacturing) is described as well as the empirical methods employed to analyse the dynamics of assessments and expectations across business cycle phases. Section 3 provides a description of the expansion, contraction and pandemic phases of 2009 – 2022 on the basis of descriptive statistics of observed and expected changes in five fields of economic activity, and Section 4 – on the basis of entropy and dissimilarity measures. Section 5 presents a summary of the empirical results and their interpretation in terms of the goals of the study, as well as conclusions and limitations.

2. Data and methods

The data on assessment and expectations concerning major economic variables has been obtained from the monthly business tendency surveys in manufacturing conducted by the Research Institute for Economic Development of SGH Warsaw School of Economics (henceforth RIED) since March 1997. The scope of the survey and variants of the answers are presented in Table 1.

Table 1: Monthly RIED questionnaire in the manufacturing industry

Code	Category	Observed within the last month	Expected for the next 3-4 months
q01	Level of production	up unchanged down	will increase will remain unchanged will decrease
q02	Level of orders	up normal down	will increase will remain normal will decrease
q03	Level of export orders	up normal down not applicable	will increase will remain normal will decrease not applicable
q04	Stocks of finished goods	up unchanged down	will increase will remain unchanged will decrease
q05	Prices of goods produced	up unchanged down	will increase will remain unchanged will decrease
q06	Level of employment	up unchanged down	will increase will remain unchanged will decrease
q07	Financial standing	improved unchanged deteriorated	will improve will remain unchanged will deteriorate
q08	General situation of the economy	improved unchanged deteriorated	will improve will remain unchanged will deteriorate

Source: RIED database.

Eight fields of economic activity are evaluated by the respondents with respect to changes they observe and expect for the next 3-4 months.[2] On the basis of individual qualitative responses, balance statistics (i.e. differences between the number of optimists – those who report or expect improvement – and pessimists), are calculated and presented in percentage points. Aggregated results and comments are regularly published in the RIED Bulletins (see Adamowicz, Walczyk 2022).

The starting point for empirical analysis is October 2009, when the contraction phase associated with the financial crisis of 2008–09 came to an end. Following Tomczyk (2022), the following phases of business cycle are identified:

- expansion phase of October 2009 – June 2012,
- contraction phase of July 2012 – December 2012,
- expansion phase of January 2013 – February 2020.

In Tomczyk (2022), the last phase ended in December 2019 as it was the final point of database then available. For the purpose of current analysis, expansion phase has been extended until February 2020. Even though in January and February 2020 the first signs of deterioration of the macroeconomic situation and business sentiment emerged, pandemic-related restriction have not been yet introduced in Poland. The first confirmed case of COVID-19 in Europe occurred in France on January 24, 2020, and in Poland – on March 4, 2020. Officially, the state of pandemic has been declared on March 14, 2020 (Regulation of the Minister of Health on the declaration of an epidemic threat in the territory of the Republic of Poland, Journal of Laws of 2020, item 433). It has not yet been revoked, but most of the restrictions, including the obligation to wear masks and of home isolation, border quarantine, and home quarantine for family members, were lifted on March 28, 2022. Consequently, the pandemic phase has been defined as starting in March 2020 and continuing until the end of RIED sample available (February 2022), that is:

- pandemic phase: March 2020 – February 2022.

The variables selected from the RIED questionnaire in manufacturing (see Table 1) are those than can be compared with aggregated Statistics Poland data to quantify survey expectations data for further analysis: q01 (level of production), q05 (prices of goods produced), q06 (level of employment), q07 (financial standing), and q08 (general situation of the economy).

Two sets of methods of empirical analysis of business survey data are employed in this paper. First, averages, medians and standard deviations for both observed and expected changes in balance statistics for selected fields of economic activity surveyed by RIED are calculated in order to measure typical levels and volatility of expectations

[2] For the purposes of empirical analysis, the 3-month forecast horizon has been selected on the basis of previous studies of the RIED business survey data (Tomczyk 2011).

and assessments of the current situation by manufacturing enterprises during expansion, contraction, and pandemic phases. These results are presented and analysed in Section 3.

Second, entropy and dissimilarity measures are used to evaluate similarities between *a priori* information supplied by business tendency surveys (i.e. expectations), and *a posteriori* information (i.e. realizations). Following Wędrowska (2010), let us define structure S^n as a vector $S^n = [s_1, s_2, \dots, s_n]^T \in R^n$ whose elements s_i $(i = 1, 2, \dots, n)$ fulfil two conditions:

$$0 \leq s_i \leq 1, \tag{1}$$

$$\sum_{i=1}^{n} s_i = 1. \tag{2}$$

Structure S^n is, therefore, fully described by a vector of fractions (structure elements) summing to a total of 1.

The amount of information provided by a message (i.e. its information content) is defined in information theory in relation to the probability that a given message is received from the set of all possible messages: the less probable the message, the more information it carries. On the basis of the elements of S^n it is now possible to define the empirical measure of entropy introduced by C. E. Shannon in his classic 1948 paper *A mathematical theory of communication* as

$$H(S^n) = \sum_{i=1}^{n} s_i \, log_2 \frac{1}{s_i}. \tag{3}$$

It is worth noting that the value of $H(S^n)$ depends only on characteristics of the structure analyzed, i.e. its elements s_i.

An important property of $H(S^n)$ as a measure of entropy is that it reaches its maximum value of $H_{max} = log_2 n$ if all structure elements s_i are equal (i.e. $s_1 = s_2 = \cdots = s_n$). As $H(S^n)$ approaches its maximum value, differences between structure elements decrease, and for $H(S^n) = H_{max}$, the distribution of structure elements becomes uniform. Also, $H(S^n) = H_{min} = 0$ if one of the elements s_i $(i = 1, 2, \dots, n)$ is equal to 1, and all the remaining structure elements are equal to 0 (i.e. distribution is concentrated in one element of structure only). The value of $H(S^n)$ can be, therefore, interpreted as the measure of concentration of elements s_i of structure S^n, and can be used in empirical setting to evaluate information content of a structure. When several structures ordered in time are available, it is also possible to analyse their dynamics. Empirical values and dynamics of entropy measure $H(S^n)$ for expectations and realizations expressed in the RIED business tendency surveys are presented in the next section.

In practice, however, not only the degree of uncertainty associated with *a priori* and *a posteriori* structures may be economically interesting but also the extent of changes detected between assumed (*a priori*) and observed (*a posteriori*) structures. In order to

analyse the size of change between *a priori* structure S_p^n and *a posteriori* structure S_q^n, relative entropy (or Kullback-Leibler divergence; see Zhang, Jiang 2008) is calculated:

$$I\left(S_q^n : S_p^n\right) = \sum_{i=1}^{n} q_i \, log \frac{q_i}{p_i}. \tag{4}$$

Relative entropy is also known as information gain; it measures expected amount of "new" information provided by *a posteriori* structure. One of the properties of (4) states that it takes its minimum value of zero if both structures are identical (i.e. $S_p^n = S_q^n$), and increases with the size of differences between the structures to infinity (see Wędrowska 2010). $I(S_q^n : S_p^n)$ can be interpreted as the degree of change between assumed (*a priori*) and observed (*a posteriori*) structures, and therefore serve as measure of dissimilarity of structures: the larger it is, the less similar the structures are.

In empirical setting, it is more convenient to apply a standardized coefficient defined on interval [0, 1] to facilitate interpretations and comparisons. Chomątowski and Sokołowski (1978) introduce a similarity measure to classify data into comparable phases, and employ it to define clusters of industrial production in Poland. They also provide a related dissimilarity measure that can be used to evaluate extent of change from *a priori* to *a posteriori* structure:

$$P\left(S_q^n : S_p^n\right) = 1 - \sum_{i=1}^{n} min(q_i, p_i). \tag{5}$$

From the properties of the structure defined by (1) and (2) it follows that $P(S_q^n : S_p^n) \in [0, 1]$. The lower limit is attained when analysed structures are identical, i.e. $S_p^n = S_q^n$. As dissimilarities between structures increase, value of $P(S_q^n : S_p^n)$ increases towards the upper limit of 1.

Empirical values and dynamics of dissimilarity measure $P(S_q^n : S_p^n)$ employed to evaluate similarities between expectations and realizations expressed in business tendency surveys are presented in Section 4. They are introduced to supplement results obtained on the basis of the entropy measure as both methods reflect structure change from its *a priori* to *a posteriori* state.

3. Statistical properties of observed and expected balance statistics

In Table 2, means, medians and standard deviations for both observed and expected changes in balance statistics for selected fields of economic activity surveyed by RIED are presented, aggregated into expansion and contraction phases. Means and medians of balance statistics measure average level of optimism in each phase across assessments and expectations; standard deviation – its volatility. Also, the average percentages of "no change observed / expected" answers are calculated in each case in order to evaluate the dynamics of no-change (i.e. "everything remains/will remain stable") responses.

Table 2: Descriptive statistics for observed and expected balance statistics

Variable	Measure	Expansion 2009.10 – 2012.06	Contraction 2012.07 – 2012.12	Expansion 2013.01 – 2020:02	Pandemic 2020.03 – 2022.02
Production	mean	2.97	-9.47	-0.68	-9.85
Observed	median	2.40	-6.20	0.40	-6.75
	std dev	11.58	9.47	9.51	15.07
	avg.unch	47.82	47.67	50.91	47.12
Production	mean	6.33	-11.67	3.21	-5.37
Expected	median	9.70	-12.40	4.95	-2.85
	std dev	11.40	9.02	9.16	18.61
	avg.unch	50.80	49.17	54.00	46.14
Prices	mean	7.10	-3.45	1.45	23.29
Observed	median	6.60	-4.35	-1.80	27.95
	std dev	9.53	3.30	8.46	23.67
	avg.unch	73.16	79.48	77.79	63.38
Prices	mean	8.48	-0.77	5.41	29.78
Expected	median	8.40	-1.30	2.60	31.95
	std dev	7.80	2.43	10.02	24.55
	avg.unch	73.95	77.82	76.70	55.53
Employment	mean	-8.09	-12.80	-1.47	-3.29
Observed	median	-6.90	-11.45	0.00	-0.95
	std dev	6.55	4.36	6.35	6.18
	avg.unch	66.54	67.67	70.22	76.13
Employment	mean	-12.55	-21.53	-2.85	-2.36
Expected	median	-12.00	-22.45	-2.15	-0.60
	std dev	5.79	5.46	5.62	9.22
	avg.unch	70.39	66.37	72.45	71.83
Finances	mean	-7.94	-15.22	-8.74	-20.35
Observed	median	-8.10	-14.40	-8.30	-17.80
	std dev	6.51	2.63	6.20	12.28
	avg.unch	63.48	65.57	64.17	59.45
Finances	mean	-3.75	-19.17	-7.74	-17.23
Expected	median	-3.30	-19.55	-6.90	-11.80
	std dev	5.74	3.95	6.60	16.96
	avg.unch	64.56	63.22	64.70	55.46
General	mean	-21.95	-49.38	-12.88	-52.10
Observed	median	-22.50	-48.85	-11.20	-54.80
	std dev	9.19	5.38	16.04	18.49
	avg.unch	62.12	48.02	62.90	35.13
General	mean	-20.52	-53.30	-16.47	-45.93
Expected	median	-18.10	-53.40	-15.00	-48.60
	std dev	13.19	5.05	13.86	19.76
	avg.unch	57.77	42.77	59.06	33.76

Notation: see Table 1; avg.unch – average percentage of "no change observed/expected" answers.
Source: own calculations on the basis of RIED data.

As far as average level of optimism is concerned, it is much lower as measured by means and medians in the pandemic phase than in the preceding expansion phase. (Let us keep in mind that in the case of prices (q05), higher mean and median signify higher prices observed or expected, which is generally not good news for the economy; higher values are therefore consistent with the interpretation of less optimism in the pandemic phase.) This finding, of course, is hardly surprising and is consistent with results already noted in the literature. For example, Teresiene *et al.* (2021) show widespread pessimism among manufacturing and service sectors enterprises, both locally (by Eurozone countries) and globally. In particular, they document negative and significant impact of COVID-19 infections and fatalities on business sentiment indicators.

In the pandemic phase there are several instances of sizable differences between the average and median, which may suggest that more of the data values are clustered towards one end of their range or a few extreme values are observed. This may suggest more uncertainty during the pandemic. Also, much higher volatility (as measured by standard deviation) in the pandemic phase as compared to the preceding expansion phase of January 2013 – February 2020 is observed, particularly in the case of production (q01), prices (q05), and financial standing of companies (q07) in the manufacturing sector. This stands in contrast with the previous analysis of expectations expressed in Polish business tendency surveys, where more volatility was noted during expansion phases, more often for observed changes than for forecasts, and lower uncertainty was observed in contraction phases (see Tomczyk 2022). It is perhaps a first empirical indication that the pandemic phase cannot be straightforwardly interpreted as another contraction phase. Instead, it seems to be a separate phenomenon not to be confused with previous slumps in economic activity. The ambiguous behaviour of price expectations during pandemic has been noted previously. For example, Meyer *et al.* (2022) note that in the United States, enterprises expect lower selling prices in the short term and lower inflation in contrast to rising household inflation expectations. Generally, behaviour of price expectations during pandemics requires further detailed analysis as it is not typical either for expansion or contraction phases of a business cycle.

There are exceptions to the "higher volatility during pandemics" rule though: standard deviations of observed and expected changes in employment (q06) and general situation of the economy (q08) remain stable across expansion and pandemic phases.

Fractions of "no change" responses are generally lower for both observed and expected changes in the pandemic phase than in the expansion phases directly preceding. This result suggests that survey respondents found it easier to express a specific (and generally pessimistic, judging by means and medians) opinion about all the economic variables. This effect is particularly strong in the case of a general situation of the economy (q08), where percentages of "no change" answers fell from 63–59 percent to 34–35 percent between the expansion phase of January 2013 – February 2020 and pandemic phase of March 2020 – February 2022).

4. Results of application of entropy and dissimilarity measures

As the next step in analysis of assessment and expectations of enterprises across business cycle phases, Shannon's entropy was used for investigating the level of concentration of the structures, defined as percentages of "up – no change – down" answers. Table 3 shows the summary statistics for entropy measure $H(S^n)$ given by formula (3), calculated for five variables selected from the RIED business tendency survey in manufacturing, separately for expectations and observed changes, across business cycle phases. Since mean and median values were very similar, only mean is reported for purposes of clarity.

Table 3: Summary statistics for entropy measures: observed and expected changes

Variable	Measure	Expansion 2009.10 – 2012.06	Contraction 2012.07 – 2012.12	Expansion 2013.01 – 2020:02	Pandemic 2020.03 – 2022.02
Production	spread	0.1143	0.0646	0.1929	0.2927
Observed	mean	1.4978	1.4973	1.4738	1.4717
	std dev	0.0317	0.0260	0.0388	0.0630
Production	spread	0.1188	0.0432	0.1832	0.2899
Expected	mean	1.4654	1.4755	1.4376	1.4750
	std dev	0.0307	0.0169	0.0417	0.0681
Prices	spread	0.3588	0.1088	0.5196	0.5196
Observed	mean	1.0657	0.9291	0.9562	1.0475
	std dev	0.0818	0.0438	0.1054	0.1495
Prices	spread	0.3297	0.2502	0.6480	0.3808
Expected	mean	1.0478	0.9803	0.9652	1.1466
	std dev	0.0772	0.0842	0.1373	0.0837
Employment	spread	0.2317	0.0304	0.3085	0.2990
Observed	mean	1.2280	1.1899	1.1633	1.0129
	std dev	0.0601	0.0125	0.0667	0.0821
Employment	spread	0.2326	0.1594	0.3440	0.2336
Expected	mean	1.1226	1.1395	1.1113	1.1139
	std dev	0.0534	0.0700	0.0721	0.0680
Finances	spread	0.2481	0.1354	0.2495	0.2995
Observed	mean	1.2890	1.2198	1.2737	1.2655
	std dev	0.0552	0.0524	0.0522	0.0742
Finances	spread	0.1809	0.0249	0.2692	0.3472
Expected	mean	1.2813	1.2380	1.2657	1.3305
	std dev	0.0383	0.0098	0.0520	0.0754
General	spread	0.1806	0.1428	0.3681	0.9566
Observed	mean	1.2183	1.0767	1.2305	1.1643
	std dev	0.0487	0.0496	0.0833	0.2386
General	spread	0.2646	0.1631	0.3329	0.8692
Expected	mean	1.2940	1.1021	1.2925	1.2617
	std dev	0.0668	0.0591	0.0892	0.2119

Notation: see Table 1; obs – observed changes, exp – forecasted (expected) changes; spread = maximum – minimum value. Source: own calculations on the basis of RIED data.

High mean values of entropy obtained in the case of production (q01), both in comparison to other variables and in absolute terms, seem to be the most striking result. The maximum value of measure of entropy is $H_{max} = log_2 n = log_2 3 = 1.5850$; the closer empirical entropy of a structure to its maximum value, the more uniform the structure is, and therefore the less informative *a priori* structure becomes in relation to *a posteriori* structure. Mean values obtained for production across the business cycle phases (for example, 1.4750 for expectations and 1.4717 for realizations during the pandemic phase) are considerably higher than mean entropy of prices, employment, financial standing, or general business conditions. In the case of production, therefore, distribution of increase / no change / decrease fractions is relatively uniform, leading to high entropy and providing little information. On the other hand, entropy is equal to zero if one of the elements of a structure is equal to 1, i.e. there is no uncertainty associated with distribution of outcomes. The value of zero is not attained for any of the variables analysed, and the lowest values (slightly above or below 1) are observed for prices (q05). Since entropy allows to evaluate degree of concentration, in the case of prices fractions of survey answers seems to be particularly cantered on one of the three options provided in the questionnaire. In theory, answers might be cantered on either of the three options (increase / no change / decrease) and vary from one questionnaire to another. In practice, however, they are heavily biased towards the "no change" category (see Table 2) for all the variables in the RIED business tendency survey.

Compared to any other phase of the business cycle since 2009, the highest spread of entropy (i.e. difference between the maximum and minimum values) is observed in the pandemic phase, with a single exception of employment (q06), for which the highest spread, for both observed and expected changes, was noted during the expansion phase of January 2013 – February 2020. The largest increase as compared with the last expansion phase, the largest spread is noted for general condition of the economy (q08), where spread increases from 0.3881 to 0.9566 for observed and from 0.3329 to 0.8692 for expected changes. Also, in the case of the general situation of the economy, there is the most dramatic increase in variability of entropy as measured by standard deviation: from 0.0833 to 0.2386 for observed and from 0.0892 to 0.2119 for expected changes, confirming that the general situation of the economy is subject to the most volatile changes in information content of surveys from one month to another.

Finally, dissimilarity measure $P(S_q^n : S_p^n)$ given by equation (5) is used to quantify the divergence between the *a priori* and *a posteriori* structures; i.e. expectations and observed changes. Since expectations have to be matched with observed realizations to calculate the measure of dissimilarity, the length of time series is reduced by three observations. The final phase (pandemic) is therefore reported for March 2020 – November 2021 since the last three expectations data points (for December 2021, and January and February 2022) do not have matching observed changes to calculate the dissimilarity statistics. Statistical details, i.e. mean, median and standard variation across business cycle phases, are reported in Table 4.

Table 4: Summary statistics for dissimilarity measure (5)

Variable	Measure	Expansion 2009.10 – 2012.06	Contraction 2012.07 – 2012.12	Expansion 2013.01 – 2020:02	Pandemic 2020.03 – 2021.11
Production	mean	0.0763	0.0693	0.0800	0.0765
	median	0.0710	0.0655	0.0715	0.0690
	min	0.0240	0.0300	0.0140	0.0110
	max	0.1280	0.1420	0.3140	0.2610
	std dev	0.0331	0.0411	0.0474	0.0584
Prices	mean	0.0490	0.0278	0.0495	0.0723
	median	0.0470	0.0285	0.0385	0.0670
	min	0.0070	0.0080	0.0040	0.0010
	max	0.1410	0.0540	0.2620	0.1660
	std dev	0.0299	0.0180	0.0432	0.0480
Employment	mean	0.0571	0.0457	0.0487	0.0520
	median	0.0590	0.0470	0.0490	0.0430
	min	0.0060	0.0260	0.0020	0.0150
	max	0.1180	0.0730	0.1310	0.1090
	std dev	0.0275	0.0174	0.0271	0.0293
Finances	mean	0.0430	0.0308	0.0475	0.0941
	median	0.0440	0.0340	0.0380	0.0770
	min	0.0030	0.0140	0.0020	0.0310
	max	0.0910	0.0400	0.2480	0.2570
	std dev	0.0215	0.0098	0.0386	0.0507
General	mean	0.0753	0.0532	0.0765	0.1156
	median	0.0710	0.0430	0.0670	0.1000
	min	0.0190	0.0160	0.0070	0.0380
	max	0.1680	0.0980	0.3620	0.2390
	std dev	0.0413	0.0321	0.0587	0.0589

Notation: see Table 1. Source: own calculations on the basis of the RIED data. Min – minimum value, max – maximum value.

The highest mean value of the dissimilarity measure is observed in the divergence between the *a priori* and *a posteriori* structures of the expectations and assessments of general business conditions during the pandemic: 0.1156. It is the global maximum across all the business cycle phases and all variables. The majority of the values of the dissimilarity measure indicate only minor divergences between the analysed structures. The lowest means and medians are generally observed for prices (q05) with the global minimum of 0.0278 during the short contraction phase of July 2012 – December 2012, but, during the pandemic phase, the lowest value (0.0520) is associated with employment (q06). Volatility of dissimilarity of structures is consistently higher during pandemic than in any other business cycle phase with the maximum of 0.0589 for the general economic situation (q08) and a close second high of 0.0584 for production

(q01). These results confirm that for general situation of the economy, *a posteriori* structures of responses differ significantly from their *a priori* counterparts and, with their high variability, reflect a lot of uncertainty among the respondents as far as overall economic conditions are concerned.

Employment (q06) stands out as the only variable which exhibits constant sizable variation across the entire sample without the peak at the beginning of 2020. This result can be interpreted as structures (i.e. percentages of increase/ no change/ decrease answers) for employment expectations and assessments being relatively unaffected by the onset of the pandemic. Previous studies (for example, Bartik et al. 2020) show that businesses' expectations about the longer-term impact of COVID-19 on employment strongly depend on sector's familiarity with pandemic-relief programs and government assistance procedures. Lack of this type of data in case of Polish business surveys may explain the relatively uniform behaviour of the dissimilarity measure in the case of employment.

5. Summary and conclusions

COVID-19 pandemics is the second major event of this type in current (economic) memory, the first being the Spanish flu pandemic of 1918-1920, the most severe pandemic in modern history. However, recent abundance of research articles on economic consequences of COVID-19 outbreak is unprecedented in the post-pandemic economic literature. The Spanish flu pandemic, caused by an H1N1 virus of avian origin, is estimated by the Center for Disease Control and Prevention to have affected about 500 million people (one-third of the world's population) and caused at least 50 million deaths worldwide (CDC, 2021). As for COVID-19, there are more than 504 million registered cases and 6.2 million deaths as of April 17, 2022 (Worldometer, 2022). Boianovsky and Erreygers (2021) note that despite of the huge scale of the Spanish flu pandemic, none of the major economics journals published an article on the pandemic in the period of 1918–1921. As possible reasons they cite factors related to the organization of the economic profession, lack of nation-wide anti-pandemic government measures such as lockdowns, and generally low degree of visibility of the economic characteristics of the pandemic; let us note is took place right after the World War I when academic and publishing efforts were not given priority. The interest taken by 20th century economists in analysing economic consequences of the COVID-19 pandemic if fully warranted by remarkable irregularities of business tendency survey data dynamics in comparison to other phases of a business cycle. This is particularly visible for the general business conditions and much less so for individual variables such as production, prices, employment and financial standing of manufacturing sector companies.

On the basis of empirical results presented in Sections 3 and 4, the following overall conclusions can be drawn. General business conditions (q08) consistently stand out as the variable associated with the highest volatility and evident difficulties with predicting *a posteriori* structures of responses on the basis of *a priori* information. This category exhibits the highest discrepancies across characteristics of expectations and assessments, ranging from non-informative to relatively informative structures. Also, the largest global values of the dissimilarity measure are observed in the divergence between the *a priori* and *a posteriori* structures of general business conditions during the pandemic. Fractions of expected and observed percentages differ markedly, reflecting respondents' insecurity with respect to general economic conditions.

During COVID-19, higher volatilities of expected and observed changes in responses are noted, which in previous analyses (see Tomczyk 2022) were associated rather with expansion phases of the business cycle. Combined with results of the application of entropy and dissimilarity measures, this finding strongly suggests that the pandemic phase cannot be straightforwardly interpreted as another contraction in the business cycle. Instead, it seems to be a separate phenomenon not to be confused with previous slumps in economic activity.

Analysis of expectations of entrepreneurs during recent pandemic should be further extended to include tests of rationality of expectations with respect to the cycle phase (including the pandemic phase separately from typical upturns or downturns) or correlation of sentiments expressed in tendency surveys with other aggregated measures of economic activity. Special attention should be paid to general business situation as this variable exhibits the most traits separating the pandemic from other phases of the business cycle. However, since we have only two year's worth of pandemic-related data (and hopefully no more), the limited number of observations will make quantification procedures statistically dubious. What is more, the 2022 Russian invasion of Ukraine and the resulting war that continues at the time of writing of this article will likely further distort empirical results.

An additional research problem worth considering is whether current situation of an enterprise (particularly its financial standing reported in question q07) systematically influences its expectations, and consequently the degree of concentration of answers on a particular option.

Still another approach, significantly extended with respect to the current research project cantered on properties of business survey data in separate business cycle phases, would focus on entropy and dissimilarity measures disaggregated by years or quarters. It would allow to analyse their variability in more detail, and seems to be particularly suitable during expansion phases which tend to be relatively long as compared to contractions. This research question remains as one of the promising directions of further study of statistical and information content properties of business tendency survey data.

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