The impact of the COVID-19 shock on response distributions in business tendency surveys: An application of the Kullback–Leibler divergence

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Abstract. This paper applies the Kullback-Leibler divergence (KLD) to quantify discrepancies between expectations and subsequent assessments in business tendency surveys for Polish manufacturing firms. Using monthly survey data from May 2004 to January 2026, it examines how closely firms' expectations align with subsequent assessments across key economic variables and how this relationship evolves during the COVID-19 pandemic. The results indicate that, under normal conditions, expectations and assessments remain closely aligned, suggesting a high degree of consistency. However, during the pandemic, the KLD increased across all variables, with statistically significant rises observed for some of them, indicating a widening gap between expectations and assessments. The strongest effects are found for aggregate economic indicators, particularly the general economic situation and, to a lesser extent, firms' financial standing. On the other hand, employment and inventories exhibit relatively greater stability. Overall, the results demonstrate that the KLD provides a useful distribution-based measure for identifying regime shifts in expectation formation and for assessing the information content of survey data under changing economic conditions.

Keywords: Kullback–Leibler divergence, business tendency surveys, survey data, expectations, COVID-19

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1. Introduction

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Expectations play a central role in economic decision-making and constitute a key component of business tendency surveys (BTS). These surveys are a valuable tool for monitoring economic dynamics, as they provide timely and forward-looking information about firms' perceptions of current and future economic conditions. Traditionally, the analysis of such data has relied on balance statistics or aggregate indicators, which summarise the direction of change but provide limited insight into the underlying distribution of responses.

This paper adopts an alternative perspective by focusing on the full distribution of aggregated survey responses and applying the Kullback-Leibler divergence (KLD) to quantify shifts in response distributions in BTS. KLD is used as a measure of dissimilarity between expected and reported outcomes, capturing the distance between expectations and subsequent assessments. Rather than directly measuring uncertainty, KLD provides indirect evidence on the difficulty of forming expectations that are supported by actual developments. This is achieved by quantifying the mismatch between expectations and later assessments.

The empirical analysis is based on monthly BTS in manufacturing conducted by the Research Institute for Economic Development (RIED) at the SGH Warsaw School of Economics. The dataset covers the period from May 2004 to January 2026, enabling a comparison between normal economic conditions and the disruptions associated with the COVID-19 pandemic. By examining changes in KLD for several economic variables across time, the study aims to identify patterns in the divergence between expectations and assessments and to examine how this relationship changes during periods of economic instability.

This paper contributes to the literature in three ways. First, it presents a distribution-based framework for analysing expectation-assessment divergence in BTS data, which is a topic that has received limited attention in the literature. Second, it provides empirical evidence illustrating how this divergence responds to systemic shocks. Third, it identifies heterogeneity across economic variables, showing that expectations linked to variables related to the overall economic sentiment and firms' financial standing are particularly sensitive to external shocks.

2. Literature review

The existing literature contains relatively few empirical studies that apply KLD (or any related information-theoretic measures) to analyse probability distributions of expectations and assessments in BTS. Instead, most quantitative analyses of BTS data focus on the statistical properties of balance statistics, the determinants of expectation accuracy and the usefulness of aggregated survey indicators in econometric modelling. In addition, Bayesian approaches are often used to combine survey data with prior information and to account for measurement error and noise.

On the other hand, KLD is typically used in financial econometrics, entropy-based risk modelling and instability detection in time series. To provide two recent examples, Ishizaki and Inoue (2024) employed short-term KLD to identify instability in high-frequency financial time series, while Fan et al. (2025) used the same measure to evaluate the performance of alternative methods for detecting anomalies in financial time series. Applications in Poland include Wędrowska (2011), who employed KLD to study the dynamics of household expenditure structures, and Pawelec (2021), who used a related

concept of structural distance to analyse the similarities and differences in expenditure patterns across different household demographic types.

Only a few previous studies employed entropy-based measures, including KLD to evaluate the information content of responses in business tendency surveys. In two separate studies, Tomczyk applied entropy and dissimilarity measures to assess the information content of Polish business tendency survey data across four variables: two ownership sectors and four firm-size groups (2011), and to examine how the COVID-19 pandemic influenced the dynamics of expectations and assessments reported in business tendency surveys of Polish manufacturing firms (2023). In addition, Tomczyk and Kowalczyk (2023) used entropy-based methods to measure the degree of consensus among survey respondents.

Despite the limited use of KLD in business tendency surveys, this approach relates closely to the established literature on survey expectations, encompassing analyses of disagreement, forecast errors and alternative measures of uncertainty. In the BTS literature, disagreement is typically proxied by cross-sectional dispersion of qualitative responses and interpreted as heterogeneity in firms' expectations (Lahiri & Sheng, 2010; Mokinski et al., 2015). However, such measures capture only selected moments and may not fully reflect the distributional structure of three-category responses, nor distinguish clearly between disagreement and uncertainty (Rich & Tracy, 2021).

A related strand of the literature evaluates expectations expressed in BTS through forecast errors, defined as differences between *ex ante* expectations and *ex post* outcomes. Empirical evidence shows that these errors increase with subjective uncertainty and become more pronounced during periods of volatility (Buchholz et al., 2021; Morikawa, 2023). However, the categorical

nature of BTS data limits the applicability of standard point-based error measures.

The present study contributes to a broader body of research on BTS in Poland, which has demonstrated that qualitative survey data provide valuable information for tracking business-cycle developments, forecasting macroeconomic variables and estimating output gaps (Białowolski et al., 2010, 2014; Ratuszny & Walczyk, 2022). Other studies examined the information content of survey responses and the mechanisms underlying the formation of expectations among firms (Białowolski, 2013; Kalinowski & Kokocińska, 2015). This research clearly demonstrates the usefulness of BTS as a source of economic information. However, they focus on forecasting performance, composite indicators or structural relationships between expectations and economic outcomes. Much less is known about the extent to which firms' expectations are subsequently reflected in their assessments, especially during periods of heightened uncertainty and economic turbulence. Understanding this relationship is important, because major shocks may alter not only economic conditions but also the ability of firms to anticipate them.

In Poland, these issues have been explored within a broader research tradition devoted to BTS. An important centre of this kind of research is the RIED, where an extensive body of work has been devoted to the analysis of survey data. It encompasses a wide range of topics: the formation of firms' expectations, the relationship between assessments and forecasts, the forecasting performance of qualitative survey data and methodological developments, including distribution-based approaches (Bernardelli & Dędys, 2017). The present study particularly extends the literature on distribution-based methods by demonstrating the practical application of KLD, a well-established information-theoretic measure that has so far been only rarely used in the analysis of survey response distributions.

Polish science has also addressed the formation and rationality of economic expectations. A prominent example is the extensive body of research on inflation expectations conducted within the National Bank of Poland. Among these contributions, Łyziak (2016) examined the behaviour and information properties of inflation expectations in Poland, while also relating them to issues of expectation accuracy and macroeconomic performance. Kowalczyk and Tomczyk (2008) examined the rationality of firms' expectations, focusing on unbiasedness and information efficiency. More recently, Ziembińska (2021) explored alternative approaches to testing expectation-formation mechanisms and the rationality of economic forecasts. Altogether, these studies have contributed to a wider understanding of how economic expectations are formed, revised and evaluated. However, they focus primarily on the properties of expectations, typically rationality, rather than on the degree to which expectations and subsequent assessments reported in BTS correspond with each other.

A related, though still somewhat limited strand of the literature, examines survey-based expectations from the perspective of uncertainty and consensus among respondents (Dudek, 2017; Tomczyk & Kowalczyk, 2023). This line of research includes both traditional uncertainty measures derived from survey and financial market data, as well as more recent approaches based on text-mining and web-scraping techniques (Hołda, 2019). Lately, Kocięcki et al. (2022) analysed subjective expectations and uncertainty, emphasising the role of survey-based measures in capturing the agents' perceptions of future economic developments. While KLD is not a direct measure of uncertainty, its elevated values indicate a growing divergence between expectations and subsequent assessments. The present study contributes to the literature by focusing on the distribution of survey responses, represented by the probabilities of the qualitative response categories.

This paper differs from earlier Polish studies in three aspects. First, rather than examining information content, respondent consensus or forecasting performance, it focuses explicitly on the divergence between expectations and assessments. Second, the analysis is conducted at the level of full response distributions available from a qualitative tendency survey rather than balance statistics or selected summary measures, capturing the changes in the entire structure of responses. Third, the study draws on a long monthly sample covering different phases of the business cycle, making it possible to examine how the divergence between expectation and assessment evolves across economic regimes, including the COVID-19 shock. Thus, the paper extends the previous applications of entropy-based methods in Polish BTS and demonstrates the usefulness of KLD as a tool for identifying periods in which firms' expectations become less consistent with the reported subsequent assessments.

3. Methods and data

Originally introduced by Kullback and Leibler (1951), KLD has been extensively studied in the literature, with its properties and interpretations discussed in popular textbooks such as Cover and Thomas (2006), and Joyce (2011). The standard definition of KLD is as follows:

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

where S_p^n stands for *a priori* structure, S_q^n for *a posteriori* structure, and structure S^n itself is defined as a vector: $S^n = [s_1, s_2, \ldots, s_n]^T \in R^n$, whose elements s_i ($i = 1, 2, \ldots, n$) fulfil two conditions:

$$0 \leq s_i \leq 1, \tag{2}$$

$$\sum_{i=1}^{n} s_i = 1. \tag{3}$$

Structure S^n is therefore fully described by a vector of fractions (structure elements) summing to a total of 1. In the context of BTS, *a priori* structure S_p^n reflects the distribution of expectations (typically a discrete distribution over three or five response categories), whereas *a posteriori* structure S_q^n describes the distribution of assessment (i.e. the observed changes).

One of the key properties of (1) is that it attains its minimum value of zero if and only if the two structures are identical (i.e. $S_p^n = S_q^n$) and it increases to infinity (as it is not bounded from above) with the magnitude of the differences between the structures. Accordingly, (1) can be interpreted as a measure of the divergence between the *a priori* (expected) and *a posteriori* (observed) probability distributions. In this sense, it serves as a measure of structural dissimilarity: the larger its value, the greater the disparity between the two structures, i.e. the distributions of respondents' answers to questions about their expectations and their subsequent assessments.

It is important to note that KLD does not measure uncertainty *per se*, but rather the divergence between the expected and realised distributions. Higher values of KLD indicate a greater mismatch between expectations and later assessments. While such discrepancies may be associated with heightened uncertainty or increased forecasting difficulty, KLD should not be interpreted as a direct measure of uncertainty. Instead, it is best viewed as a distribution-based indicator of the degree to which the observed outcomes deviate from the previously reported expectations.

KLD was selected over alternative measures such as the Jensen-Shannon divergence, Hellinger distance and total variation distance for both theoretical and substantive reasons. First, KLD has a direct information-theoretic interpretation as the expected information loss when the forecast distribution is used instead of the realised distribution. Second, unlike purely metric measures, KLD explicitly preserves the directional distinction between expectations (*a priori* distributions) and subsequent assessments (*a posteriori* distributions), which is central to the objective of this study. Third, previous comparative reviews of probability-distribution distances identify KLD as one of the most widely used information-theoretic measures for analysing discrepancies between categorical probability distributions and expectation-related processes (Cha, 2007).

The data on assessments and expectations concerning major economic variables have been obtained from the monthly BTS in manufacturing conducted by RIED at the SGH Warsaw School of Economics. The scope of the survey and variants of the answers are presented in Table A in the Appendix. Eight fields of economic activity are evaluated by respondents with respect to the changes observed in the previous month and expectations for the next three to four months. To ensure consistency between the expectations and the subsequent assessments, expectations reported in month t are matched with assessments reported three months later ($t + 3$). This is reflected in the survey design, where the respondents formulate expectations for the next three to four months. Following previous analyses of RIED BTS data (Tomczyk & Kowalczyk, 2023), a three-month period was adopted as the effective expectation horizon.

It should be noted that the analysis compares aggregated distributions of survey responses rather than expectations and the subsequent outcomes reported by the same firms. Consequently, the KLD should be interpreted as a

measure of dissimilarity between aggregate expectations and assessment distributions. In addition, assessment responses represent the firms' subsequent subjective evaluations rather than objectively observed outcomes. The measure therefore captures the extent to which the later assessments differ from the previously reported expectations, rather than forecasting performance in the conventional sense of comparing expectations with outcomes recorded in official statistics.

4. Results of the empirical analysis

This section presents the results of the empirical analysis, examining the distributional behaviour of the KLD across variables and over time. Table 1 presents the basic descriptive statistics of the KLD for the full sample.

Table 1. Basic KLD descriptive statistics for the full sample (May 2004 – January 2026)

Variable	Minimum	Maximum	Mean
Level of production	0.000169	0.428026	0.039396
Level of orders	0.000147	0.407289	0.041480
Level of export orders	0.000048	0.389705	0.038750
Stocks of finished goods	0.000247	0.176382	0.030195
Prices of goods produced	0.000029	0.273608	0.024966
Level of employment	0.000025	0.125837	0.021060
Financial standing	0.000012	0.302973	0.024777
General situation of the economy	0.000185	0.444007	0.045507

Source: author's work based on the RIED database.

Across the full sample, the average KLD values were relatively low, ranging between 0.02 and 0.046, indicating that expectations were, on average, fairly consistent with the subsequent assessments. Minimum values close to zero for all variables confirm that there were many periods when the expectations and

the observed outcomes were almost perfectly aligned, which is typical under stable macroeconomic conditions.

However, important differences emerged across the variables. The highest average KLD values were observed for the general economic situation, as well as orders and production. This indicates that firms face considerable difficulties in forming accurate expectations about the overall economy, as it is strongly influenced by external shocks, policy decisions and global developments. Relatively high values for orders and production place these variables in the same category as the general economic situation.

The lowest average KLD values were observed for employment, prices and financial standing. These variables tended to adjust more slowly and were often subject to institutional rigidities (e.g. labour contracts, pricing strategies and financing conditions). As a result, the distribution of the expectations in these domains was relatively well reflected in the distribution of the assessments.

The presence of high maximum KLD values indicates episodic shocks, which are likely associated with major crises. Indeed, most of the maximum values were observed at the onset of the pandemic (for export orders, prices and the general economic situation, the maximum was reached in April 2020, for stocks in May 2020 and for financial standing in July 2020). This suggests that at the beginning of this unprecedented crisis, expectations based on historical patterns failed. Table 2 presents the maximum, minimum and mean values of KLD for the pandemic subsample.

Table 2. Basic KLD descriptive statistics for the pandemic sample (March 2020 – March 2022)

Variable	Minimum	Maximum	Mean
Level of production	0.000507	0.311640	0.054086
Level of orders	0.001220	0.399952	0.058409
Level of export orders	0.004233	0.389705	0.063080

Stocks of finished goods	0.001798	0.176382	0.034339
Prices of goods produced	0.000029	0.273608	0.052187
Level of employment	0.001126	0.119150	0.026147
Financial standing	0.003217	0.302973	0.056791
General situation of the economy	0.007801	0.444007	0.100685

Source: author's work based on the RIED database.

The key result is that the average KLD increases for all variables during the pandemic, reflecting a substantial increase in the divergence between expectations and assessments. The pandemic period was characterised by radical uncertainty (e.g. lockdowns, supply-chain disruptions and policy interventions) and rapid regime shifts. As a result, firms' expectations lost their predictive power and were frequently revised. The KLD captures this as a persistent divergence between expectations and assessments.

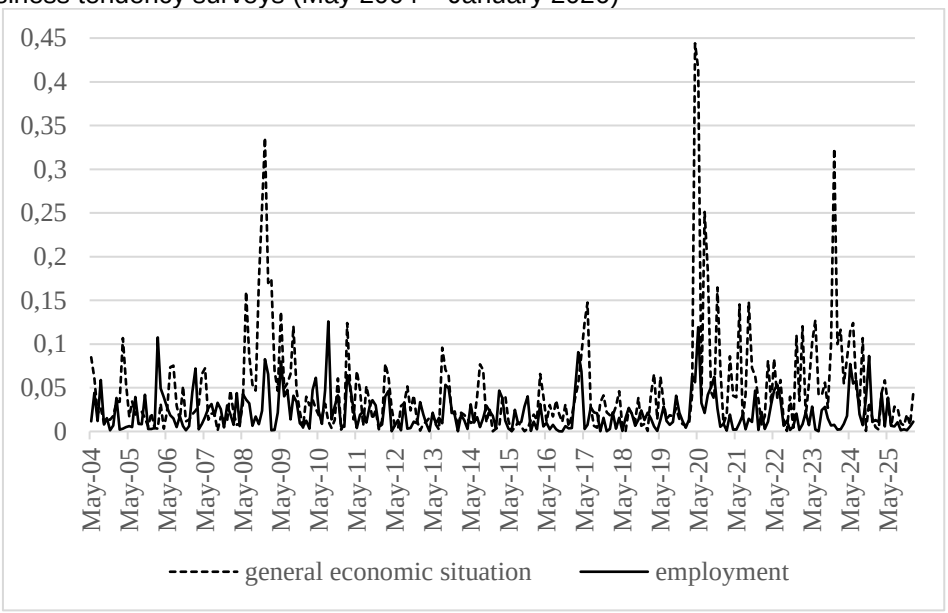
The variable most affected is the general economic situation. The average KLD during the pandemic more than doubled relative to its long-run level, indicating that firms were unable to form coherent expectations about the macroeconomic environment. This variable reflects uncertainty related to health policies, fiscal measures, international developments and demand conditions. A similarly strong effect was observed for prices, where the pandemic average KLD also more than doubled compared to the full sample. This suggests a breakdown in price-setting expectations relative to the subsequent assessments: shortages, rising energy prices and transport costs, and policy interventions weakened firms' ability to anticipate price developments. Export orders also exhibited an increase in KLD, indicating that border closures and highly volatile foreign demand made external conditions extremely difficult to predict.

By contrast, the labour market and inventories exhibited a relative resilience during periods of economic turbulence. Although the KLD increased for employment and stocks, the rise was more moderate compared to demand and

macroeconomic variables. This may be explained by labour hoarding, government subsidies and job-protection schemes that stabilised employment dynamics. Inventories, in turn, reflected adjustment margins which, at least to some extent, responded automatically to the disruptions. Consequently, expectation formation in these dimensions remained relatively more stable, even under extreme conditions.

The Figure below shows the evolution of the KLD for two variables: the general economic situation and employment. Higher values indicate a greater divergence between firms' expectations and their subsequent assessments.

Figure. Monthly KLD between expectations and subsequent assessments in business tendency surveys (May 2004 – January 2026)



Source: authors' calculations based on the RIED database.

These two variables were selected because they represent distinct patterns in the data: a strong pandemic effect (general economic situation) and relative stability (employment). Together, they provide a concise illustration of the heterogeneous impact of the COVID-19 shock on the divergence between expectations and assessments.

It should be noted that throughout the sample period, the KLD for the general economic situation was considerably more volatile than for employment. While the most pronounced increase occurred during the COVID-19 period, elevated KLD values were also observed during the global financial crisis in 2008–2010, indicating that firms' expectations regarding broad macroeconomic conditions were particularly sensitive to major economic disturbances. A temporary spike in divergence also occurred around 2023, suggesting that the post-pandemic period did not mean a complete return to stability. To verify whether these patterns are statistically significant, differences in mean KLD values across the sub-periods are assessed using Welch's two-sample *t*-test. To avoid sample overlap and ensure a meaningful comparison, the analysis distinguishes between the pre-pandemic period (May 2004–February 2020, number of observations $N_1 = 190$), the pandemic period (March 2020–March 2022, $N_2 = 25$), and the post-pandemic period (April 2022–January 2026, $N_3 = 46$). A comparison between the full sample and the pandemic subsample (as presented in Tables 1 and 2) would be misleading, as the latter is part of the former and therefore influences its average.

Welch's *t*-test has been selected because the assumption of equal variances was unlikely to hold, as indicated by the differences in the standard deviations across the studied periods. Unlike the classical Student's *t*-test, Welch's test does not impose the assumption of homoscedasticity and is therefore more robust in the presence of unequal variances and sample sizes. The analysis compares non-overlapping time periods, allowing for a meaningful comparison of the mean values across the subperiods. However, since the observations form a time series, they may exhibit serial correlation. As a result, the effective sample size may be smaller than the nominal number of observations due to the lack of independence among observations, potentially affecting the accuracy of the standard errors and *p*-values. The results of

Welch's *t*-test should be regarded as approximate and interpreted primarily as descriptive evidence of the differences across subperiods.

Table 3 presents the results of Welch's two-sample *t*-test for equality of means, presenting the *t*-statistics and two-sided *p*-values. The values in bold denote statistical significance at a 0.10 level. Negative *t*-values in the first comparison indicate higher mean KLD during the pandemic relative to the pre-pandemic period.

Table 3. Results of Welch's two-sample *t*-test for equality of means

Variable	Pre-pandemic vs pandemic (t)	*p*-value	Pandemic vs post-pandemic (t)	*p*-value
Level of production	-0.793	0.435	1.111	0.276
Level of orders	-0.607	0.549	1.511	0.143
Level of export orders	-1.469	0.153	1.085	0.286
Stocks of finished goods	-0.367	0.716	1.459	0.154
Prices of goods produced	**-2.297**	**0.030**	1.010	0.321
Level of employment	-0.785	0.437	0.950	0.348
Financial standing	**-2.298**	**0.029**	**2.089**	**0.046**
General situation of the economy	**-2.557**	**0.016**	**1.704**	**0.099**

Source: authors' calculations based on the RIED database.

The results of the Welch *t*-tests demonstrate that the increase in the KLD observed during the pandemic period is statistically significant only for a subset of variables. In particular, the null hypothesis of equal means between the pre-pandemic and pandemic periods is rejected for variables related to prices ($t = -2.297$, $p = 0.030$), financial standing ($t = -2.298$, $p = 0.029$) and the general economic situation ($t = -2.557$, $p = 0.016$). These findings suggest that the similarity between the distributions of the expectations and assessments decreased significantly in areas most closely linked to macroeconomic conditions and financial performance.

For the remaining variables – production, orders, export orders, stocks and employment – the differences in mean KLD values between the pre-pandemic and pandemic periods are not statistically significant. Although the average divergence increased for several of these indicators, the changes are not sufficiently large relative to their variability to be distinguished from random fluctuations.

Comparing the pandemic and post-pandemic periods, the results indicate a general weakening of the effect. Only financial standing ($t = 2.089$, $p = 0.046$) remained statistically significant, indicating a persistent mismatch between the expectations and the subsequent assessments regarding firms' financial conditions. For the general economic situation, the difference remained elevated, but it is only marginally significant at a 10% significance level ($t = 1.704$, $p = 0.099$). For all other variables, no statistically significant differences were detected.

Given the time-series nature of the data, the results of the *t*-tests should be interpreted with caution, as serial correlation may affect the estimated standard errors. To address this issue, mean equality was additionally evaluated using the Newey-West heteroskedasticity and autocorrelation consistent (HAC) framework, which adjusts standard errors for both heteroskedasticity and autocorrelation. The following results are based on comparisons of the mean KLD values across the subsamples. Statistical significance was assessed using Newey-West HAC standard errors with a lag length of 12, which is commonly adopted for monthly data. The results are shown in Table 4. The values in bold denote statistical significance at a 0.10 level. The negative *t*-values in the first comparison indicate a higher mean KLD during the pandemic relative to the pre-pandemic period.

Table 4. Results of the Newey-West HAC test for equality of means

Variable	Pre-pandemic vs pandemic (t)	*p*-value	Pandemic vs post-pandemic (t)	*p*-value
Level of production	-0.490	0.624	0.700	0.484
Level of orders	-0.426	0.670	1.007	0.314
Level of export orders	-1.030	0.303	0.794	0.427
Stocks of finished goods	-0.197	0.844	0.988	0.323
Prices of goods produced	-1.356	0.175	0.617	0.537
Level of employment	-0.548	0.584	0.602	0.547
Financial standing	**-1.745**	**0.081**	1.626	0.104
General situation of the economy	**-1.986**	**0.047**	1.335	0.182

Source: authors' calculations based on the RIED database.

Financial standing ($t = -1.745$, $p = 0.081$) and general situation of the economy ($t = -1.986$, $p = 0.047$) were the only variables for which the increase in mean KLD during the pandemic remained statistically significant after correcting for heteroskedasticity and autocorrelation at a 0.1 significance level. By contrast, comparisons between the pandemic and post-pandemic periods revealed no statistically significant differences in mean KLD values for any of the analysed variables.

The results of the Newey-West HAC tests largely confirm the main conclusions drawn from Welch's *t*-tests. The most pronounced and statistically significant increases in KLD during the pandemic were observed for the financial standing and general situation of the economy, indicating that these variables were most strongly affected by the disruption caused by the COVID-19 shock. However, the effect observed for prices in the Welch *t*-test disappeared once HAC standard errors were employed.

Overall, the two sets of results indicate that the pandemic-related increase in divergence was concentrated in a limited number of variables, primarily those linked to the firms' financial conditions and overall economic sentiment. The more conservative HAC estimates suggest that part of the statistical

significance detected by Welch's tests may have been driven by serial correlation in the monthly data; however, this does not alter the substantive conclusions.

Overall, the results suggest that the deterioration in the alignment between the expectations and assessments during the pandemic was not universal but restricted to certain domains, particularly those associated with macroeconomic conditions and the financial situations of the studied firms. Moreover, the absence of statistically significant differences between the pandemic and post-pandemic periods points to a gradual normalisation of these relationships, although some effects may have still persisted.

5. Discussion

The results obtained using the KLD are partially consistent with the related research. Lahmiri and Bekiros (2020) empirically demonstrated that entropy-based measures are not only effective in capturing increases in uncertainty, nonlinearities and structural breaks in financial markets during the COVID-19 crisis, but they also outperform traditional econometric tools in detecting early-stage instability. Although their study does not rely directly on KLD, it provides important empirical evidence supporting the usefulness of entropy-based measures in analysing uncertainty and expectation dynamics.

Other studies, employing different methodologies, also confirm rising uncertainty and growing difficulties in forming accurate predictions. Castelnuovo (2022) showed a systematic survey of the role of uncertainty in business cycles, with particular emphasis on how it surged and propagated during the COVID-19 pandemic, and how this surge compares with previous crises. He found that COVID-19 generated an unprecedented increase in uncertainty and led to greater disagreement among firms and forecasters.

Furthermore, the pandemic triggered frequent revisions of expectations and showed a high degree of persistence. The KLD-based results confirmed these findings in terms of the similarity between the distributions of the expectations and subsequent assessments.

Meyer et al. (2022) investigated the nature, magnitude and persistence of uncertainty during the COVID-19 pandemic, particularly focusing on forward-looking uncertainty and firm-level expectations. They showed that COVID-19 caused an extraordinary increase in uncertainty, although short- and long-horizon expectations evolved differently. Moreover, they characterised COVID-19 as a prolonged expectations shock rather than merely a volatility episode. The elevated KLD observed during the pandemic is consistent with their evidence of a breakdown in forecast reliability and structural changes in the information environment faced by firms.

The findings also contribute to the growing Polish literature on BTS. While earlier studies focused primarily on forecasting performance, expectation formation, information content and respondent consensus, the present analysis highlights a different dimension: the extent to which expectations are subsequently reflected in firms' assessments. The results suggest that this relationship becomes substantially less stable during periods of major economic disruption.

In conclusion, these results suggest that entropy-based measures effectively complement traditional indicators of uncertainty and disagreement, particularly in the context of qualitative survey data.

6. Conclusions

The results indicate that the relationship between expectations and assessments is state-dependent and the effects are stronger and statistically significant for

some variables, while weaker for others. Given the relative nature of KLD, expectations and subsequent assessments remain fairly closely aligned in normal conditions, whereas during systemic crises their consistency deteriorates with varying effects across all variables. This pattern, particularly evident during the COVID-19 period, suggests that BTS capture changes in the degree of similarity between the distributions of expectations and subsequent assessments. KLD proves especially useful as a distribution-based measure, revealing changes in belief formation beyond aggregate indicators such as balances or means.

Higher KLD values indicate greater divergence between expectations and subsequent assessments. One plausible interpretation here is that the elevated divergence reflects increased uncertainty, forecasting difficulties or changes in the information environment faced by firms. In descriptive terms, the highest divergence is observed for variables related to demand and macroeconomic conditions, i.e. production, orders, export orders and the general economic situation, indicating that these expectations are the most sensitive to shocks. Statistically significant differences are found for financial standing and the general economic situation. For these variables, systemic crises should be interpreted not only as real shocks but also as expectation shocks that impair firms' ability to form expectations consistent with actual future developments.

By contrast, employment exhibits consistently low divergence throughout the sample. Financial standing and the general situation of the economy show the most pronounced increases in divergence during the pandemic, with both variables displaying statistically significant changes relative to the pre-pandemic period in the Newey-West HAC framework. On the other hand, prices, although characterised by a noticeable increase in average divergence during the pandemic, do not remain statistically significant once serial correlation and heteroskedasticity are taken into account. The smallest effects,

both in magnitude and statistical significance, are observed for employment and stocks, which are firm-level operational indicators and therefore appear to reflect firm-specific rather than aggregate economic conditions.

It is worth noting that the KLD employed in this study measures divergence between aggregate distributions of survey expectations and subsequent survey assessments. It does not compare the expectations with the objectively observed outcomes, nor does it track revisions made by the same firms over time. Accordingly, the results should be interpreted as evidence on the consistency of aggregate survey responses rather than on individual forecasting accuracy.

These findings have important implications for both measurement and policy. From a methodological perspective, they highlight the advantages of distribution-based approaches such as KLD, in capturing shifts in expectations and assessments that remain hidden in conventional summary measures. They also highlight the importance of analysing the full distribution of survey responses (at least as captured by the probabilities of qualitative response categories, when more detailed data are unavailable), rather than relying solely on aggregate indicators such as balances.

From a policy perspective, elevated KLD values suggest a weaker correspondence between expectations and subsequent assessments during periods of economic disruption. In this context, effective communication and stabilisation policies may contribute to a closer alignment between expectations and subsequent assessments. This observation is particularly relevant for financial standing and the general economic situation, for which statistically significant increases in KLD are observed.

In light of the above, several avenues for further research emerge. First, the analysis could be extended to other countries and sectors to assess the generality of the observed patterns. Such extensions may be constrained by

data availability, as detailed distributional survey responses (shares of positive, neutral and negative answers) are not always published.

Second, KLD could be complemented with other entropy-based or information-theoretic measures to provide a more comprehensive evaluation of the divergence between expectations and subsequent assessments. In particular, future research could examine whether the substantive conclusions are robust to alternative measures of distributional divergence. Such comparisons could help identify the extent to which empirical findings depend on the specific properties of KLD, including its asymmetry, and provide further insights into the advantages and limitations of alternative information-theoretic approaches in the analysis of business tendency survey data.

Third, future studies could use micro-level survey data to examine heterogeneity in expectations across firms, e.g. by size, ownership structure or international exposure.

Fourth, the pandemic period is analysed separately in this study because descriptive evidence indicates that it differs substantially from the rest of the sample, with the highest KLD values for most of the variables observed during this interval. The post-pandemic period, by contrast, is characterised by several overlapping shocks, including the energy crisis, elevated inflation and the consequences of Russia's invasion of Ukraine, making a clean separation of individual effects difficult. Given the limited number of observations available after 2022, identifying the effects of individual post-pandemic shocks remains a promising avenue for future research.

Finally, the dynamic properties of KLD warrant further investigation in a time-series framework, including its potential role as an early-warning indicator of regime shifts and its relationship with macroeconomic activity. Further research could also explore how policy interventions affect expectation

formation and whether they help stabilise the link between expectations and subsequent assessments.

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Appendix

Table A. Monthly RIED questionnaire in the manufacturing industry

Variable	Observed within the last month	Expected for the next 3-4 months
Level of production	up / unchanged / down	will increase / will remain unchanged / will decrease
Level of orders	up / unchanged / down	will increase / will remain unchanged / will decrease
Level of export orders	up / unchanged / down / not applicable[b]	will increase / will remain unchanged / will decrease / not applicable[a]
Stocks of finished goods	up / unchanged / down	will increase / will remain unchanged / will decrease
Prices of goods produced	up / unchanged / down	will increase / will remain unchanged / will decrease
Level of employment	up / unchanged / down	will increase / will remain unchanged / will decrease
Financial standing	up / unchanged / down	will increase / will remain unchanged / will decrease
General situation of the economy regardless of the situation in your sector and enterprise	up / unchanged / down	will increase / will remain unchanged / will decrease

a 'Not applicable' answers to the Level of export orders question are omitted from the empirical analysis.
Source: RIED database.