BUSINESS AND CONSUMER SURVEYS: THE WEIGHTING SCHEME

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Abstract

The development of national economies is a popular theme nowadays. A great number of analysts focus on surveys which have an ability to predict a business cycle or the gross domestic product (GDP). Business and consumer surveys are ones of these popular instruments. These surveys have many advantages – results are published monthly, and they can identify the turning points in the economy. Of course, there are some areas left for improvement – for example, many analysts discuss the weighting scheme, a system of weights indicating an importance of individual parts of the surveys. Thanks to harmonisation, the weighting scheme is the same for all European countries. Unfortunately for some of them, it is not the best option because the weights do not suit the structure of the economy a very well. In this article, the authors want to construct a new weighting system for the calculation of the composite confidence indicator. Using this modified method, we could obtain a better prediction of the GDP, and could be better prepared for a potential future economic crisis.

Key words: Business Survey, Consumer Survey, weighting scheme, prediction ability

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Introduction

Many experts in the field would like to know how the future development of the economy will look like. Analysts and economists discuss which surveys or economic indicators can help with the predictions. Business and consumer surveys belong to the favourite ones because they collect opinions about the current situation "of" the companies and "by" the companies, as well as their expectations for the near future (Abberger, 2007).

Thanks to a quick publication, we have new pieces of information about our economy very soon. Although the data are based only on opinions and feelings of the companies, they can help us to illustrate (at least on a limited scale) how the economy is developing nowadays even before we are able to get a real raw data about the gross domestic product or gross value added. Economic Sentiment Indicator or each one of the specific confidence indicators (main outputs of the survey), respectively, can be used as a forecasting instrument. The European

Commission (2006) talks about short-term forecasting and defines confidence as a "level of certainty that the economic processes will develop in a positive direction, i. e., a result in higher level of production, gross domestic product or consumption". Many empirical analyses proved that business and consumer surveys could be appropriately used for predictions (nowcasting[1] or forecasting) of the national economic indicators. As was mentioned before, the goal for the authors is to improve the prediction ability of the surveys described above. While there are lots of ways how to change the surveys for the better, we have focused on the weighting scheme of the Economic Sentiment Indicator construction and went deeper in the set of values of the weights in order to adjust them to make the ongoing predictions using the weight more accurate.

Thus, the aim of the paper is to find an optimal weighting system for the Economic Sentiment Indicator in the Czech Republic such that the predictions using the new weighting scheme are able to return more accurate results. The set of the weights (there is exactly one weight for each one of the confidence indicators) was found using brute force approach. In order to evaluate performance of the predictions based on the weighting schemes, we have used three commonly used performance metrics: Pearson's correlation coefficient, Mean Squared Error (MSE) and Mean Absolute Error (MAE), respectively.

1 Literature Review

Business and consumer surveys are important sources of data for official statistics. The results are published on a monthly basis and they can fill in the gap of time before the official and precise results about the gross domestic product (GDP), gross value added (GVA) or the industrial production index (IPI), respectively, are calculated and got publicly available. As we mentioned in the beginning, business and consumer surveys are popular tools for making predictions (nowcasting or forecasting) about national economies. According to Etter and Köberl (2006), we can use the results from the business and consumer surveys as leading indicators of the GDP. They warned, however, that weights used during the data aggregation might be often insufficient when considering any ongoing predictions.

Polish authors, Tomczyk and Kowalczyk (2010), found that Polish industrial companies cannot predict their expectations – the main reasons were both large unit non-response rate and poor-performing weighting system. Tomczyk and Kowalczyk continued on with the following analysis and tested the rationality of expectations related to the level of

[1] Nowcasting stands for predictions of the present or very close future, while forecasting is used for predictions of the long-term future.

industrial productions using the weights from the survey and non-response. They used two weighting schemes for the balance statistics construction – the first one used and omitting population weights and the second one is a relative inclination of pessimist and optimist response (constant in time), respectively. They concluded that the results are stable across weighting scheme and the non-response rate does not affect the prediction results (Tomczyk and Kowalczyk, 2011). Arkadievich *et al* (2008) tried to improve the forecasting accuracy of the annual GDP growth rates for each of the 16 German states (i. e. on the aggregate level). They used panel data, but – unlike other authors' data – their dynamic data models allow not only to utilize a temporal interdependence in the regional level but also their spatial interdependence. The forecast of the model within the spatial dependence matrix – in comparison to the one without such a matrix – has got only marginal improvements in terms of the root mean square forecast error. Lehmann and Wohrable (2015) also focused on regional forecasting in Germany. Their main problem was a "data-poor-environment" at the sub-national level. They also warned against the length of predictions – forecast improvement decreases with length, as we could expect and therefore it is not such a surprise. Fusari and Pellissier (2008) criticised the current construction of the confidence indicators, which are based only on respondents' opinions of the present situation. Despite the mentioned problems, analysts try to find a suitable model for the predictions. Claveria, Monte and Torra (2019) proved that the surveys are able to predict the GDP. They calculated the most accurate forecast of the GDP for Sweden so far. According to Dapkus and Stundziene (2016), changes in the industry's confidence indicator have a significant impact on the changes in all production indices. Emerson and Hendry (1996) defined five problems with the construction of the indicators: the first one is (i) the selection of the single indicators (for the construction of the leading indicator), then (ii) the fixed weighting scheme during the analysed time, (iii) missing lagged values of the single indicators in the leading indicator, (iv) missing lagged values of the single indicators and (v) the last one is the time-series cointegration (between some indicators and target variable), respectively.

2 Methods and results

European Commission (2019) proposes two options for the calculation:

- *simple a counting of the answers*: we calculate the number of positive and negative answers and then publish them as a percentage of the total number of companies in the stratum

- *weighting accounting*: we use a weighting coefficient for each company's response, e.g. employment, production or turnover, as an estimate of importance of such a company.

Weighting improves the quality of the predictions because the weighting coefficients reflect the importance of the each area in the population and each one of the companies in the specific sector. This information is derived from the official statistics; for example, GVA in the specific sector (European Commission, 2019).

In the Czech Republic, the Czech Statistical Office is responsible for all the results which arise from the business and consumer surveys and publishes the basis indices (and balances, respectively) of the confidence indicators in selected areas, then consumer confidence indicator and Economic Sentiment Indicator (ESI), respectively, on a monthly basis. It is important to say that the mentioned surveys collect qualitative data. Respondents are asked how – according to their perspective – could the development of economics in near future look like and are supposed to choose exactly one from the following (typically three) options: "improve" (positive answer), "no change", or "deteriorate" (negative answer), respectively (Czech Statistical Office, 2019).

2.1 Weighting scheme in the Czech Republic

The Czech Statistical Office collects the respondents' opinions in the domains of industry, construction, trade and selected services, respectively, and calculates the business confidence indicator using the four confidence indicators. These individual confidence indicators are constructed as an average of seasonally adjusted and weighted balances, where the balance is a difference between the percentage of positive answers and the percentage of negative answers:

- confidence indicator in the industry is an average of balances calculated from the following questions: the assessment of total demand, assessment of stocks of final production (with an inverted sign) and the expected development of production activity;
- confidence indicator in the construction is an average of calculated from the following questions: the assessment of total demand and the expected development of employment;
- confidence indicator in trade is an average of balances calculated from the following questions: the assessment of the economic situation, assessment of stocks (with an inverted sign) and the expected development of the economic situation;

- confidence indicator in selected services is an average of balances calculated from the following questions: the assessment of the economic situation, the assessment of demand and expected demand (Czech Statistical Office, 2019).

After that, the business confidence indicator is computed using the following weighting scheme: confidence indicator in industry = 40%, confidence indicator in construction = 5%, confidence indicator in trade = 5%, confidence indicator in selected services = 30%. The last component is the consumer confidence indicator which worths a weight of 20%. Its value is calculated as an average of the four following indicators: the consumer's expected financial situation, expected overall economic situation, expected total unemployment (with an inverted sign) and expected consumer savings in the next 12 months, respectively.

2.2 Optimisation Methods – Brute force approach

The brute force approach is usually used for finding an optimum whenever it is at least a little possible. We used this approach in order to find a new weighting scheme of the Economic Sentiment Indicator believing it should give a better calculation structure for Czech data. To be more specific, we used the brute force approach to estimate a set of new weights (belonging to individual confidence indicators) such that the new weights applied in the ongoing prediction (of the GDP or GVA) make results of the prediction more accurate.

According to Yuan and Gallagher (2005), brute force is better than a random search which is not efficient and reliable. "*For example, when it comes to evaluating an individual, which contains non-searchable parameters, it will first be expanded to a set of individuals containing all possible combinations of the values of those non-searchable parameters*." Schmidtlein *et al.* (2011) applied the brute force approach during the cluster analysis where they optimise three parameters, which means that they calculated all possible solutions (in a predefined range of parameter settings) and, afterwards, the optimum values were found as one of the values precalculated during the previous step.

For our calculation, the formula of the Economic Sentiment Indicator, ESI, follows the form:

$$ESI = w_1 \cdot CI_1 + w_2 \cdot CI_2 + w_3 \cdot CI_3 + w_4 \cdot CI_4 + w_5 \cdot CI_5 \quad (1)$$

where CI_i is i-th one of the confidence indicator and w_i is i-th one of the weights of the confidence indicators such that i is an index of the specific sector from the set {the industry, the construction, the trade, the selected services, the consumers}.

The weight themselves are constrained such that the following formulas hold

$$\sum_i w_i = 1 \tag{2}$$

$$w_i \geq 0 \tag{3}$$

where i is an index of the specific sector from the set {the industry, the construction, the trade, the selected services, the consumers}

In order to find a new set of the unique weights, we performed the following optimizations:

- maximization of the (linear) relationship between values of the GDP and ESI (using Pearsons's correlation coefficient)
- minimization the error (difference) in-between values of the GDP and ESI (using Mean Squared and Mean Absolute Error).

After that, we picked values w_i the weights such that one of the metrics described above was optimized. Finally, we got a bit new form of how to calculate the Economic Sentiment Indicator still using the formula (1) but new weights satisfying (2) and (3). As we said before, we used the following three performance measures of "closeness" between values of the GDP and ESI (and their optimization):

- Pearson's correlation coefficient (r_{xy}) is used as a normalised calculation for describing how the two variables are linearly related (R Tutorial, 2019).
- Mean Squared Error (MSE) calculates the average squared difference between two numeric variables (Frasco, 2018).
- Mean Absolute Error (MAE) calculates the average absolute difference between numeric variables (Frasco, 2018).

2.3 Results and Discussion

We analysed data between January 2003 and December 2018 for all sectors (industry, construction, trade and selected services, respectively) and consumers in the Czech Republic. All computations we performed using the R language and environment for statistical computing and graphing.

We decided to focus on the GDP only as the main economic indicator. From the literature review, we know that business and consumer surveys should perform well when considering prediction of the GDP. We used data from the Czech Statistical Office and the

Eurostat website. Whereas the GDP is published quarterly as basic indices which have the base in year of 2010, individual confidence indicators are published on a monthly basis – we had to transform each three consecutive values of the confidence indicator to the quarterly basic index as an average of the three values, considering the base of the average in 2005. We found the weighting scheme for the mentioned economic indicator in order to obtain better prediction ability from the business and consumer surveys. Moreover, we focused on nowcasting rather than on forecasting of the GDP; it means, that the ESI value in time *t* should inform about the GDP value also in time *t* (Table 1). It is helpful because the values of the GDP are published with the delay, but the BTS results are available at the end of the current month.

Tab. 1: Weighting schemes (original, correlation coefficient, Mean Square Error, Mean Absolute Error, respectively)

	Industry (w_1)	**Construction (w_2)**	**Trade (w_3)**	**Services (w_4)**	**Consumers (w_5)**
ESI_orig	0.40	0.05	0.05	0.30	0.20
ESI_r_{xy}	0.95	0.05	0.00	0.00	0.00
ESI_MSE	0.15	0.20	0.25	0.25	0.15
ESI_MAE	0.00	0.30	0.70	0.00	0.00

Source: own calculation

According to ESI_MAE, when calculating the ESI indicator we should not take into consideration the confidence indicator in industry, selected services and the consumer confidence indicator, respectively, since their weights were estimated to be zeroes. Similarly, using Pearson's correlation coefficient_r_{xy} for weights estimation, we could omit the confidence indicator in trade, selected services and the consumer confidence indicator, respectively, within ESI computation. From these three options, ESI_MSE based approach of weights estimation returned the most acceptable outputs supposing no one of the sectors or consumers could be omit from the ESI calculation (each of the weights estimate is greater than zero). In comparison to the ESI calculation based on European Commission methodology and using the estimates, weights should be increased a bit for the confidence indicator both in construction and trade, respectively. On the other hand, weights for the confidence indicator in industry, selected services and the consumer confidence indicator could be lowered a little.

In our opinion, the weight for the industry should be a bit higher than so far because it is definitely a key area in the Czech economy and also the most respondents in the surveys (in business area) come from this field. However, the value of industry weight about 0.15, which

is in fact lower value than the one that is currently in official applied, minimized the mean squared error between true values of the GDP ant their EIS predictions the most. Another reason for significant differences from the European Commission's methodology may be that we focused on nowcasting but no forecasting. Some authors assume that business and consumer surveys predict economic indicators (GDP) three months in advance, though. Furthermore, we can try the calculation considering the GDP growth rather than the GDP itself. These options will be explored in our further research.

Conclusion

The business and consumer surveys have prediction ability, but there are still some issues needed an improvement. Fusari and Pellissier (2008) disagree with the current version of the indicators' construction – they did not adopt the fact that any calculations could be based on natural-language worded questions concerning only the current situation (right at the moment when the question is asked). We focused on the weighting scheme used when the indicators are calculated rather than on a suitability of the survey quetions. The aim of the paper was to find a weighting scheme for the Economic Sentiment Indicator in the Czech Republic such that the scheme tends to the most accurate predictions of the gross domestic product based on the indicator. We calculated these schemes taking account into the forecasting on the main economic indicator, the gross domestic product (Etter, Köberl, 2006).

In our paper, we tried to find the weighting scheme using brute force approach and using the following three performance metrics, Pearsons's correlation coefficient, mean squared error and mean absolute error, respectively, to evaluate how accurate the prediction of the gross domestic product by Economic Sentiment Indicator using the weighting scheme is. Assuming the three performance measures, the mean squared error seems to return the most acceptable results because no one of the confidence indicators would be omitted from the computations. According to this calculation, the weighting scheme should be following: confidence indicator in industry is 0.15, confidence indicator in construction is 0.20, confidence indicator in trade is 0.25, confidence indicator in services is 0.25 and consumer confidence indicator is 0.15, respectively. In reality, we discussed the weight for the industry sector should be a bit larger. According to our point of view, the value should be higher because the industry is the most important and beneficial field in the Czech Republic. It is in fact debatable if the GDP is actually the economic indicator the ESI could even predict. There is still a room of ideas how to get the prediction ability better and find more suitable weights.

Firstly, we could open a discussion which performance metric comparing closeness between the GDP and the ESI is convenient for the calculation based on the business and consumer surveys. We have discussed three metrics so far, but we can try some else, too. Secondly, we could consider both forecasting and nowcasting, as we said above in the previous text. Further research can also calculate the weighting schemes for other economic indicators (gross value added, growth of the GDP or business cycle, respectively).

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