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The Variability of the Belgian Business Survey Indicator

Analysis and Predictive Power

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Abstract

The Belgian business survey indicator, which is published monthly by the National Bank of Belgium, is a well-known indicator of the evolution of the economy. Two different measures of its variability are proposed here; the variance of the business survey indicator (BSI) and the variance of a new indicator called the evolution of individual responses (EIR). The first is understood as the (dis)agreement among respondents, while the second corresponds to the amount of changes in answers.

In the context of the business survey, the data is trichotomous, since there are only three possible answers to the questions of the survey. This comes with interesting properties as the mean-variance relation and the bound of the variance between 0 and 1.

The survey has the particularity of being a panel survey. The new indicator of EIR takes advantage of this. The information of the evolution of each participant is compared to its previous answer. This comes with new information which is not directly accounted for in the BSI, as the volatility of the business survey, in other words, the magnitude of participants changing their answer.

The variance of the BSI was shown as being a good predictor of GDP when using a linear regression which includes the BSI. A model including the BSI and its variance outperforms a model only using the information of the BSI. On the other hand, the EIR and its variance showed potential predictive power.

Aside from the predictive power, the variance of the BSI and the variance of the EIR can be used to diagnose potential bias occurring in a panel survey. A decrease of the variances can be a sign of potential attrition or dropout bias. The new indicator and the variances showed interesting interpretation properties and can be used to study a survey and better understand respondents behaviour.

Keywords

Business Surveys - Business Barometer - Trichotomous Observations - Survey Variance - Survey Volatility - Evolution of Individual Responses - Nowcasting

Samenvatting

De Belgische conjunctuurenquête, waarvan de resultaten maandelijks door de Nationale Bank van België wordt gepubliceerd, is een bekende indicator van de evolutie van de economie. Hier worden twee verschillende maatstaven voor de variabiliteit ervan voorgesteld: de variantie van de Conjunctuurindicator (BSI) en de variantie van een nieuwe indicator die de evolutie van de individuele antwoorden (EIR) wordt genoemd. De eerste wordt opgevat als hoe akkoord respondenten gaan, terwijl de tweede overeenkomt met het aantal wijzigingen in de antwoorden.

In de context van de conjunctuurenquête zijn de gegevens trichotomisch, aangezien er slechts drie mogelijke antwoorden op de vragen van de enquête zijn. Dit levert interessante eigenschappen op als de gemiddelde-variantie relatie en de grens van de variantie tussen 0 en 1.

De enquête heeft het bijzondere karakter van een panelonderzoek. De nieuwe indicator voor de evolutie van de individuele antwoorden maakt er gebruik van. Het antwoord van elke deelnemer wordt vergeleken met die van de maand ervoor. Dit komt met nieuwe informatie die niet rechtstreeks in de BSI wordt verwerkt, zoals de volatiliteit van de conjunctuurenquête, begrepen als een maat van de deelnemers die hun antwoord wijzigen.

De variantie blijkt een goede voorspeller van het BBP te zijn bij het gebruik van een lineaire regressie naast de conjunctuurenquête-indicator. Een model waarin de conjunctuurindicatoor en zijn variantie zijn opgenomen, presteert beter dan een model dat alleen gebruik maakt van de informatie van de conjunctuurindicatoor. Aan de andere kant lieten het EIR en zijn variantie ervan een potentiële voorspellende kracht zien.

Naast de voorspellende kracht kunnen de variantie van de conjunctuurindicatoor en de variantie van de EIR worden gebruikt om een mogelijk panel gerelateerde bias te diagnosticeren. Een afname van de varianties is een teken van potentiële paneelconditionering en uitval bias. De nieuwe indicator en de varianties vertonen interessante interpretatie-eigenschappen en kunnen gebruikt worden om een onderzoek te bestuderen en het gedrag van de respondenten beter te begrijpen.

List of Abbreviations

AIC	Akaike's Information Criterion
ARDL	Auto-Regressive Distributed Lag
ARIMA	Autoregressive integrated moving average
BIC	Bayesian Information Criterion
BSI	Business Survey Indicator/Barometer
Cor	Correlation
Cov	Covariance
DM	Diebold-Mariano
E	Mean
ECB	European Central Bank
EIR	Evolution of Individual Responses
EU	European Union
Eurostat	The European Statistical Office
GDP	Gross Domestic Product
INSEE	Institut National de la Statistique et des Etudes Economiques (France)
LOCF	Last Observation Carried Forward
MAE	Mean Absolute Error
MAPE	Mean Absolute Percentage Error
MASE	Mean Absolute Scaled Error
MIDAS	Mixed Data Sampling
MPE	Mean Percentage Error
MS	Markov Switching
NBB	The National Bank of Belgium
NBER	The National Bureau of Economic Research (US)
RMSE	Root Mean Squared Error
S-I	Seasonal-Irregular
Var	Variance
YoY	Year on Year

Contents

CHAPTER 1

Introduction

Each month, around 3000 companies reply to several questions of a survey that holds on one page and where questions only have three possible responses. The answers are summarised in an indicator and deliver a surprisingly accurate picture of the present state of the Belgian economy and can be used in short term predictions. The Belgian business survey is 65 years old and business surveys are today widely used around the world. At the European level, the European Commission started a harmonisation program in 1961 that makes it possible to compare business survey results across the EU.

This thesis is part of a tradition of research proposing improvement and ways to add value to surveys. Different methods will be proposed to add information to the Belgian business survey indicator (BSI), that could also be applied to other similar surveys. The research at hands is focused on the variability, which is measured with two different indicators. Both variances but from different indicators. First it will be measured with the variance of the indicator, as a measure of the agreement or disagreement among respondents. The second variability measure will be the variance of the so called evolution of individual responses (EIR) and will account for magnitude of the changes in responses of the different participants. This is possible since the business survey is a panel survey where respondents participate in the survey for a long period.

This master thesis is divided into two main parts, first a theoretical part (Chapter 2-4), then an empirical research part (Chapter 5-9). Chapter 2 will introduce the business survey and the business survey indicator. Explaining the history, the objectives and the methodology of the business survey. The calculation of the different business survey indicators will then be presented. The method will be the same for the other indicators, first the unweighted and weighted procedure will be explained when taking one question into account. Then the method of calculation taking more than one question into account will be presented. Chapter 3 will present the variance of the business survey indicator. Starting from one question variance when unweighted or weighted, it will then be enlarged to several questions taken into account. Chapter 4 will present the indicator of the evolution of individual responses (EIR) while Chapter 5 will present its variance. The same method as for the BSI will be applied to the EIR. Chapter 6 will present the data at hand and explain the choices made regarding data collection. Chapter 7 tests for seasonal

effects and explains the seasonal correction applied to the data. It will then discuss some potential issues and biases of the survey; non-responses, non-participation, dropout and attrition. In Chapter 8, descriptive statistics will be made of the different variables at hand and the correlations among the different variables will be studied. Chapter 9 applies linear regressions in order to account for the potential predictive power of the EIR and the different variances. The chapter includes the comparison of several models with different test statistics, a step-wise model selection procedure, predictions test statistics and out-of-sample modelling to ensure robust results.

CHAPTER 2

The Business Survey Indicator

This chapter is a presentation of the Belgian business survey and the business survey indicator (BSI), also referred to as the business survey barometer or business confidence indicator/barometer.

First, a brief history of the business survey indicator will be presented. The second section will discuss the sampling method while the third section will discuss the objectives of the business survey, which are (1) understanding the short term evolution per sector of the Belgian economy, (2) nowcasting and (3) the analysis of business cycles. The next part will discuss the methodology regarding the questions and the weighting procedure(s). In the last section of the chapter, the calculation method of the business survey indicator will be presented.

2.1 History

The Belgian business survey celebrates this year its 65th anniversary. The survey was launched by the National Bank of Belgium in 1954, it was then part of the pioneers since only the United States (1930) and West Germany (1949) had a business survey at the time.

In 1972, the results were first synthesised in an indicator. The business survey barometer started by including only the industrial sector. It was then from 1970 on, bit by bit enlarged to other sectors: construction, trade, and services.

Over time, several improvements to the business survey were proposed and applied (1983, 1990 and 2009). The last improvements will be discussed in detail in section 2.3.

At the European level, it was in 1961 that the European Commission launched a harmonisation program of the business survey in the manufacturing industry. Since then, the sector coverage of the program has widened to account for the different sectors. The harmonisation program and the large implication of the EC, make it possible to compare BSI around the European Union. More information can be found in the *"The Joint Harmonised EU Programme of Business and Consumer Surveys User Guide"* European Commission (2016).

Over time, the business survey barometer became well-known for being a very informative and useful indicator. In an article published in the Wall Street Journal titled *"Euroland Discovers A Surprise Indicator: Belgian Confidence"* (Rhoads, 1999), the BSI is described as an important and accurate measure of the evolution of the Belgian economy. It also suggested that it could be a good indicator for the European Union. This hypothesis was tested for the period between 1985-2000 in Vanhaelen et al. (2000) and the conclusion was very flattering for the BSI. It was shown that the BSI was indeed a leading indicator of the evolution of the European economy and could quite accurately forecast turning points. The explanation proposed by the authors is, first of all, that the Belgian economy, in itself, had some predictive power for the European Area for that period, since it is specialised in intermediate goods and is a very open economy. The other potential explanation pointed out, is the high representation of small and medium-sized enterprises in the business survey.

Today the business survey indicator is a well-known indicator of the Belgian economy, the indicator is on the homepage of the National Bank website and is used in several predictive models.

2.2 Objectives of the Business Survey

The main objective of the business survey barometer is to obtain a sense of how the present economy is and how it will evolve in the short term. The main objectives of the business survey consist of three subjects; (1) the direct information of the Belgian economy that can be delivered by the global and sector specific BSI, (2) Nowcasting which refers to the now and short term prediction of the economy growth and (3) the long term analysis of the business cycles and the importance of identifying turning points.

The three objectives have all in common the importance and the necessity of only capturing the real evolution of the economy, without taking into account short term noise as seasonal effects or bias that could erupt due to the survey method. This will be looked into in chapter 7 where seasonal effects, dropout, non-response, and attrition will be discussed.

2.2.1 National and sector-specific short-term information

The business survey indicators are published at the end of each month (around the 21 - 25 of the month) and give a quick overview of the evolution of the Belgian economy over the past months. The data is available on stat.nbb.be and a press release is published on nbb.be. The press release contains a summary and interpretation of the BSI followed by graphs to show the evolution of the BSI over the 4 - 5 last years for the sector-specific and overall indicator. The public can use that information to have a snapshot of the economy, while other indicators, as GDP or unemployment, may take a very long time before being published.

2.2.2 Nowcasting

Also called "flash" estimation, nowcasting has increasingly gained importance in the last decade. It consists in the short term estimation of the economy,usually GDP growth. It

is a fundamental approach since the business survey indicator is published monthly while other indicators like GDP are published quarterly.

As can be seen in Figure 2.1, the lag between the observation and publication is even greater since the business survey indicator is published at the end of each month (around the 24-25$^{\text{th}}$ of each month), while the GDP is published with a lag of 3 to 4 weeks and is subject to revision.

When looking at Figure 2.1, it can be seen that at the end of the month of January, the GDP is published for the last quarter of the previous year, so the information is already out-dated by some weeks, when the business survey indicator is published for the month of January around the same date. After the end of January publication, observers of the economy have to wait for three months to obtain new information about the GDP, while each month, the BSI is published and available for everyone.

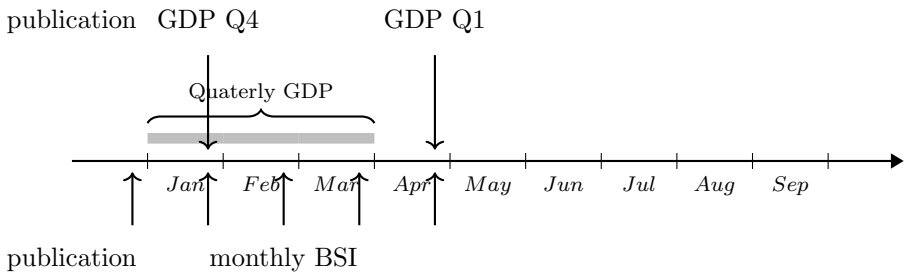

Figure 2.1: Timeline of the period and the publication of the business survey indicator (BSI) and the gross domestic product (GDP)

Nowcasting became a catch-all word and includes a variety of predictive models as Linear regression, ARIMA models, State-Space models, Mixed-data sampling (MIDAS) regressions, Autoregressive Distributed Lag (ARDL) models and much more. Indicators that can be used aside from the business survey are average weekly work hours, factory orders for goods, housing permits and stock prices index of consumer expectations, average weekly claims for unemployment insurance and the interest rate and more.

2.2.3 Business cycles

In 1946, Mitchell and Burns defined a business cycles as a recursive fluctuations, affecting macroeconomics variables. Since then a lot of variables where used to model business cycles but it's commonly admitted that Growth Domestic Product (GDP) is the most important of them. A good measure of the growth of GDP is year on year GDP that is obtained as follows

$$\text{YoY GDP} = \frac{\text{GDP}_t - \text{GDP}_{t-12}}{\text{GDP}_{t-12}} \tag{2.1}$$

Figure 2.2 shows a simplified version of business cycles theory when using as measure GDP or YoY GDP.

A very important question considering business cycles is their duration. Figure 2.2 can give the false impression that business cycles are all of the same lengths, this is, in real life, not so simple.

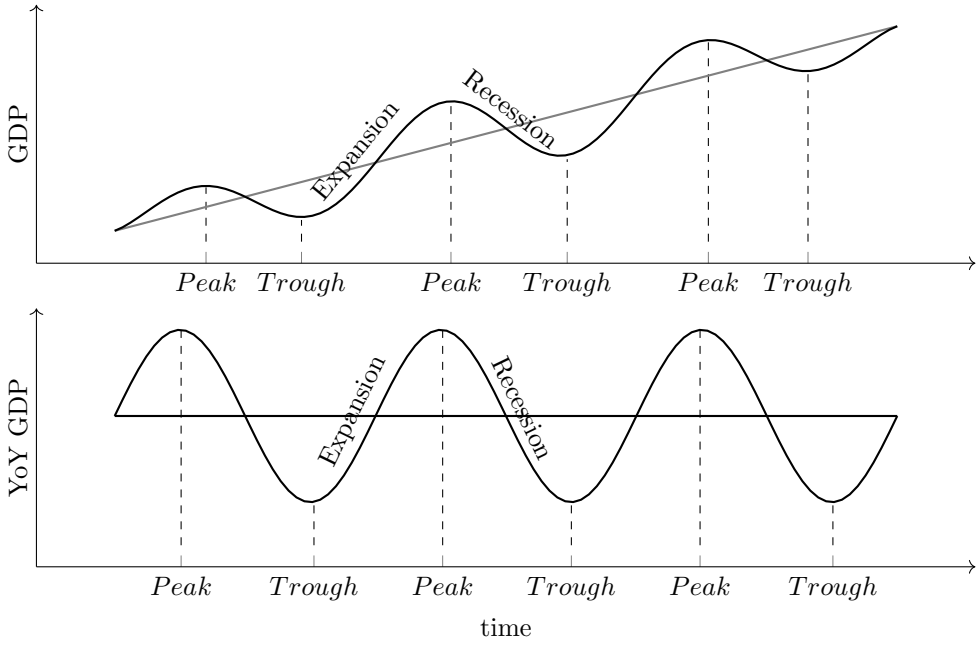

Figure 2.2: The business cycle theory of GDP and year on year GDP

Probably the first person to explore the duration of a business cycle was a French statistician, Juglar (1862), who set the business cycles to have a duration of 7 to 11 years. Mitchell and Burns (1946) proposed a minimum duration of 16 - 22 months and a maximum duration of 100 - 106 months. Lot of other propositions were done even though business cycles are rather more empirically defined than theory based. Therefore let us put the theory aside and look into real data. The example of the United States is interesting since the National Bureau of Economic Research (NBER) has precisely and methodologically dated the turning points for the American economy. The empirical evidence that comes out of this work, is that the time from one economic peak to the next is on average 5 and a half years for the period 1945 - 2009.

It can be seen from Figure 2.3, which represents the different bottoms and peaks of business cycles identified by the NBER from 1975 to 2009, that there is no symmetry of the business cycles. Some business cycles are very short while others last more than ten years. It can be noted that periods of economic growth, usually last longer than economic decrease.

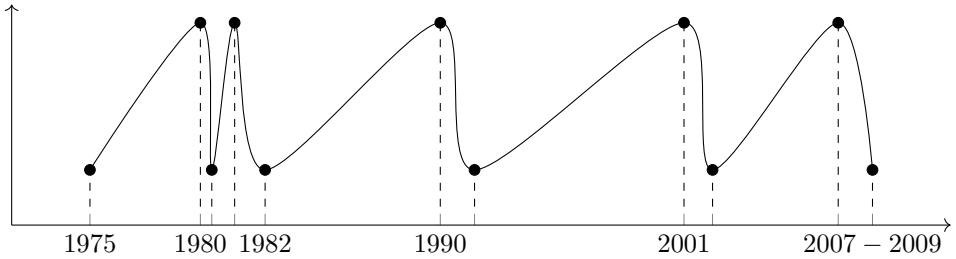

Figure 2.3: Business cycles from 1975 to 2009 of the American economy according to the NBER[1]

[1]data available at https://www.nber.org/cycles.html

2.3 Methodology of the Business Survey

Since 65 years of existence, the business survey has been able to evolve without losing in long term comparability. Three main methodology revisions have taken place since the launch of the business survey, in 1983, 1990 and 2009 (De Greef and Van Nieuwenhuyze, 2009). The most significant changes brought in 2009 were the number of questions taken into the calculation of the BSI, which was reduced to 3-4 questions, depending on the sector, for more simplicity and accuracy. Other improvements where the inclusion of the sector of services in the calculation of the global indicator and a new, simple method of smoothing the indicator.

2.3.1 Sampling method

The Belgian business survey - as most of the business surveys around the world - has the particularity of not using random sampling. The selection of participants is quite complex and a lot of decisions are human; never is a statistical program or a random sampling system used to select new participants.

The selection of new participants is done by waves. When the department responsible for the business survey at the NBB decides that there aren't enough participants in a specific sector anymore, the recruitment of new participants is launched.

To find new respondents, the first step is to decide for an optimal amount of new participants needed, regarding the different stratification of the sector. Each sector is composed of quite advanced diagrams of sub-sectors, sub-sub-sectors, and more. For example, the industry sector is divided into more than 300 sub-sectors over 6 different levels.

It could be that some subdivision of a certain sector only has 1 or 2 respondents while it accounts for a significant part of the Belgian economy. The Department of the business survey of the NBB will then look into which company, from that specific part of the economy, could be a good fit as new respondent of the business survey, considering its activity, it's size, region, and other characteristics. As will be seen in subsection 2.3.3 more in detail, companies are weighted by there size (profit, number of employees, etc.) and the size of the sector they are part of. That information is crucial for selecting new participants. The procedure is quite complex and therefore contains a lot of human decisions.

Out of this process comes a list of potential new participants. This list is then sent to the Communication Department which makes contact with those potential new participants. Not always, but usually, a representative of the National Bank visits the new participant to explain the survey and establish a contact. As a reward for participating in the survey, the companies receive privileged information. Each month they receive access to sub-sector indicators information that isn't publicly distributed. This can give them economical information regarding their specific sector of economic activity.

At the National Bank of Belgium, this procedure is usually referred to as prospecting, rather than selecting or sampling, since it is mostly based on recruiting new companies that will collaborate with them. New companies can be included in the survey outside of this procedure but this happens many occasionally.

An important side of the business survey is that people are staying as long as possible in the survey. From the moment companies are part of the survey, they stay until they

decide to leave, there are no participants removed from the survey by the National Bank, but what can happen is that if participants don't answer for three months, contact will be made with the company to see if they want to continue participating.

The NBB uses resources to make sure companies answer the survey, and stay within it. This means that some companies are part of the survey for a very long time. To have an idea, when looking at the survey for the industry and trace respondents back to 30 years ago (1989), it's seen that today, approximately one-third of the respondents were already in the survey in 1988.

From a statistical point of view, it can seem rather problematic to draw general conclusions about a population when not using random sampling. Without undermining one of the most important pillars of statistics, there are two main reasons why in this case, having a non-random selection of participants is not truly problematic. The first reason is that the sampling method used is trying to represent as good as possible the population which it is representing. Therefore stratification is used at a quite advanced level as explained before. This recruitment method could be called "non-random stratification", as opposed to random stratification. Since it's not using sampling but takes into account the stratification of the population it's studying. The second reason, the most import one, is that the value of the business survey indicator is of no interest on its own. Indeed having a BSI equal to 0.5 or 0.1 doesn't mean much, but what's important is the evolution of the indicator. If it was equal to 0.3 last month and this month it's equal to 0.5, it means that the economy is most probably growing and that an increase of GDP over the month can be forecast. On the other hand, if it's now equal to 0.1, it means a decrease in economic confidence among businesses and a deceleration or decline of the economy over the month can be anticipated.

2.3.2 Questionnaire

The questionnaire exists in two languages, French and Dutch (see Appendix Figure 2 on page 54 for the Dutch version). It can be answered by mail, email, over the phone or by fax. It is divided into two part: (1) questions concerning current production and level of activity (*"verloop en beoordeling"*) and (2) questions concerning predictions, expectation of the level of activity over the next three months ("*vooruitzichten voor de volgende drie maanden*").

The business survey indicator is also called the confidence indicator, since its a measure of how confident companies are in the Belgian economy. Almost all the questions have only three possible answers that can be interpreted as a negative, neutral or positive answer.

2.3.3 Weighting procedure

The different companies participating in the business survey have all a specific weight based on (1) the size of the company and (2) the size of the sector branch, which the company is part of. The first is calculated based on the profit the company is making, the capital it's owning, the number of employees and other characteristics. The calculation is quite complex and is specific to each sector. For example, the companies having an industrial activity have a different calculation than a restaurant or a financial services company. This weighting will be called the weight of the company.

The second is obtained by measuring the importance in the economy of a certain subdivision. In other words, what will be referred to here as the globalisation weight, is the weight given to a specific sub-sector according to its importance in Belgian economy. The procedure developed by the National Bank of Belgium to obtain the globalisation weight, is an elaborate division of the Belgian economic activity. This means that for example, the industry is subdivided into different sub-sectors, that them selves contain sub-sectors that contain sub-sectors and so on for a total of six levels. Each division has a percentage according to its size in the economy. To obtain the weight of the lowest globalisation, the weight of each subdivision needs to be multiplied.

The procedure of weighting is then as follow

$$\omega_i = \frac{\text{weight company } i}{\sum \text{company weights within globalisation}} * \text{globalisation weight} \tag{2.2}$$

where $\sum_{i=1}^{n} \omega_i = 1$. In other words, the specific weight for each company is taking the two weighting procedures into account, the weight specific to the size of the company, and the weight specific to the sub-sector the company is part of.

Since the characteristics taken into account during the calculation of the weight of each company aren't fixed, the weight of the companies is corrected periodically. Once the new weight is calculated, the transition between the old and new weight is smoothened over a year. The difference between the new and old weights is divided by 12 and is then adapted each month for a year.

This method can be written as follows

$$\omega_{i,t} = \omega_{i,old} + \frac{t}{12}\Delta\omega_i \quad \text{where } \Delta\omega_i = \omega_{i,new} - \omega_{i,old} \tag{2.3}$$

where $\omega_{i,old}$ is the previous weight, $\omega_{i,new}$ is the new weight and $\Delta\omega_i$ is the difference between the two. t can take values between 1 and 12, representing a month during which the weight is adapted. $\omega_{i,t}$ is then the monthly weight of a certain company during that one year adaptation period that increases linearly from the first to the last month.

2.4 Calculation of the Business Survey Indicator

This section presents the method of calculation of the business survey indicator. The calculation in itself is rather standard, but the different ways to write it are important for the interpretation and a better understanding of the indicator and the following chapters. First, the unweighted calculation of the indicator taking one question into account is presented, then the calculation for the weighted indicator. The last part will present how different questions are combined together to obtain a business survey indicator.

2.4.1 Unweighted business survey indicator

The calculation of the unweighted indicator for a specific question at a specific time is the mean of the responses and can be written as follow;

$$\mathrm{E}(X) = \frac{\sum_{i=1}^{n} x_i}{n} \tag{2.4}$$

where x_i is the answer of the respondent i and can take value -1 (negative answer), 0 (neutral answer) and 1 (positive answer). n is the number of respondents.

Since x_i can only take three different values, it can be decomposed into

$$\mathrm{E}(X) = \frac{\sum_{i=1}^{n_+} x_{+i} + \sum_{i=1}^{n_0} x_{0i} + \sum_{i=1}^{n_-} x_{-i}}{n} \tag{2.5}$$

where x_{+i}, x_{0i} and x_{-i} are the positive (+), neutral (N) and negative (-) answers of the respondent i.

Since it's known that $\sum_{i=1}^{n} x_{0i} = 0$, $x_{+i} = 1$ and $x_{-i} = -1$ the equation can be written as follow

$$\mathrm{E}(X) = \frac{n_+}{n} - \frac{n_-}{n} \tag{2.6}$$

Where n_+/n is the proportion of positive answers and n_-/n is the proportion of negative answer. The following equation and notation is chosen

$$\mathrm{E}(X) = \pi_+ - \pi_- \tag{2.7}$$

where π_+ and π_- are the proportion of respondents answering positive and negative to the specific question. π was chosen as symbol here since it can be interpreted as a probability: if it's assumed that all the respondents have the same probability of giving a certain answer, π is the probability that a respondent answers positive (π_+), negative (π_-) or neutral (π_0) to the question.

2.4.2 Weighted business survey indicator

As described in subsection 2.3.3, each respondent has two different weighting procedures: one according to its size and one according to the size of the sector it's part of. Those weights are then combined and end up with a specific weight ω_i. The business survey indicator is then obtained with the following equation

$$\mathrm{E}(X) = \sum_{i=1}^{n} \omega_i x_i \quad \text{where } \sum_{i=1}^{n} \omega_i = 1 \tag{2.8}$$

x_i is the answer of the respondent i and can take values -1, 0 and 1. ω_i is the weight of respondents i. The weights are standardised so their sum is equal to one.

As for the unweighted indicator, it can be decomposes by the three possible answers with, in this case, their according weights.

$$\mathrm{E}(X) = \sum_{i=1}^{n_+} \omega_i x_{+i} + \sum_{i=1}^{n_0} \omega_i x_{0i} + \sum_{i=1}^{n_-} \omega_i x_{-i} \tag{2.9}$$

and again it's known that $\sum_{i=1}^{n} \omega_{0i} x_{0i} = 0$, $x_{+i} = 1$ and $x_{-i} = -1$ so the equation can be simplified to the following

$$\mathrm{E}(X) = \sum_{i=1}^{n_+} \omega_i - \sum_{i=1}^{n_-} \omega_i \tag{2.10}$$

Which will be written as follow

$$\mathrm{E}(X) = \Omega_+ - \Omega_- \tag{2.11}$$

where Ω_+ and Ω_- are the sum of weights of positive and negative respondents. In other words, Ω_+ and Ω_- are the weighted proportion of respondents answering positive and negative.

Ω can also be interpreted in a probabilistic way, as it is the weighted probability that a respondent answers positive (Ω_+), negative (Ω_-) or neutral (Ω_0) assuming all the respondents have the same weighted probability of answering a certain way.

From Equation 2.7 and 2.11 it can be seen that the weighted and unweighted indicators are bounded between -1 and 1. In the two cases, the indicator is the smallest if all respondents have a negative answer and is the largest when every answer is positive.

2.4.3 Taking different questions into account

The previous calculations were specific to one question. The published indicators are usually taking different survey questions into account. For example, the industry indicator, that will be at interest, is composed of four questions:

$$\text{Industry BSI } = \frac{\mathrm{E}(X_{Q1}) + \mathrm{E}(X_{Q2}) + \mathrm{E}(X_{Q3}) + \mathrm{E}(X_{Q4})}{4} \tag{2.12}$$

where $\mathrm{E}(X_{Q1})$, $\mathrm{E}(X_{Q2})$, $\mathrm{E}(X_{Q3})$ and $\mathrm{E}(X_{Q4})$ are the different averages for question 1, 2, 3 and 4 (see Appendix section I on page 51). The averages can be weighted or unweighted.

The equation can also be written as follows for the unweighted indicator[2]

$$\text{Unweighted Industry BSI } = \frac{\sum_{i=1}^{n}(x_{iQ1} + x_{iQ2} + x_{iQ3} + x_{iQ4})}{4n} \tag{2.13}$$

and as follow for the weighted indicator[3]

$$\text{Weighted Industry BSI } = \frac{\sum_{i=1}^{n}\omega_i(x_{iQ1} + x_{iQ2} + x_{iQ3} + x_{iQ4})}{4} \tag{2.14}$$

In other words, the industry BSI is the weighted or unweighted mean of responses of all the respondents.

Another way to write the unweighted business survey indicator is as follows

$$\begin{aligned}\text{Unweighted industry BSI } = \; & \frac{1}{4}\big(\pi_{Q1,+} + \pi_{Q2,+} + \pi_{Q3,+} + \pi_{Q4,+} \\ & -\pi_{Q1,-} - \pi_{Q2,-} - \pi_{Q3,-} - \pi_{Q4,-}\big)\end{aligned} \tag{2.15}$$

and regarding the weighted indicator, it can be written as

[2]Assuming the respondents that answered, answered to all the questions.

[3]Assuming the respondents that answered, answered to all the questions and that the weighting (ω_i) is the same across all the questions.

$$\begin{aligned}\text{Weighted Industry BSI} &= \frac{1}{4}\big(\Omega_{Q1,+} + \Omega_{Q2,+} + \Omega_{Q3,+} + \Omega_{Q4,+} \\ &\quad -\Omega_{Q1,-} - \Omega_{Q2,-} - \Omega_{Q3,-} - \Omega_{Q4,-}\big) \qquad (2.16)\end{aligned}$$

The weighted or unweighted industry BSI are here equal to to difference between the positive proportions and the negative proportions of responses.

The previous equations can easily be generalised to all combinations of answers in the calculation of indicators. The general formulas for the unweighted business survey indicator when taking several questions into account can be written as follows

$$\begin{aligned}\text{Unweighted BSI} &= \frac{\mathrm{E}(X_{Q1}) + \mathrm{E}(X_{Q2}) + \ldots + \mathrm{E}(X_{Qq})}{q} \qquad (2.17)\\ &= \frac{\sum_{i=1}^{n}(x_{iQ1} + x_{iQ2} + \ldots + x_{iQq})}{nq} \qquad (2.18)\\ &= \frac{1}{q}\big(\pi_{Q1,+} + \pi_{Q2,+} + \ldots + \pi_{Qq,+} - \pi_{Q1,-} - \pi_{Q2,-} - \ldots - \pi_{Qq,-}\big) \qquad (2.19)\end{aligned}$$

Where q is the number of questions taken into account for the calculation of the indicator.

The formulas for the weighted business survey indicator when taking several questions into account can be written as follows

$$\begin{aligned}\text{Weighted BSI} &= \frac{\mathrm{E}(X_{Q1}) + \mathrm{E}(X_{Q2}) + \ldots + \mathrm{E}(X_{Qq})}{q} \qquad (2.20)\\ &= \frac{\sum_{i=1}^{n}\omega_i\,(x_{iQ1} + x_{iQ2} + \ldots + x_{iQq})}{q} \qquad (2.21)\\ &= \frac{1}{q}\big(\Omega_{Q1,+} + \Omega_{Q2,+} + \ldots + \Omega_{Qq,+} - \Omega_{Q1,-} - \Omega_{Q2,-} - \ldots - \Omega_{Qq,-}\big) \qquad (2.22)\end{aligned}$$

CHAPTER 3

The Variance of the Business Survey Indicator

The variance is, with the mean, one of the first tool for statisticians when studying a certain variable. Next, to the mean, that is the average value of a certain variable, the variance is the measure of the dispersion. In the context of the business survey, the variance can be seen as "how much companies (dis)agree on the present state of the Belgian economy", a piece of important information that can be extracted from the survey.

This chapter will present the calculation of the variance of the unweighted and weighted indicator for one question of the business survey. Its properties and specificities will be studied. The last section will present the method of calculation when different questions are taken into account.

3.1 Variance of the Unweighted Business Survey Indicator

The formula of the variance can be written as

$$\mathrm{Var}(X) = E\left[(X - \mathrm{E}(X))^2\right] = E\left(X^2\right) - E\left(X\right)^2 \tag{3.1}$$

The variance of one question of the unweighted business survey indicator can be decomposed and developed as follows

$$\begin{aligned} \mathrm{Var}(X) &= E\left(X^2\right) - E\left(X\right)^2 \\ &= \frac{\sum_{i=1}^{n_+} x_{+i}^2 + \sum_{i=1}^{n_0} x_{0i}^2 + \sum_{i=1}^{n_-} x_{-i}^2}{n} - \mathrm{E}(X)^2 \end{aligned} \tag{3.2}$$

Since the positive answers take value 1 and negative answers value -1, their square is equal to 1 ($x_{+i}^2 = x_{+i} = 1$ and $x_{-i}^2 = |x_{-i}| = 1$). On the other hand, the neutral answers have value 0, and can therefore be taken out of the equation.

The equation can further be simplified to

$$\begin{aligned} \mathrm{Var}(X) &= \frac{n_+}{n} + \frac{n_-}{n} - \mathrm{E}(X)^2 && (3.3) \\ &= \pi_+ + \pi_- - E(X)^2 && (3.4) \end{aligned}$$

Where π_+ and π_- are the proportions of positive and negative answers.

In other words, the variance of the BSI is equal to the sum of the proportion of positive and negative answers, minus the squared indicator.

Knowing $\mathrm{E}(X) = \pi_+ - \pi_-$, and $\pi_+ + \pi_- = 1 - \pi_0$ (from $\pi_+ + \pi_0 + \pi_- = 1$), it's possible to write the variance in different ways;

$$\begin{aligned} \mathrm{Var}(X) &= \pi_+ + \pi_- - E(X)^2 \\ &= \pi_+ + \pi_- - (\pi_+ - \pi_-)^2 && (3.5) \\ &= 1 - \pi_0 - \mathrm{E}(X)^2 && (3.6) \end{aligned}$$

3.2 Variance of the Weighted Business Survey Indicator

The same as for the unweighted indicator is applied to the weighted indicator, the equations are very similar.

$$\begin{aligned} \mathrm{Var}(X) &= E\left(X^2\right) - E\left(X\right)^2 \\ &= \sum_{i=1}^{n_+} \omega_i x_{+i}^2 + \sum_{i=1}^{n_0} \omega_i x_{0i}^2 + \sum_{i=1}^{n_-} \omega_i x_{-i}^2 - \mathrm{E}(X)^2 && (3.7) \\ &= \sum_{i=1}^{n_+} \omega_i + \sum_{i=1}^{n_-} \omega_i - \mathrm{E}(X)^2 \\ & && (3.8) \end{aligned}$$

As for the indicator, the equation is further developed by taking into account weighted proportion and written the same way as for the unweighted variance. Again the variance can be written in different ways

$$\begin{aligned} \mathrm{Var}(X) &= \Omega_+ + \Omega_- - E(X)^2 && (3.9) \\ &= \Omega_+ + \Omega_- - (\Omega_+ - \Omega_-)^2 && (3.10) \\ &= 1 - \Omega_0 - \mathrm{E}(X)^2 && (3.11) \end{aligned}$$

3.3 Properties

Based on the previous development of the equation of the variance of the indicator, some observations can be made.

First of all, the variance is bounded between 0 and 1. A variance can't be negative since it's a sum of squares, so the lower bound shouldn't surprise anyone. On the other hand, the upper bound is more unusual. An interesting approach is to take Equation 3.6 and see that π_0 and $\mathrm{E}(X)^2$ can only take positive values since π_0 is a proportion and $\mathrm{E}(X)^2$ is squared. Both variables have a minus sign in the equation, so the highest results are obtained when both variables are equal to zero. In other words, the highest variance is obtained when no respondent answers "neutral" and the BSI is equal to 0. This happens when there are as many negative as positive answers (50-50). This corresponds to the interpretation described before, since it's the situation with the highest disagreement among respondents. On the other hand, if all participants answer the same ("negative", "neutral" or "positive"), the variance is equal to zero. It corresponds to the situation where the agreement among respondents is the highest.

Another approach to better understand the variance of the business survey barometer, is to plot the different possible values of $\mathrm{Var}(X)$, π_0 and $\mathrm{E}(X)$ from Equation 3.6 or Equation 3.11. The results can be seen in Figure 3.1. It's interesting to see from the plot that each $\mathrm{E}(X)$ can only have a certain amount of possible variance, in other words, there is a specific upper and lower bound for each indicator. For example, an indicator of 0.5 can only have a variance between 0.25 and 0.75. It's also interesting to notice that to know that with two of the three variables ($\mathrm{Var}(X)$, π_0 and $\mathrm{E}(X)$), it's very easy to calculate the third. In other words, the three variables are related. See Appendix section II for further interpretation.

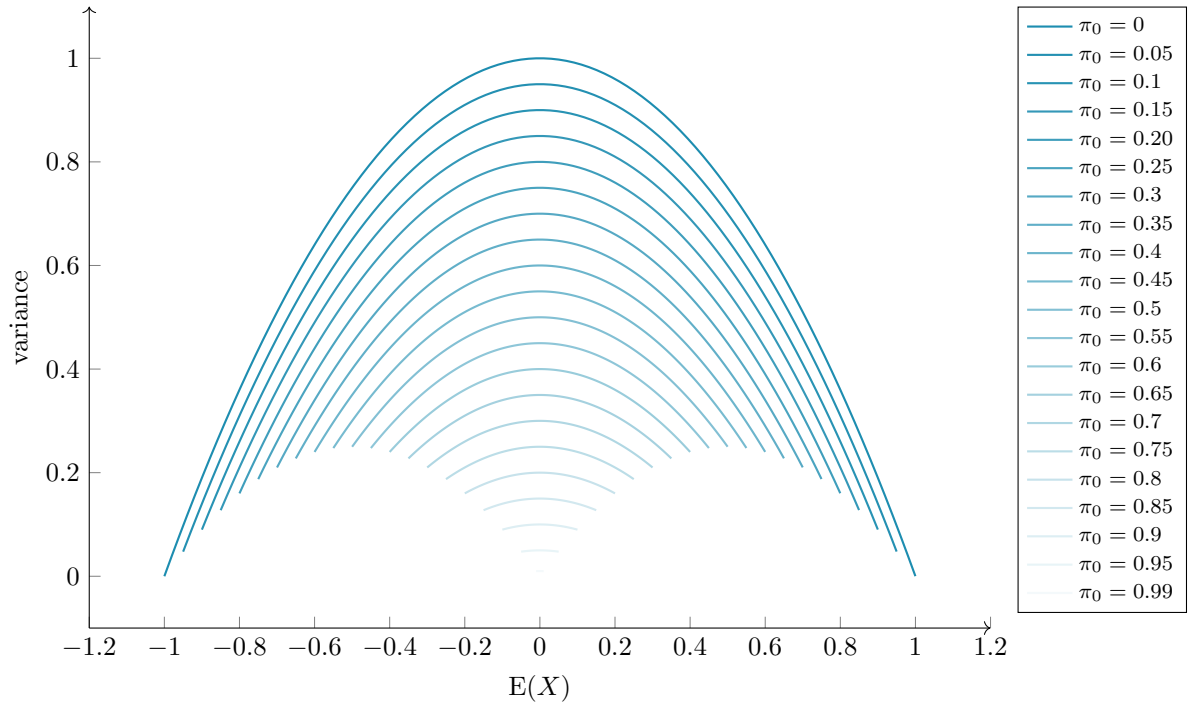

Figure 3.1: Plot of the possible values of the indicator (X axis) and variance (Y axis) for different values of π_0

3.4 Taking Different Questions Into Account

As already seen, the published indicator takes different questions into account. The combination of the variance of different questions is slightly more complex than the combination of different indicators since the questions are correlated, which means that covariance has to be taken into account.

The formula to combine different variances is the following

$$\operatorname{Var}\left(\sum_{i=1}^{q} X_i\right) = \sum_{i=1}^{q}\sum_{j=1}^{q} \operatorname{Cov}\left(X_i, X_j\right) = \sum_{i=1}^{q} \operatorname{Var}\left(X_i\right) + 2 \sum_{1\leq i<j\leq q} \operatorname{Cov}\left(X_i, X_j\right) \quad (3.12)$$

In the case of combining the variances of the four different questions of the industry business survey, the following equation applies

$$\begin{aligned} \operatorname{Var}\left(\text{Industry BSI}\right) &= \frac{1}{16}\Big[\operatorname{Var}(X_{Q1}) + \operatorname{Var}(X_{Q2}) + \operatorname{Var}(X_{Q3}) + \operatorname{Var}(X_{Q4}) \\ &\quad +2\operatorname{Cov}(X_{Q1}, X_{Q2}) + 2\operatorname{Cov}(X_{Q1}, X_{Q3}) + 2\operatorname{Cov}(X_{Q1}, X_{Q4}) \\ &\quad +2\operatorname{Cov}(X_{Q2}, X_{Q3}) + 2\operatorname{Cov}(X_{Q2}, X_{Q4}) + 2\operatorname{Cov}(X_{Q3}, X_{Q4})\Big] \end{aligned} \quad (3.13)$$

The complexity of the formula encourages to rather calculate the indicator (taking all the questions into account), and then calculate the variance of that indicator, which can be written as follows for the unweighted BSI

$$\begin{aligned} \operatorname{Var}(\text{BSI}) &= E\left[(\text{BSI} - \operatorname{E}(\text{BSI}))^2\right] = \operatorname{E}\left(\text{BSI}^2\right) - \operatorname{E}\left(\text{BSI}\right)^2 && (3.14)\\ &= \frac{\sum_{i=1}^{n}[(x_{iQ1} + x_{iQ2} + x_{iQ3} + x_{iQ4})/4]^2}{n} - \operatorname{E}(\text{BSI})^2 && (3.15)\\ &= \frac{\sum_{i=1}^{n}(x_{iQ1} + x_{iQ2} + x_{iQ3} + x_{iQ4})^2}{16n} - \operatorname{E}(\text{BSI})^2 && (3.16) \end{aligned}$$

and for the weighted BSI can be written as follows

$$\begin{aligned} \operatorname{Var}(\text{BSI}) &= E\left[(\text{BSI} - \operatorname{E}(\text{BSI}))^2\right] = \operatorname{E}\left(\text{BSI}^2\right) - \operatorname{E}\left(\text{BSI}\right)^2 && (3.17)\\ &= \sum_{i=1}^{n}\left[\omega_i(x_{iQ1} + x_{iQ2} + x_{iQ3} + x_{iQ4})/4\right]^2 - \operatorname{E}(\text{BSI})^2 && (3.18) \end{aligned}$$

where $\text{BSI} = \left(x_{iQ1} + x_{iQ2} + \ldots + x_{iQq}\right)/q$ in the case of the unweighted indicator and $\text{BSI} = \omega\left(x_{iQ1} + x_{iQ2} + \ldots + x_{iQq}\right)/q$ for the weighted indicator.

The generalisation of the previous equation - when taking q questions into account - can be written as follows for the variance of the unweighted indicator

$$\begin{aligned}
\text{Var(BSI)} &= E\left[(\text{BSI} - \text{E(BSI)})^2\right] = \text{E}\left(\text{BSI}^2\right) - \text{E}\left(\text{BSI}\right)^2 && (3.19)\\
&= \frac{\sum_{i=1}^{n}[(x_{iQ1} + x_{iQ2} + \ldots + x_{iQq})/q]^2}{n} - \text{E(BSI)}^2 && (3.20)\\
&= \frac{\sum_{i=1}^{n}(x_{iQ1} + x_{iQ2} + \ldots + x_{iQq})^2}{q^2 n} - \text{E(BSI)}^2 && (3.21)
\end{aligned}$$

and as follows for the weighted BSI

$$\begin{aligned}
\text{Var(BSI)} &= E\left[(\text{BSI} - \text{E(BSI)})^2\right] = \text{E}\left(\text{BSI}^2\right) - \text{E}\left(\text{BSI}\right)^2 && (3.22)\\
&= \sum_{i=1}^{n}[\omega_i(x_{iQ1} + x_{iQ2} + \ldots + x_{iQq})/q]^2 - \text{E(BSI)}^2 && (3.23)
\end{aligned}$$

CHAPTER 4

The Evolution of Individual Responses

In the same logic as for the variance, a proposition is made in this chapter of a method to extract more information out of the business survey. As explained in Chapter two - which presented the business survey - the business survey is answered by the same companies over time. Some new participants join and some companies leave the survey, but the survey can be referred to and treated as a panel survey.

Is it possible to have more information by taking the evolution of the individual respondents into account? This chapter will address this question by applying a method proposed by Caron et al. (1996) that, by taking the individual evolution of responses into account, offers a method to calculate an indicator that will be referred to as the indicator of the evolution of individual responses (EIR).

When only one period is taken into account, there are three possible answers; "negative", "neutral" and "positive". When two periods are taken into account - a month (t) and the previous one ($t-1$) for example - there are nine possible situations as represented in Table 4.1.

Table 4.1: Possible observations when taking t and $t-1$ into account

		t		
		x_{i-}	x_{i0}	x_{i+}
$t-1$	x_{i-}	z_{i--}	z_{i-0}	z_{i-+}
	x_{i0}	z_{i0-}	z_{i00}	z_{i0+}
	x_{i+}	z_{i+-}	z_{i+0}	z_{i++}

The same as for the business survey indicator, the evolution of individual responses takes different possible values. In the case of the BSI, x_i can take value -1, 0 and 1. In the case of the EIR, z_i can take values -2, -1, 0, 1 and 2.

The EIR defers also from the BSI in the sense that it's a measure of change, so if the answer of a certain respondent is the same at a as its previous answer, z_i will take value zero. On the other hand, if a certain participant changes his answer for a more positive answer it will take value 1, except if it's a radical change from a "negative" to a "positive" answer, then it will take value 2. Same the other way around, if it decreases it will take

value -1, except for a radical change from "positive" to "negative". The symbol z will rather be used here (not x) to make a clear distinction between the BSI and the EIR.

The calculation of z_i is the difference of x_i at $t-1$ and x_i at t

$$z_i = x_{i,t-1} - x_{i,t} \tag{4.1}$$

the different possible values of z_i can be seen in Table 4.2.

Table 4.2: Values of the different observations of z_i

		t		
		x_{i-}	x_{i0}	x_{i+}
$t-1$	x_{i-}	$z_{i--} = 0$	$z_{i-0} = 1$	$z_{i-+} = 2$
	x_{i0}	$z_{i0-} = -1$	$z_{i00} = 0$	$z_{i0+} = 1$
	x_{i+}	$z_{i+-} = -2$	$z_{i+0} = -1$	$z_{i++} = 0$

The limitation of this indicator is that the previous answer is determinant for the possible results of the indicator. If the previous response was neutral (0), then it's possible to influence the EIR in a positive or negative way. On the other hand if the previous answer was negative or positive, it can only influence the EIR in the opposite way.

For those reasons, the EIR should be complementary to the BSI rather than replacing it or else.

4.1 Indicator of the Unweighted Evolution of Individual Responses

The indicator of the evolution of the individual responses can be obtained by taking the mean of the values, as defined in Table 4.2, the formula is then

$$\begin{aligned} \mathrm{E}(Z) &= \frac{\sum_{i=1}^{n} z_i}{n} && (4.2)\\ &= \frac{\sum_{i=1}^{n_{--}} z_{--i}}{n} + \frac{\sum_{i=1}^{n_{-0}} z_{-0i}}{n} + \frac{\sum_{i=1}^{n_{-+}} z_{-+i}}{n} + \frac{\sum_{i=1}^{n_{0-}} z_{0-i}}{n} + \frac{\sum_{i=1}^{n_{00}} z_{00i}}{n} \\ &\quad + \frac{\sum_{i=1}^{n_{0+}} z_{0+i}}{n} + \frac{\sum_{i=1}^{n_{+-}} z_{+-i}}{n} + \frac{\sum_{i=1}^{n_{+0}} z_{+0i}}{n} + \frac{\sum_{i=1}^{n_{++}} z_{++i}}{n} && (4.3) \end{aligned}$$

The formula can further be simplified since $z_{--} = z_{00} = z_{++} = 0$ and the other values of z_i's are also known

$$\begin{aligned} \mathrm{E}(Z) &= \frac{\sum_{i=1}^{n_{-0}} z_{-0i}}{n} + \frac{\sum_{i=1}^{n_{-+}} z_{-+i}}{n} + \frac{\sum_{i=1}^{n_{0-}} z_{0-i}}{n} + \frac{\sum_{i=1}^{n_{0+}} z_{0+i}}{n} \\ &\quad + \frac{\sum_{i=1}^{n_{+-}} z_{+-i}}{n} + \frac{\sum_{i=1}^{n_{+0}} z_{+0i}}{n} && (4.4)\\ &= \frac{n_{-0}}{n} + \frac{2n_{-+}}{n} - \frac{n_{0-}}{n} + \frac{n_{0+}}{n} - \frac{2n_{+-}}{n} - \frac{n_{+0}}{n} && (4.5) \end{aligned}$$

As for the indicator, it's possible to have a formula with proportions.

$$\mathrm{E}(Z) = \pi_{0+} + \pi_{-0} - \pi_{+0} - \pi_{0-} + 2\pi_{-+} - 2\pi_{+-} \tag{4.6}$$

where π is the proportion/probability of respondent answering negative(-), neutral (0) and positive (+) at $t-1$ and t.

The evolution of individual responses is equal to the difference between the proportion of respondents becoming more positive and the proportion of respondents becoming more negative. Where radical changes count double. The EIR can take values between -2 and 2.

4.2 Indicator of the Weighted Evolution of Individual Responses

As for the business survey indicator, the evolution of individual responses can also be weighted. The calculation is very similar.

$$\begin{aligned}
\mathrm{E}(Z) &= \sum_{i=1}^{n} \omega_i z_i && (4.7)\\
&= \sum_{i=1}^{n_{--}} \omega_i z_{--i} + \sum_{i=1}^{n_{-0}} \omega_i z_{-0i} + \sum_{i=1}^{n_{-+}} \omega_i z_{-+i} + \sum_{i=1}^{n_{0-}} \omega_i z_{0-i} + \sum_{i=1}^{n_{00}} \omega_i z_{00i} \\
&\quad + \sum_{i=1}^{n_{0+}} \omega_i z_{0+i} + \sum_{i=1}^{n_{+-}} \omega_i z_{+-i} + \sum_{i=1}^{n_{+0}} \omega_i z_{+0i} + \sum_{i=1}^{n_{+-}} \omega_i z_{++i} && (4.8)\\
&= \sum_{i=1}^{n_{-0}} \omega_i + 2\sum_{i=1}^{n_{-+}} \omega_i - \sum_{i=1}^{n_{0-}} \omega_i + \sum_{i=1}^{n_{0+}} \omega_i - 2\sum_{i=1}^{n_{+-}} \omega_i - \sum_{i=1}^{n_{+0}} -\omega_i && (4.9)
\end{aligned}$$

The weighted EIR can, as for the unweighted EIR now be calculated with the following expression

$$\mathrm{E}(Z) = \Omega_{0+} + \Omega_{-0} - \Omega_{+0} - \Omega_{0-} + 2\Omega_{-+} - 2\Omega_{+-} \tag{4.10}$$

where Ω's are the different sum of weights, or in other words, weighted proportions. The formula can be interpreted the same way as for the unweighted indicator.

4.3 Generalisation for Different Period Lags

Changes in the economy are usually taking several months to influence all the companies. There can be some lag of effects on, for example larger companies, or a very specific sector. The idea of only taking a certain month and the previous month can seem non-sufficient, it can be relevant to take a larger period into account.

Different methods were explored to take more than two periods into account, but it was found to be flawed and very complex to interpret. A rather simple generalisation is proposed here; use $t-n$ rather than $t-1$. The answer at $t-n$ is compared with the answer at time t, without taking the between answers into account.

The calculation is then the same for the unweighted as Equation 4.6 and for the weighted as Equation 4.10 except $t-1$ is replaced by $t-n$, the two periods taken into account are the actual month and the n^{th} previous month.

4.4 Taking Different Questions Into Account

The generalisation, when taking different questions into account in order to obtain an indicator, can be written with the following formula [1]

$$\text{Industry EIR } = \frac{\sum_{i=1}^{n}\left(z_{iQ1}+z_{iQ2}+\ldots+z_{iQq}\right)}{qn} \tag{4.11}$$

In the case of the unweighted evolution of individual responses, the formula can be written as follows

$$\begin{aligned}\text{Unweighted EIR} &= \frac{\sum_{i=1}^{n}\left(z_{iQ1}+z_{iQ2}+\ldots+z_{iQq}\right)}{qn}\\ &= \pi_{Q1,0+}+\pi_{Q1,-0}-\pi_{Q1,+0}-\pi_{Q1,0-}+2\pi_{Q1,-+}-2\pi_{Q1,+-}\\ &\quad +\pi_{Q2,0+}+\pi_{Q2,-0}-\pi_{Q2,+0}-\pi_{Q2,0-}+2\pi_{Q2,-+}-2\pi_{Q2,+-}\\ &\quad +\ldots\\ &\quad +\pi_{Qq,0+}+\pi_{Qq,-0}-\pi_{Qq,+0}-\pi_{Qq,0-}+2\pi_{Qq,-+}-2\pi_{Qq,+-}\end{aligned} \tag{4.12}$$

and the weighted formula of the EIR when taking different questions into account can be written as

$$\begin{aligned}\text{Weighted EIR} &= \frac{\sum_{i=1}^{n}\omega_i\left(z_{iQ1,}+z_{iQ2}+\ldots+z_{iQq}\right)}{q}\\ &= \Omega_{Q1,0+}+\Omega_{Q1,-0}-\Omega_{Q1,+0}-\Omega_{Q1,0-}+2\Omega_{Q1,-+}-2\Omega_{Q1,+-}\\ &\quad +\Omega_{Q2,0+}+\Omega_{Q2,-0}-\Omega_{Q2,+0}-\Omega_{Q2,0-}+2\Omega_{Q2,-+}-2\Omega_{Q2,+-}\\ &\quad +\ldots\\ &\quad +\Omega_{Qq,0+}+\Omega_{Qq,-0}-\Omega_{Qq,+0}-\Omega_{Qq,0-}+2\Omega_{Qq,-+}-2\Omega_{Qq,+-}\end{aligned} \tag{4.13}$$

[1] Assuming the respondents who participated, answered to all the questions

CHAPTER 5

The Variance of the Evolution of Individual Responses

The evolution of individual responses has a variance with an interesting interpretation. While the EIR is a measure of the direction companies change their answers, the variance of the EIR can be understood as the measure of changes in answers. From there, the variance of the EIR can be seen as the volatility of the indicator, in the sense that the variance of the EIR accounts for the dispersion of the difference in answers over two periods.

While the variance of the business survey indicator is the measure of disagreement among respondents, the variance of the evolution of individual responses is the measure of the magnitude of changes of respondents.

5.1 Variance of the Unweighted Evolution of Individual Responses

The calculation of the variance of the EIR for one question is the following

$$\begin{aligned}
\mathrm{Var}(Z) &= \mathrm{E}\left(Z^2\right) - \mathrm{E}\left(Z\right)^2 \\
&= \frac{\sum_{i=1}^{n_{--}} z_{--i}^2}{n} + \frac{\sum_{i=1}^{n_{-0}} z_{-0i}^2}{n} + \frac{\sum_{i=1}^{n_{-+}} z_{-+i}^2}{n} + \frac{\sum_{i=1}^{n_{0-}} z_{0-i}^2}{n} \\
&\quad + \frac{\sum_{i=1}^{n_{00}} z_{00i}^2}{n} + \frac{\sum_{i=1}^{n_{0+}} z_{0+i}^2}{n} + \frac{\sum_{i=1}^{n_{+-}} z_{+-i}^2}{n} \\
&\quad + \frac{\sum_{i=1}^{n_{+0}} z_{+0i}^2}{n} + \frac{\sum_{i=1}^{n_{++}} z_{++i}^2}{n} - \mathrm{E}(Z)^2
\end{aligned} \tag{5.1}$$

The method of simplification is quite similar to the method applied for the variance of the BSI in order to write the equation with proportions of responses.

$$\text{Var}(Z) = \frac{n_{-0}}{n} + 4\frac{n_{-+}}{n} + \frac{n_{0-}}{n} + \frac{n_{0+}}{n} + 4\frac{n_{+-}}{n} + \frac{n_{+0}}{n} - \text{E}(Z)^2 \tag{5.2}$$

See Table 4.2 for the different values of z. As done before, simplification of the previous equation can be done knowing that the equation contains proportions, and the sum of all the proportions (π) is equal to one.

$$\begin{aligned}
\text{Var}(Z) &= \pi_{0+} + \pi_{-0} + \pi_{+0} + \pi_{0-} + 4\pi_{-+} + 4\pi_{+-} \\
&\quad -(\pi_{0+} + \pi_{-0} - \pi_{+0} - \pi_{0-} + 2\pi_{-+} - 2\pi_{+-})^2 && (5.3)\\
&= \pi_{0+} + \pi_{-0} + \pi_{+0} + \pi_{0-} + 4\pi_{-+} + 4\pi_{+-} - \text{E}(Z)^2 && (5.4)\\
&= 1 - \pi_{++} - \pi_{00} - \pi_{--} + 3\pi_{+-} + 3\pi_{-+} - \text{E}(Z)^2 && (5.5)
\end{aligned}$$

In other words, the variance is quite similar to the variance of the business survey indicator. In this case there is the particularity that there are nine possible answers where three take value zero, two take value one, two take value minus one, one takes value two and another takes value minus two. This has as main consequence that the variance formula also have two proportions that have a much larger influence. This are the more radical changes and therefore it makes sens that they have a larger influence on the final value of the variance.

5.2 Variance of the Weighted Evolution of Individual Responses

As in the case of the variance of the BSI, the equation of the variance of the weighted EIR is very similar to the equation of the unweighted EIR with different symbols. The formula can be written as follows

$$\begin{aligned}
\text{Var}(Z) &= \Omega_{0+} + \Omega_{-0} + \Omega_{+0} + \Omega_{0-} + 4\Omega_{-+} + 4\Omega_{+-} \\
&\quad -(\Omega_{0+} + \Omega_{-0} - \Omega_{+0} - \Omega_{0-} + 2\Omega_{-+} - 2\Omega_{+-})^2 && (5.6)\\
&= \Omega_{0+} + \Omega_{-0} + \Omega_{+0} + \Omega_{0-} + 4\Omega_{-+} + 4\Omega_{+-} - \text{E}(Z)^2 && (5.7)\\
&= 1 - \Omega_{++} - \Omega_{00} - \Omega_{--} + 3\Omega_{+-} + 3\Omega_{-+} - \text{E}(Z)^2 && (5.8)
\end{aligned}$$

5.3 Properties

The properties of the variance of the evolution of individual responses are quite similar to the properties of the variance of the business survey indicator.

The first property is that the variance of Z is bounded between 0 and 4. As for the variance of the BSI, the variance of the EIR can't take any value. The variance can go as low as 0 but in this case can go as high as 4. One method to obtain this is by calculating the following. Here it's the extreme situation where half of the respondents answered

positive the previous month, and now negative, and the other half of respondents did the opposite.

$$\begin{aligned} \mathrm{Var}(Z) &= 1 - \pi_{++} - \pi_{00} - \pi_{--} + 3\pi_{+-} + 3\pi_{-+} - \mathrm{E}(Z)^2 \\ &= 1 - 0 - 0 - 0 + 3 * 0.5 + 3 * 0.5 - 0 = 4 \end{aligned}$$

As for the variance of the BSI, there also exists a mean-variance relation as can be seen from the different equations of the variance at hand.

5.4 Taking Different Questions Into Account

As before, the formulas need to be generalised to take more than one question into account. It was seen in Equation 3.12, that the sum of correlated variances is not equal to a simple sum of all the variances, the covariance needs to be taken into account.

The formula when combining four different variances can be written as follow

$$\begin{aligned} \mathrm{Var}\left(\text{Industry EIR}\right) &= \frac{1}{16}\Big[\mathrm{Var}(Z_{Q1}) + \mathrm{Var}(Z_{Q2}) + \mathrm{Var}(Z_{Q3}) + \mathrm{Var}(Z_{Q4}) \\ &\quad +2\,\mathrm{Cov}(Z_{Q1}, Z_{Q2}) + 2\,\mathrm{Cov}(Z_{Q1}, Z_{Q3}) + 2\,\mathrm{Cov}(Z_{Q1}, Z_{Q4}) \\ &\quad +2\,\mathrm{Cov}(Z_{Q2}, Z_{Q3}) + 2\,\mathrm{Cov}(Z_{Q2}, Z_{Q4}) + 2\,\mathrm{Cov}(Z_{Q3}, Z_{Q4})\Big] \end{aligned} \tag{5.9}$$

A similar approach as the one applied for the variance of the BSI is applied here.

The generalisation of the unweighted EIR - when taking q questions into account - can be written as follows

$$\mathrm{Var}(\mathrm{EIR}) = E\left[(\mathrm{EIR} - \mathrm{E}(\mathrm{EIR}))^2\right] = \mathrm{E}\left(\mathrm{EIR}^2\right) - \mathrm{E}\left(\mathrm{EIR}\right)^2 \tag{5.10}$$

$$= \frac{\sum_{i=1}^{n}[(z_{iQ1} + z_{iQ2} + \ldots + z_{iQq})/q]^2}{n} - \mathrm{E}(\mathrm{EIR})^2 \tag{5.11}$$

$$= \frac{\sum_{i=1}^{n}(z_{iQ1} + z_{iQ2} + \ldots + z_{iQq})^2}{q^2 n} - \mathrm{E}(\mathrm{EIR})^2 \tag{5.12}$$

The formula for the weighted variance of the EIR can be written as follows

$$\mathrm{Var}(\mathrm{EIR}) = \mathrm{E}\left[(\mathrm{EIR} - \mathrm{E}(\mathrm{EIR}))^2\right] = \mathrm{E}\left(\mathrm{EIR}^2\right) - \mathrm{E}\left(\mathrm{EIR}\right)^2 \tag{5.13}$$

$$= \sum_{i=1}^{n}\left[\omega_i(z_{iQ1} + z_{iQ2} + \ldots + z_{iQq})/q\right]^2 - \mathrm{E}(\mathrm{EIR})^2 \tag{5.14}$$

Further explanation including examples in order to better understand the different indicators and variances, can be found in Appendix section II.

CHAPTER 6

Data at Hand

For the empirical research, the data at hand is the unweighted industry business survey monthly results from 1988 to 2018. This chapter will explain those different specificities and, to some extend, explain the different reasons why it's the data used in this paper.

In the next chapter the seasonal correction of the different variables will be explained, the analysis will all be done with the data after seasonal correction since it's the method applied by the NBB.

6.1 Unweighted Observations

The business survey indicator published monthly uses a complex method of weighting that takes into account the size of the companies and the size of the specific sub-sector they are part of as explained in subsection 2.3.3.

In order to have a large period of time for the empirical analysis, the decision is made to take only unweighted indicators, since the weights of the different respondents are not available before the year 2008. Another reason not to use weighted measures is that the weighting procedure is very complex and prone to some companies largely influencing the indicator, and with it the results of the research.

6.2 Indicator and Questions

For similar reasons as for taking only unweighted results, the answers are obtained only for the industrial sector. It is the first sector that was taken into account in the business survey before it was enlarged to trade, construction and services. It is the sector with the largest amount of respondents and according to previous exploratory analysis and previous research, is the sector which has the highest correlation with national growth.

Four questions are taken into account, since it are the four questions that are taken today in the calculation of the industry BSI.

It has to be noted that before 2009, almost all the questions where taken into account for the calculation of the indicator. Since the 2009 revision of the business survey (see

subsection 2.3.2), only four questions are taken into account for more accuracy. In order to have the best comparability over the whole period, only those four questions will be used for the whole period (see questions in Appendix section I).

The first two questions relate to the current state of the company while the two others ask the participants their prediction for the next three months. The first question is about the stock of the company, the second question relates to the demand of their products, the third question relates to the company's predictions of the need for work forces and the last question asks about their predictions regarding demand.

In this paper, the answers and results of the industry business survey barometer will be used since 1988. Therefore it's very important to see if modifications were applied over time to the questionnaire. A questionnaire from 1990 can be seen in Appendix (see Figure 3 on page 55) and can be compared to a more recent version (see Figure 2 on page 54).

The layout was modified, and the phrasing of the questions slightly evolved over this long period. Before questions were asked in the first person while it's now phrased in the third person. Aside from those small changes, the survey kept the same questions and order. It might be interesting to have a closer look at the potential consequences of those changes over time. The layout, the phrasing and the method of answering can potentially influence the answers. Nevertheless, since it's not the subject of this paper, this study will be left for future research. What can be said, is that the influence of those changes could be limited since the respondents where mostly the same when the changes happened, so the interpretation they made from the questions could have a smaller impact.

6.3 Variables

The following research will focus on nine variables. The year on year gross domestic product (YoY GDP) which is publicly available and the most used measure of national growth. As seen in section 2.2, it's only accounting for growth and the evolution of it, what is at interest in this research. The eight other variables are obtained with the different calculations explained in the first part of this paper. The well-known business survey indicator (BSI) as explained in Chapter 2 and its less-known variance as explained in Chapter 3. The evolution of individual responses (EIR) and its variance as explained in Chapter 4 and 5, where three different measures are proposed, referred later as EIR1, EIR2 and EIR3. EIR1 is when taking the difference in answer between a month and the month before while EIR2 uses a lag of two months and EIR3 a lag of three months. The reasons for taking a larger period into account were explained in section 4.3. For each of the three measures of the EIR, the variance is calculated and will be studied further.

CHAPTER 7

Seasonal Effects, Refusal to Participate, Non-Response, Dropout and Attrition

Before modelling the data, it's important to look at the different effects that could mislead the outcome of the analysis. After exploring the data and a literature review, five main effects where found as potential sources of bias. One is due to external effects; seasonal effects while four are due to the survey structure and organisation. First seasonal effects will be studied and a well-known correction to the data will be applied to eliminate - as well as possible - the seasonal effects from the data. It will then be looked into the four survey based issues; non-participation, non-response, dropout, and attrition.

7.1 Seasonal Correction

The National Bank, before publishing the business survey indicator, applies an X11 seasonal correction. The literature about seasonal effects is very rich and varied. Without going too much into details, there are today two methods which are the most widely used and recommended which are X12/X13-ARIMA developed by the US Census Bureau and TRAMO/SEATS developed by the Bank of Spain.

The Department of Research and Development of the NBB developed JDemetra+, a statistical program which is recommended by the European Central Bank (ECB) and Eurostat for analysing seasonal effect and applying seasonal corrections.

JDemetra+ is used by the National Bank to apply seasonal corrections to the business survey indicator before publication. It will be used here, to test for seasonality and apply corrections to the data. Tests for seasonality are summarised in Table 7.1. The results are clear, there is seasonality in all the variables.

The different variables are seasonally corrected using RJDemetra, the R package based on JDemetra+. The results are plotted in Figure 7.1. The method applied is called "RSA0" and is the simplest X12/X13-ARIMA method for seasonal correction; not applying log/level, outliers and calendar corrections. It was chosen since it's the closest to the X11 applied by the NBB to the business survey.

Table 7.1: Seasonality tests

Seasonality Test	BSI	Var(BSI)	EIR	Var(EIR)	EIR2	Var(EIR2)	EIR3	Var(EIR3)
Auto-corr. at seasonal lags	YES	YES	YES	YES	YES	YES	YES	YES
Friedman test	YES	YES	YES	YES	YES	YES	YES	YES
Kruskall-Wallis test	YES	YES	YES	YES	YES	YES	YES	YES
Spectral peaks	YES	YES	YES	?	YES	?	YES	YES
Periodogram	YES	YES	YES	YES	YES	YES	YES	YES
Seasonal dummies	YES	YES	YES	YES	YES	YES	YES	YES
Seasonal dummies (AMI)	YES	YES	YES	YES	YES	YES	YES	YES

The seasonal-irregular (S-I) ratio charts, which can be seen in Appendix Figure 4 on page 56, are interesting to look at to better understand the seasonal effect influencing the different variables. The business survey indicator is usually higher in August and September, and lower in November and December. It seems that respondents are more optimistic during and slightly after summer holidays, or whether the economy is doing better during those holidays is difficult to know.

The S-I ratio chart for the variance of the indicator shows that the variance is lowest in August and September while its peak is in October. In other words, respondents agree the most at the beginning of the year or the last month of the summer holidays, while the largest disagreement is in October. The evolution of individual responses indicators (taking 1, 2 or 3 months lag into account) has a quite similar monthly behaviour as the business survey indicator. On the other hand, the variance of the EIR's seems to be less monthly influenced. The Var(EIR1) is smaller in June, while Var(EIR2) and Var(EIR3) are smaller during summer holidays.

It's important to notice that year on year GDP is, by definition, corrected for it's seasonal effects. Its formula (Equation 2.1) eliminates all of GDP's seasonality. This was confirmed when running the seasonality tests, non of the test showed significant seasonal effects. Therefore its important, for the modelling of the data - which will be done in Chapter 9 - to correct the different variables for seasonal effects.

7.2 Refusal to Participate

Non-participation in the survey is difficult to study since not much trace is kept of the companies refusing to participate in the survey. As explained in the first chapter, the selection of participants uses stratification to account for the population at study. There is a bias that can come from the selection procedure since the survey is voluntary based, which means that if companies more prompt and motivated to participate are companies with a different profile compared to non motivated companies, there could be an issue.

7.3 Non-Response

Participants not answering a certain month but continue the survey, is called non-response or non-monotone missingness and can bias the estimates. The solution applied by the NBB in case of non-response, is to assume that the respondent would have answered the same as the previous month, the method is called "Last Observation Carried Forward" (LOCF). The theory regarding missing observations states three different ways non-response can be present. Responses can be missing completely at random (MCAR), missing at random

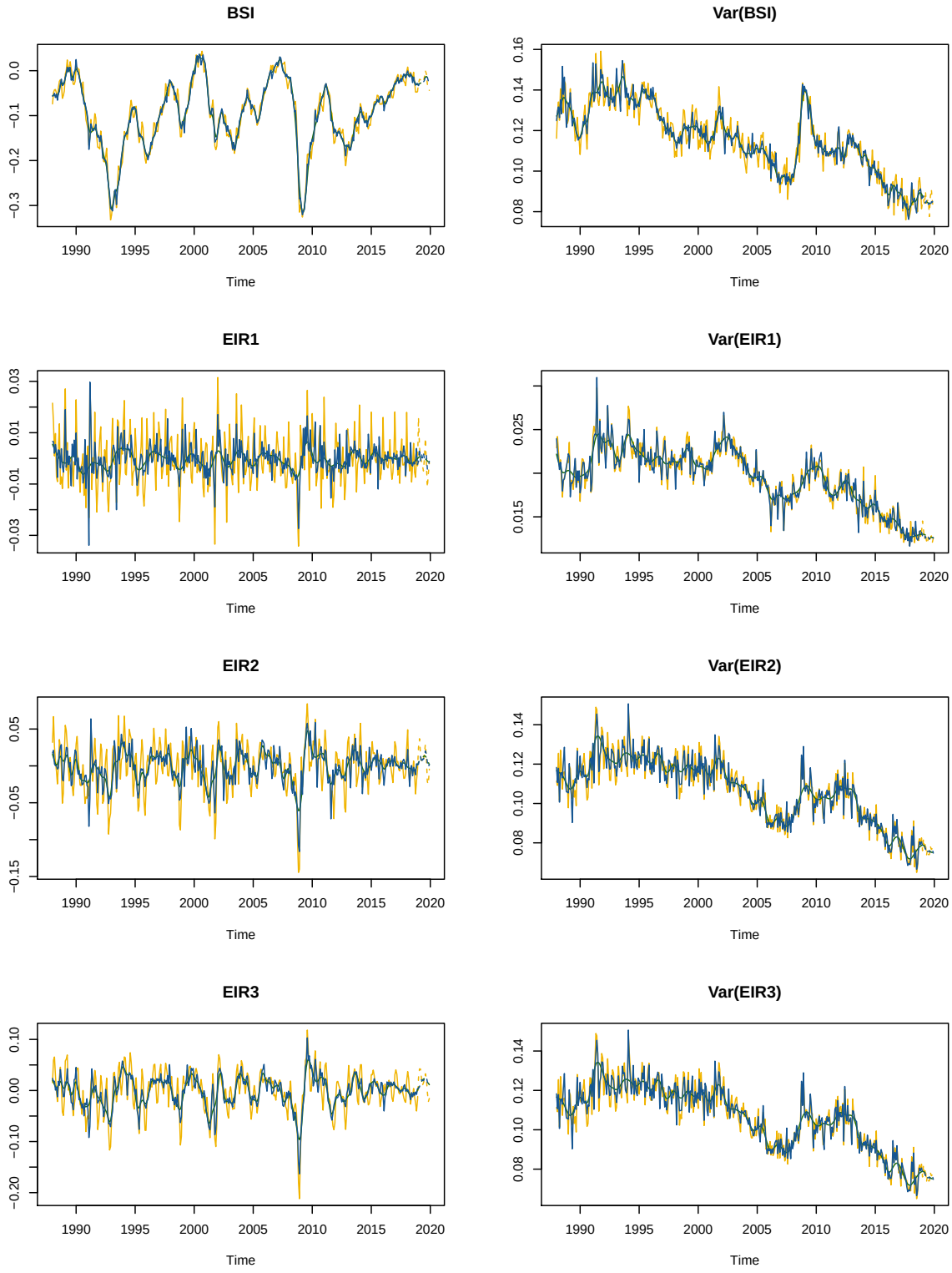

Figure 7.1: Plot of the industry business survey indicator (BSI), the indicator of the evolution of individual responses with the previous month (EIR1), two months (EIR2) and three months earlier (EIR3), with for each of them, their variance. The yellow lines are the raw variables, the blue lines the seasonally corrected variables and the green lines are the trends of the variables.

(MAR), or missing not at random (MNAR). Missing completely at random is usually hard to assume while missing not at random can be hard to account for. In the case of the business survey, the LOCF technique assumes that observations are missing completely at random. This method is not the most efficient and unbiased but has the advantage of being very simple and results in more data (compared to considering the missing observations as missing).

There is a large effort made by the NBB to contact respondents and send them reminders to make sure that non-response is as small as possible. The response rate is usually around 95%, which is quite high for a survey, therefore it will be assumed that non-response is not critical in the business survey.

7.4 Dropout and Attrition

Dropout and Attrition are related to the structure and organisation of the survey. As explained in subsection 2.3.1, once participants are recruited to participate in the business survey, they stay as long as they want. This brings two potential issues: potential bias due to companies leaving the survey (dropout) and potential bias due to companies change their answering behaviour over time (attrition).

7.4.1 Dropout

The National Bank doesn't keep track of reasons why participants leave the survey. From discussions with the persons responsible for the survey at the NBB, the two main reasons companies are leaving the survey are; (1) the company going bankrupt, acquired or merged and (2) the responsible person at the company leaves his job and the new contact person doesn't see the interest in participating in the survey. This is an issue since it means that it's a certain type of company that leaves the survey. If this type of profile has a different opinion or responds differently from the remaining companies, this will create bias.

It could be argued that the bias is very diffused, due to the small number of companies leaving the survey each month. The fact that it's the evolution of the BSI that is important, means that the bias would be rather small for each month, but if a longer period is taken into account, the bias would become larger.

Since it isn't the subject of this work, it will not be further studied, but it will be recommended to have a closer look into this for future research.

7.4.2 Attrition

Attrition, also called panel conditioning, is present when participants change there behaviour between different rounds of surveys. A very interesting master thesis was done about the Belgian labour force survey, where attrition was found to be significant (Priyana Hardjawidjaksana, 2019). The Belgian labour force survey was convenient to test for attrition since the survey is answered by participants exactly four times with a lag of six months. It was shown that indeed attrition was present in the survey, a general respondents behaviour change between the different rounds of responses.

In the case of the industry business survey, it's harder to test for since their were only two major periods of recruitment for the period at interest (1988 - 2018); in the early

1990 and around 2000 with some companies been recruited outside those periods. The other sectors have the same issue.

Table 7.2: Correlation of time with different industry business survey variables from 1988 to 2018

	GDP_year	BSI	Var(BSI)	EIR	Var(EIR)
Time	−0.339	0.133	−0.807	0.039	−0.705

An interesting approach to explore attrition and dropout is by looking at the correlations of the variances over time. In Table 7.2 it can be seen that there is a very large negative correlation between time and the variance of the BSI and the variance of the EIR. This can be interpreted as companies agreeing more and more over time and changing less and less their answers. Without making any conclusions, the variance of BSI and the variance of EIR seem to show the presence of attrition and/or dropout bias.

The same can be observed in Var(BSI) and Var(EIR) plots in Figure 7.1 where, aside from the peak of variance during the economic crises of 2008, there is a general tendency of decreasing of the variance of the BSI and the different variances of EIR after the beginning of the century, the last time there was a large recruitment.

The variance shows here an interest, it can be used to better understand the survey and the behaviour of respondents. When looking at only the evolution of the business survey indicator, it's not possible to measure the vivacity of the survey.

It would be interesting to dive more into these issues, but this will be left for further research. In the context of this paper, it's important to notice the potential importance of attrition and dropout in the industry business survey and the importance of the variances which could account for it.

CHAPTER 8

Exploratory Analysis

The previous chapter did some exploratory analysis. Further observations of the different variables at hand will be done in this chapter starting with a short descriptive statistics section. In a second part, correlations among the variables will be looked at.

8.1 Descriptive Statistics

Table 8.1: Descriptive Statistics

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
YoY GDP	124	1.936	1.634	−3.809	1.218	3.000	5.119
BSI	372	−0.094	0.075	−0.321	−0.141	−0.033	0.037
Var(BSI)	372	0.116	0.017	0.076	0.107	0.129	0.154
EIR1	372	−0.0003	0.006	−0.034	−0.004	0.003	0.030
Var(EIR1)	372	0.020	0.003	0.012	0.017	0.022	0.031
EIR2	372	−0.001	0.024	−0.116	−0.013	0.013	0.064
Var(EIR2)	372	0.107	0.016	0.067	0.095	0.119	0.151
EIR3	372	−0.002	0.031	−0.163	−0.018	0.018	0.103
Var(EIR3)	372	0.123	0.019	0.075	0.109	0.137	0.166

The variables at hand are obtained from the industry business survey and take into account the four questions available on page 51, as explained in subsection 2.3.2. The different variables are unweighted, seasonally corrected (see section 7.1) and is obtained for 30 years, from 1988 to 2018. The year on year GDP calculation was explained from GDP by the calculation in Equation 2.1 and is here obtained for the Belgian economy.

The different variables at hand are summarised in Table 8.1. The YoY GDP has only one third as many observations as the other variables since it's a quarterly measure, while the survey is monthly. The table shows the scale of the different variables, for example, the industry BSI, over 30 years, never went up more than 0.037 and never lower than -0.321.

The different variables are plotted in Figure 8.2, where it can be seen that the business survey indicator follows quite well the evolution of YoY GDP. The other variables, seem to react to major changes in GDP but are more volatile.

8.2 Correlation Analysis

Belgian industry claims 25% of the labour force in Belgium and was shown as a good indicator of the year to year GDP (De Greef and Van Nieuwenhuyze, 2009).

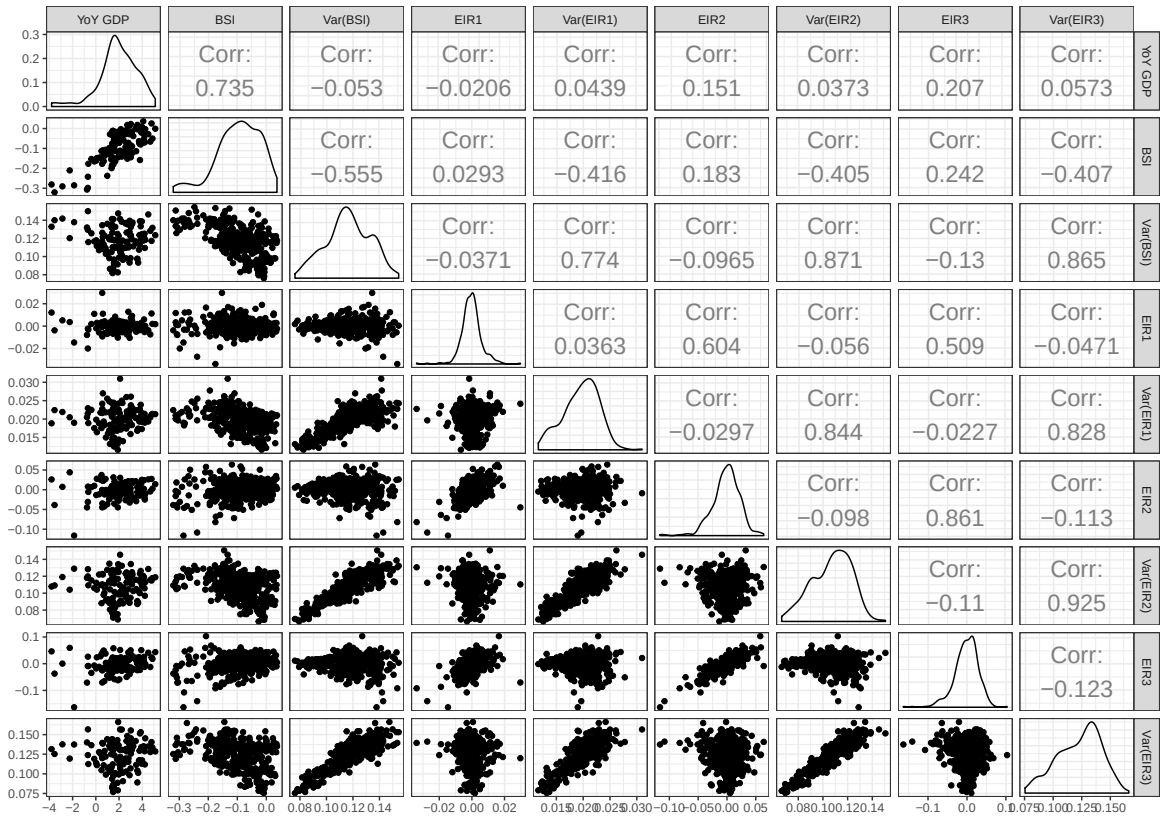

Figure 8.1: Correlation plot of the YoY GDP, the BSI and its variance, and the EIR for 1,2 and 3 months lag and their variances

Figure 8.1 shows the correlation matrix and plots of the different variables at hand. Several observations can be done. First, it can be seen that the correlation between the business survey indicator and YoY GDP is very high while other variables have a rather small correlation with YoY GDP. The correlation between the BSI and its variance is also high, this can be explained to some extent by the different properties explained in section 3.3, concerning the mean-variance relation of the indicator. The same can not be said about the correlation between the EIR and its variance since their correlation is small for the three different measures of EIR. As could be foreseen, the correlations between EIR1, EIR2 and EIR3 and the correlations between Var(EIR1), Var(EIR2) and Var(EIR3) are high. Their calculation and data used are quite close. The correlation between the different types of variances is also high, which can mean that they contain quite similar information. With this definition, it's interesting to look at the correlation

between the BSI and the EIR since it's almost equal to zero. This can be interpreted as the two variables containing different information.

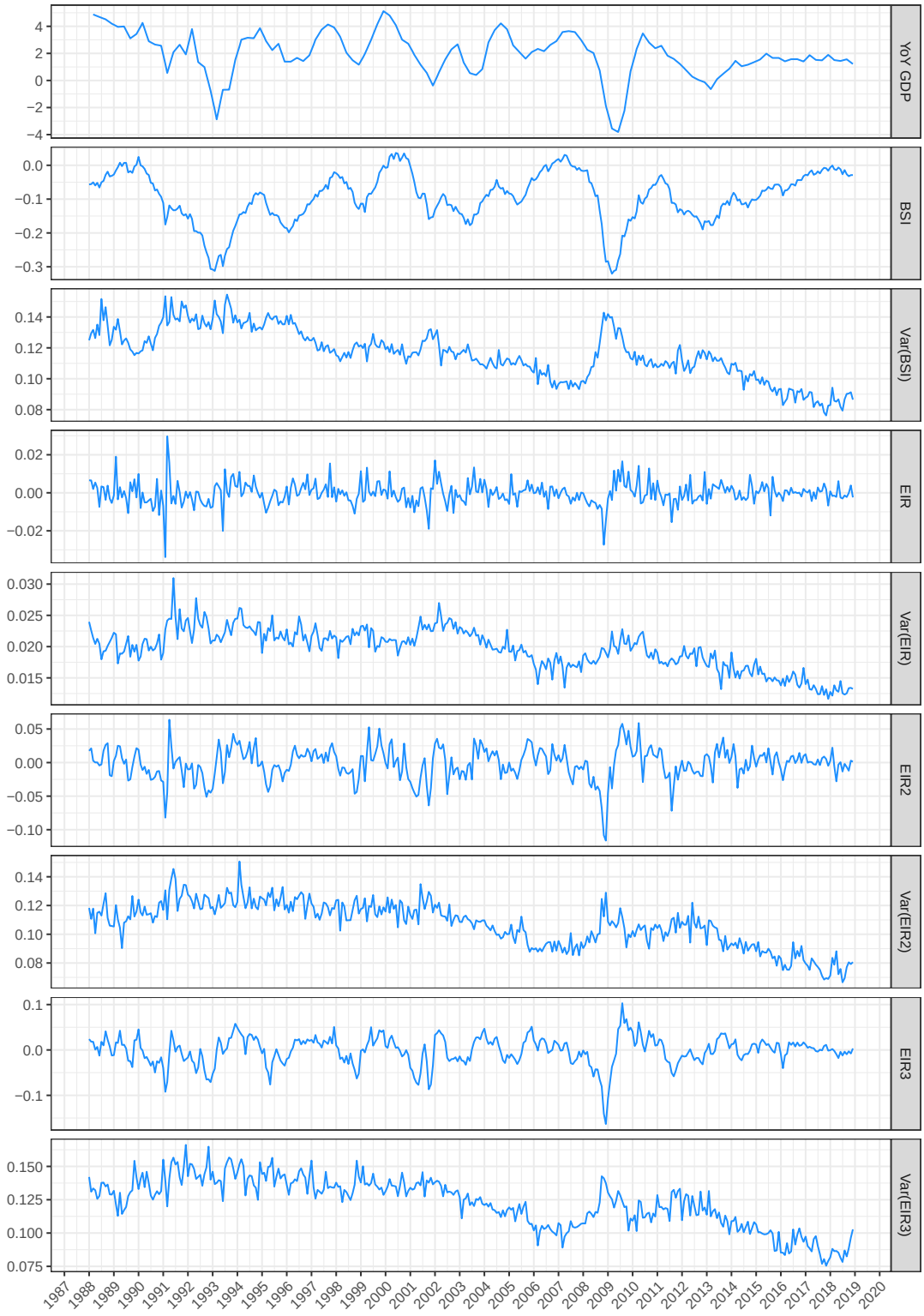

Figure 8.2: Plot of the time series of YoY GDP, the BSI, the variance of the BSI and different EIR's (taking 1, 2 or 3 months differences) and their variances for the period 1988 to 2018

CHAPTER 9

Predictive Power

This chapter uses linear models to test the pertinence of the different variables at hand in the short term prediction of the evolution of GDP.

As mentioned in subsection 2.2.2, where nowcasting was discussed, there exists a large variety of different predictive models used in econometrics to predict the National Growth based on some explanatory variables. The National Bank of Belgium for example, developed a State-Space model available in JDemetra+ (de Antonio Liedo, 2014). Other well-known methods are Autoregressive integrated moving average (ARIMA), Auto- Distributed Lag Models (ARDL), Mixed Data Sampling Regression (MIDAS) and many more.

The interest of the research at hand, is to explore the short-term predictive power of the variance of the business survey indicator, the evolution of individual responses and its variance. To achieve this objective, it's better to use a model that account easily for the interest of each variable. The idea here is not to find the best model but rather to see if including the new indicators in a certain model will improve predictions. Therefore, the linear model is preferred.

This chapter will begin with presenting the methodology applied for the modelling. It will then propose five different models, one simple model where only the BSI is used as regressor, and then four potential models that include other regressors. Several test statistics will be looked at and used to compare the different models and understand if the new regressors added to the model, improve the model fit and the estimations. A method of model selection will then be applied to see if it decides to include the new regressors into the model aside from the BSI. The last part will use out-of-sample estimation to check if the results from the previous tests are robust.

9.1 Method

The quarterly year on year GDP is set in the last month of the quarter. This is the common way to go in order to have a reasonable approach and still have some predictive properties. Indeed, when looking at Figure 9.1, it can be seen that with the linear model

it's possible to estimate quarterly YoY GDP one month before it's published. This means that the model will be estimated only with the indicators of the last month of each quarter. Ones the model is estimated, it's then possible to make predictions or estimations of YoY GDP for each month.

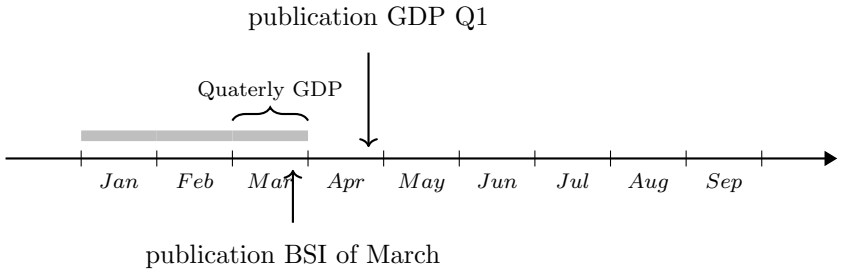

Figure 9.1: Timeline of the period observed for GDP and the business survey and their publications

9.2 Linear Models

A linear regression can be written as follows

$$\text{YoY GDP}_t = \beta_0 + \sum_{i=1}^{n} \beta_i X_t + \epsilon_t \tag{9.1}$$

Where β_0 is the intercept, β_i are the different regression coefficients of the monthly predictors (X_t) and ϵ_t is the error term.

This model is a good example of basic nowcasting, since it's modelling data that's happening at the same time, but since there is a lag of one month in the publication of GDP, it can be used to predict one month in advance, the published GDP.

It can also be used to estimate GDP monthly. Ones a linear model is obtained, based only on quarterly data, it can then be applied to all the available data, and a prediction can be done for each month. In real life, this means that at the end of January, when the results of GDP are published for the last semester of the previous year, the linear model can predict GDP for the month of January. Therefore it's not forecasting, since it doesn't predict the future, but predicts the actual state of the economy.

The first approach here is to propose five different models and compare them. The simplest model takes as unique regressor, the business survey indicator

$$\text{YoY GDP}_t = \beta_0 + \beta_1 \,\text{BSI}_t + \epsilon_t \tag{Model 1}$$

This will be the reference model. A model where only the BSI is used to predict GDP growth (YoY GDP). It will be compared to the following models.

A model that takes the business survey indicator and its variance as regressors

$$\text{YoY GDP}_t = \beta_0 + \beta_1 \,\text{BSI}_t + \beta_2 \,\text{Var(BSI)}_t + \epsilon_t \tag{Model 2}$$

And three different models where the three different evolution of individual responses with each their variances are added to the previous model

$$\text{YoY GDP}_t = \beta_0 + \beta_1 \,\text{BSI}_t + \beta_2 \,\text{Var(BSI)}_t + \beta_3 \,\text{EIR 1}_t + \beta_4 \,\text{Var(EIR 1)}_t + \epsilon_t \quad \text{(Model 3)}$$

$$\text{YoY GDP}_t = \beta_0 + \beta_1 \,\text{BSI}_t + \beta_2 \,\text{Var(BSI)}_t + \beta_5 \,\text{EIR 2}_t + \beta_6 \,\text{Var(EIR 2)}_t + \epsilon_t \quad \text{(Model 4)}$$

$$\text{YoY GDP}_t = \beta_0 + \beta_1 \,\text{BSI}_t + \beta_2 \,\text{Var(BSI)}_t + \beta_7 \,\text{EIR 3}_t + \beta_8 \,\text{Var(EIR 3)}_t + \epsilon_t \quad \text{(Model 5)}$$

The estimates can be seen in Table 9.2 for the five regressions. Some goodness of fit measures are also available. Those first results show the limited interest of EIR2 and EIR3 since the model with EIR1 and its variance (Model 3) is better performing according to all the results than the two other models (Model 4 and Model 5).

The other observation that can be done is that the interest of the variance in the prediction seems significant since adding - next to the information of the business survey - its variance, increases the Adjusted R^2 by 0.151. The model is also better according to Akaike's Information Criterion (AIC) and Bayesian Information Criterion (BIC) results.

Table 9.1: Accuracy measures

	RMSE	MAE	MPE	MAPE	MASE
Model 1	1.103	0.93	-27.657	86.696	0.764
Model 2	0.878	0.697	-10.923	61.185	0.573
Model 3	0.848	0.674	-12.455	55.698	0.554
Model 4	0.875	0.699	-12.757	62.707	0.574
Model 5	0.873	0.689	-9.83	59.311	0.566

Table 9.1 shows some more measures of goodness of fit; the Root Mean Squared Error (RMSE), the Mean Absolute Error (MAE), the Mean Percentage Error (MPE), the Mean Absolute Percentage Error (MAPE) and the Mean Absolute Scaled Error (MASE). The different measures of accuracy give similar results as before, Model 3 is performing best according to all the measures except in MPE. The results for Model 2 are quite close to the results of Model 3. There is no clear best model between the two.

In Figure 9.2, the prediction of YoY GDP according to the three first models are shown for the whole period. It can be seen that model 2 and 3 are better performing that model 1, while model 2 and 3 deliver quite similar predictions.

The Diebold-Mariano statistical (DM) test (Diebold and Mariano, 1995) is well-known for comparing forecast accuracy of different models. It determines whether forecasts of a specific model are significantly better than another model by using the residuals.

The results can be seen in Table 9.3, the predictions of model 1 are significantly outperformed by all the other regressions. While there is no clear winner between the other regressions; Model 3 is not significantly better than Model 2.

Since there are a large amount of different possible models when having eight different regressors - 255 possible combinations -, some procedure needs to be chosen to look for

Table 9.2: Linear Regression Results for the period 1988 to 2018

	Linear Regression				
	year on year GDP				
	(Model 1)	(Model 2)	(Model 3)	(Model 4)	(Model 5)
Constant	3.429***	−1.740***	−1.821***	−1.756***	−1.729***
	(0.160)	(0.631)	(0.615)	(0.635)	(0.633)
BSI	15.773***	21.443***	21.548***	21.310***	21.044***
	(1.317)	(1.252)	(1.224)	(1.306)	(1.313)
Var(BSI)		49.102***	36.477***	40.631***	38.777***
		(5.869)	(8.089)	(11.895)	(11.081)
EIR1			−28.718**		
			(13.792)		
Var(EIR1)			78.555**		
			(35.187)		
EIR2				−0.709	
				(3.878)	
Var(EIR2)				9.213	
				(11.207)	
EIR3					1.290
					(2.610)
Var(EIR3)					9.401
					(8.598)
Observations	124	124	124	124	124
R^2	0.540	0.709	0.728	0.711	0.712
Adjusted R^2	0.537	0.704	0.719	0.701	0.702
Resid. Std. Er.	1.112	0.889	0.866	0.894	0.891
AIC	382.292	327.699	323.086	330.907	330.293
BIC	390.753	338.980	340.008	347.829	347.215
Note:					*p<0.1; **p<0.05; ***p<0.01

Table 9.3: Diebold-Mariano tests for the models referred to in Table 9.2

p-values	Model 1	Model 2	Model 3	Model 4	Model 5
Model 1	1	5.126e-06	2.586e-06	6.352e-06	5.602e-06
Model 2		1	0.2055	0.6836	0.5147
Model 3			1		
Model 4			0.1613	1	0.7876
Model 5			0.3017		1

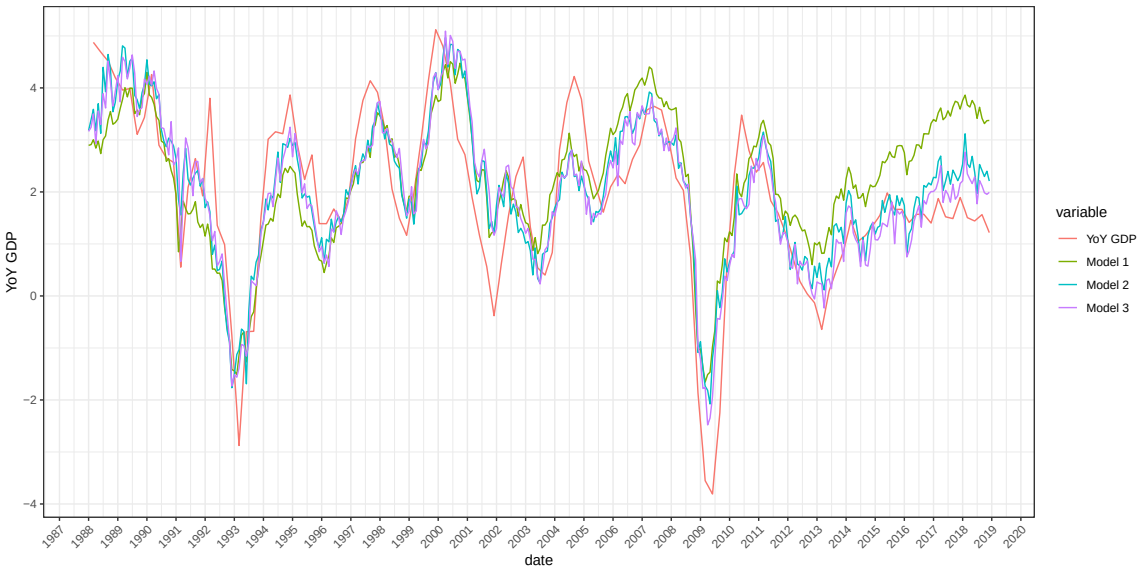

Figure 9.2: Plot of year on year GDP and the different estimations from model 1, 2 and 3

the best model. The method applied here is a step procedure where AIC is used to select the best model. Three different selection algorithms will be applied; (1) forward, (2) backward and (3) both as defined in the step() procedure in R. The three methods are all based on Akaike's information criterion (AIC) as a measure of goodness of fit. They differ in the sense that the first (1) starts from a model with no regressors and one by one adds the regressors that improve the most the model fit, the second (2) does the opposite, it starts with the full model and takes out the variables that don't improve the model fit and the last (3) is a mix of the two previous methods.

The results of the three different methods converge to the model already proposed refered to as Model 3, where BSI, Var(BSI), EIR1 and Var(EIR1) are the regressors that explain the YoY GDP.

From the different results, it can already be stated that EIR1 and its variance are bringing more in the modelling of the YoY GDP than EIR2 and EIR3 with their variances. It was also seen that the variance of the BSI improves the model quite largely and that EIR1 and its variance can also add some information.

Following those results, there are two good candidates; Equation Model 2 and Model 3. Those are the two models that will be further looked into and compared to the simplest model only including the BSI (Equation Model 1).

9.3 Out-of-Sample Performances

To know if the results from the linear model are robust, two out-of-sample estimation will be performed for model 1, 2 and 3. The first will use the period 1988 to 2000 to estimate the model, and its predictions for that period and for the period 1988 to 2018. The results will be compared using the Diebold-Mariano test. The period was chose since it's only 12 years long, and will have to be accurate for the next 18 years. The situation it is representing, is if, since January 2000, the three models where used to make predictions, which would deliver the best results.

The same will then be done for the period 1988 until 2012. The year 2012 was chosen after having a closer look at Figure 9.2, where it seems that most of the improvement brought by the models including more than only the BSI, is from 2012 on. Therefore it's interesting to see how the different models perform without taking that period into account.

Table 9.4: Diebold-Mariano tests for the models estimated with the data from 1988 to 2000, applied to the data from 1988-2000 and 1988-2018 with the estimates from Table 9.6

	1988-2000			**1988-2018**		
p-values	Model 1	Model 2	Model 1	Model 1	Model 2	Model 3
Model 1	1	0.2203	0.08282	1	1.867e-11	5.555e-11
Model 2		1	0.2886		1	0.000745
Model 3			1			1

Table 9.4 shows that the models, estimated with the data from 1988 to 2000, their predictions aren't significantly different from each others, while if the model is applied to the whole period of 1988 to 2018, Model 3 is significantly better than Model 1 and 2. The estimates and fitted plot can be seen in Table 9.6 and Figure 9.3. If exclusively the period 1988-2000 is taken into account, Model 2 and Model 3 are only slightly better than Model 1 according to most of the statistics. It can then be seen, from the plot, and even more from the DM tests, that Model 2 and Model 3 outperform Model 3 after that period, even if the data used for the estimation of the model only uses the data available before 2000.

On the other hand, Table 9.5 shows the DM tests results (p-value) for the model estimated with the data until 2012. The results for the period 1988-2012 and 1988-2018 are quite similar and come to the same conclusion, Model 2 and Model 3 outperform Model 1. While Model 3 is not significantly better than Model 2. The estimates and fitted plot can be seen in Table 9.7 and Figure 9.4.

Table 9.5: Diebold-Mariano tests for the models estimated with the data from 1988 to 2012, applied to the data from 1988-2012 and 1988-2018 with the estimates from Table 9.7

	1988-2012			**1988-2018**		
p-values	Model 1	Model 2	Model 1	Model 1	Model 2	Model 3
Model 1	1	0.00956	0.007979	1	1.269e-07	1.751e-07
Model 2		1	0.2813		1	0.09632
Model 3			1			1

Table 9.6: Linear Regression results for the period 1988 to 2000

	Linear Regression		
	Year on Year GDP		
	(1)	(2)	(3)
Constant	4.437***	0.660	−0.519
	(0.211)	(1.899)	(2.041)
BSI	17.374***	19.212***	20.327***
	(1.547)	(1.758)	(1.813)
Var(BSI)		30.545*	31.371**
		(15.269)	(14.992)
EIR1			−37.120**
			(17.899)
Var(EIR1)			53.535
			(52.433)
Observations	48	48	48
R^2	0.733	0.754	0.779
Adjusted R^2	0.727	0.744	0.758
Residual Std. Error	0.851	0.825	0.801
AIC	124.714	122.625	121.622
BIC	130.327	130.109	132.849
Note:			*p<0.1; **p<0.05; ***p<0.01

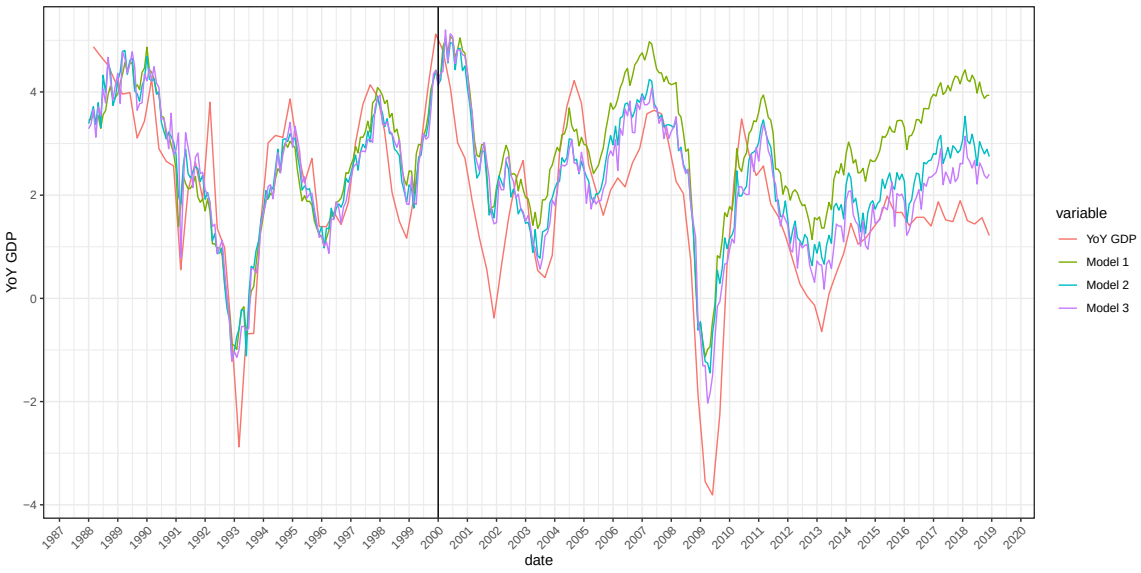

Figure 9.3: Plot of year on year GDP and the different estimations from model 1, 2 and 3 when estimated with the data from 1988 to 2000

Table 9.7: Linear Regression results for the period 1988 to 2012

	Linear Regression		
	Year on Year GDP		
	(1)	(2)	(3)
Constant	3.871***	−0.686	−1.349
	(0.171)	(1.054)	(1.102)
BSI	17.243***	20.939***	21.499***
	(1.341)	(1.491)	(1.478)
Var(BSI)		40.466***	33.997***
		(9.256)	(10.062)
EIR1			−33.401**
			(16.292)
Var(EIR1)			71.077
			(44.449)
Observations	96	96	96
R^2	0.637	0.699	0.718
Adjusted R^2	0.634	0.693	0.705
Residual Std. Error	1.064	0.974	0.954
AIC	288.325	272.383	270.247
BIC	296.018	282.641	285.633
Note:			*p<0.1; **p<0.05; ***p<0.01

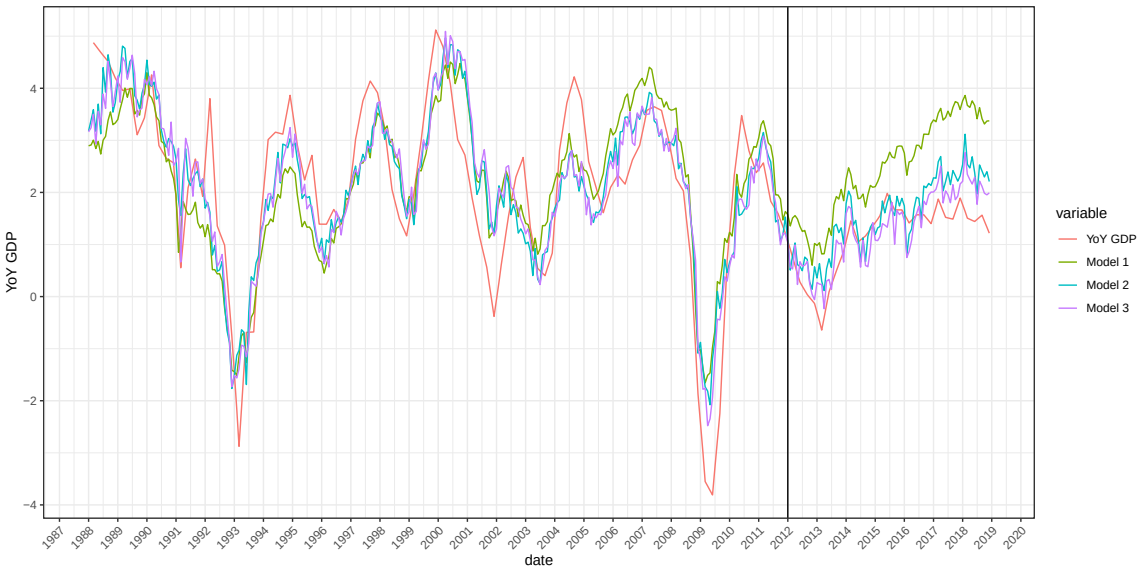

Figure 9.4: Plot of year on year GDP and the different estimations from model 1, 2 and 3 when estimated with the data from 1988 to 2012

CHAPTER 10

Conclusion

After presenting the business survey and the business survey indicator, it was seen that the variance of the business survey indicator showed some interesting interpretation and properties. Since the business survey has only three possible answers per question, the variance is related to the mean and bounded between 0 and 1.

The evolution of individual responses was developed and explained. It's variance was shown as also having a mean-variance relation and been bounded between 0 and 2.

After correcting the different variables and indicators for seasonal effects, the two different variances where shown to be potential indicators of dropout and/or attrition.

The correlation analysis confirmed the relation between the indicator and its variance since there correlation is quite high. It was also seen that none of the new indicators had a high correlation with YoY GDP while the industry BSI has a correlation slightly higher than 0.7 with the measure of growth.

The variance of the BSI, the EIR and its variance are more volatile than the business survey indicator when looking at there evolution over time and there graphical representation is less explanatory than the business survey indicator.

Considering the predictive power of the different variables, it was seen that as expected, the business survey indicator is a good predictor, and its variance would increased prediction accuracy. It was seen that if in 2000, it was decided to use linear models to do nowcasting of the YoY GDP, and that model would be used until this day, the model including the BSI, its variance, the EIR and its variance would have outperformed a model using only the BSI.

CHAPTER 11

Discussion

The Belgian industry business survey indicator was shown as very good indicator of the YoY GDP, confirming previous research.

Recruitment procedure and panel data

The recruitment of respondents to the survey was explained and reasons where given for not using a random sampling method. Nevertheless this decision has several implications that could be further studied.

The selection of new participants by waves of recruitment is an issue if it's assumed that there is attrition and dropout bias. A constant recruitment of new participants, would attenuate the potential bias. Literature has shown that respondents behaviour changes related to the participation period and some simple descriptive statistics from the business survey seemed to confirm the presence of the previous assumption. For those reasons,further research regarding this issue would be of a great benefit to better understand and correct for those issues.

Develop indicator by taking two different questions into account that are linked

Regarding the indicator of the evolution of individual responses (EIR), further research and development could take two forms. One is to develop an indicator that can take more than two months into account. This was explored but a consistent and interpretable indicator could not be found. Another method is to use different questions to obtain an indicator. In the business survey some questions are linked; questions concern the level of production in the past, some the present and other questions relate to there predictions for the following months. A new indicator could be a measure of the accuracy of the predictions of the respondents and could be used to compare the different participants or different periods.

LOCF or other non-response methods

Considering non-response, an other technique than "Last Observation Carried Forwards" could be used. Multiple Imputations would be an interesting approach to handle non-response in the business survey as was done for the German business survey in Seiler and Heumann (2013). Since it could decrease the bias and increase accuracy, it would be interesting to explore different corrections.

Variance predictive power or correction for dropout and attrition

The linear regression showed the significant importance of the variance. the out-of-sample tests showed that the importance of variance is mostly for the period after 2012. Which coincide with the period where no new recruitment was done for the industry indicator. During that period there was most probably attrition and dropout bias, which the variance of the indicator is a kind of measure of. The question that can not be answered here but should further be looked at is whether the variance has a predictive power or if it acts as a correction for the attrition and/or dropout bias in the survey.

Nonparametric tests of attrition bias as proposed in Das et al. (2011) could be adapted and applied to the case of the Belgian business survey. A further step to study attrition would be to use panel refreshments to test for presence of attrition as proposed in (Van Landeghem, 2014).

Other modelling techniques

The next step considering predictive power of the new indicators is including them in other nowcasting models and compare performances. Markov Switching (MS) models (Hamilton, 1989) are an interesting modelling approach regarding business cycles. An example is the MS model applied to the French business survey Bardaji et al. (2009). Another approach is the MS modelling proposed in Duprey and Klaus (2017), which is using variables in the estimation of the probability of change of regime. The modelling technique is then close to a logistic regression. Another approach could be to combine mixed models and Markov Chain for Panel Data as done in (de Haan-Rietdijk et al., 2017).

State-Space models, which are already implemented at the NBB, would be interesting to test the importance of the new variables in the short term prediction of GDP. Other possible modelling procedures are Auto-Regressive Distributed Lag Models (ARDL), Mixed Data Sampling Regressions (MIDAS), Bridge Models, Bayesian averaging of classical estimates method (Bialowolski et al., 2014) and more.

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Appendix

I Questions taken into account for the calculation of the industry business survey

Originally numbered question 18, 27, 32 and 33 (see page 54), for simplicity numbered here as 1, 2, 3 and 4. Note that the first question is interpreted in the opposite way from the three others. Having a higher stock than normal is considered a "negative" answer while lower stock is considered "positive".

Course and assessment

1. You would consider your current stock of this product, for the season, as:
   □ higher than normal (too high) □ normal (sufficient) □ lower than normal (too low)

2. Your current aggregate order position for this product is what you consider to be:
   □ higher than normal □ normal □ lower than normal

Prospects for the next three months

3. The personnel (workers and technicians) employed for the manufacture of this product will, according to you:
   □ be expanded □ remain unchanged □ be reduced

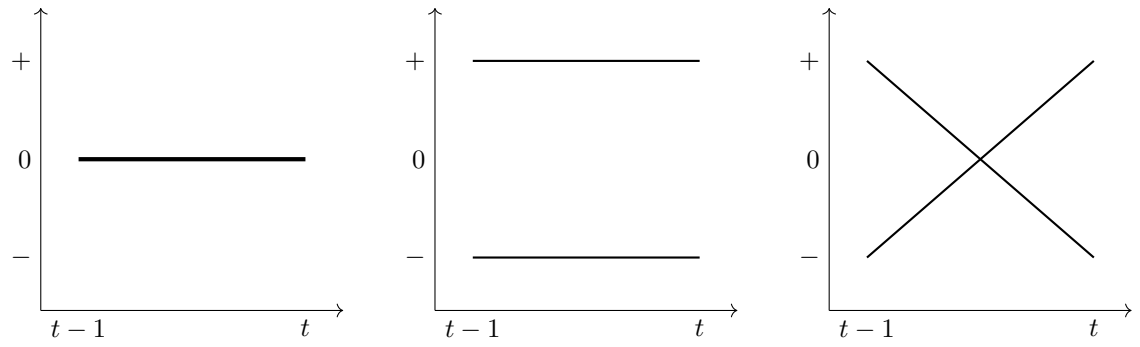
4. The demand of your customers for this product will, in your opinion:
   □ be more important □ be equally important □ be less important
   as usual at that time of the year.

II Further explanations regarding the variance of the BSI, the EIR and the variance of the EIR

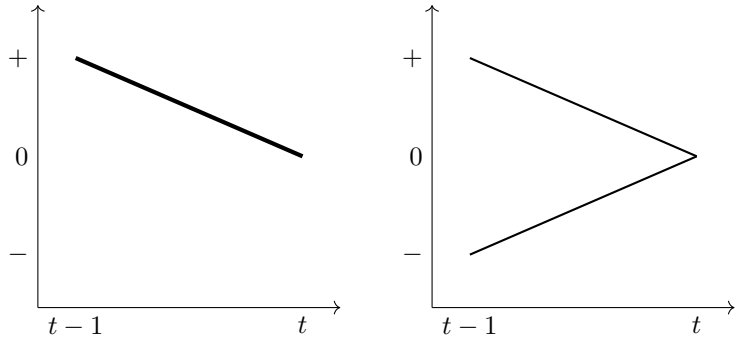
When taking a very simplified situation where there are only two respondents over a 2 months period and only taking one question into account. Five different situations are taken that will help to further understand and interpret the business survey indicator, the evolution of individual responses and their respective variances. The five different situations all have a BSI equal to zero at time t, while different Var(BSI), EIR and Var(EIR).

Table 1: Five possible situations of a simplified business survey with only two respondents over a two months period

situation	respondent 1	respondent 2	BSI	Var(BSI)	EIR	Var(EIR)
1	neutral → neutral	neutral → neutral	0	0	0	0
2	positive → positive	negative → negative	0	1	0	0
3	positive → negative	negative → positive	0	1	0	4
4	positive → neutral	positive → neutral	0	0	-1	0
5	positive → neutral	negative → neutral	0	0	0	1



(a) Situation 1 (b) Situation 2 (c) Situation 3



(d) Situation 4 (e) Situation 5

Figure 1: Plots of five possible situations of a simplified business survey with only two respondents over a two months period

By looking at Table 1 and Figure 1 it can be seen that in situation one everyone is neutral which means that all the indicators are equal to one. Situation two is slightly

different, since the two respondents hardly disagree and keep the same answer over at $t-1$ and at t. Situation three is again a situation where respondents disagree but now also change radically their answer over a two months period. So the two variances are at their highest. Situation four is a situation where the two respondents were positive the previous month and are now both neutral. Their variances are equal to zero since they both agree and they changed their answer the same but EIR is equal to -1 since compared to the previous month they decreased their answer. In situation five they disagreed largely the previous month but now are both neutral so only their variance of EIR is not equal to zero.

This explanation shows the interest of the four different indicators that each show different information about the responses.

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Kruis per vraag, het vakje aan dat overeenstemt met uw antwoord en stuur per product uw antwoorden binnen de 10 dagen terug. U kunt gebruik maken van ons gratis faxnummer 0800 95 969 (enkel geldig binnen België) of van het faxnummer + 32 (0)2 221 31 07 (vanuit het buitenland).

Product: **OKTOBER 2018**

Gelieve enkel voor het hierboven vermelde product te antwoorden. Vermeld alle schommelingen, zelfs indien ze van geringe omvang zijn. Antwoord elke maand op alle vragen. Indien u in de beschouwde maand het product niet heeft geproduceerd (of geen bestellingen heeft ontvangen), vermeldt u "verminderd". Antwoord "onveranderd" gedurende de maand(en) dat deze toestand voortduurt totdat de productie herneemt. Uw antwoorden worden strikt vertrouwelijk behandeld.

Verloop en beoordeling

- Uw productietempo voor dit product is in september 2018 t.o.v. augustus 2018:

  15 ☐ 1 versneld ☐ 5 onveranderd ☐ 9 vertraagd

  Hou geen rekening met schommelingen als gevolg van het maandelijks veranderlijke aantal werkdagen of betaald verlof.

  Tijdens de afgelopen 3 maanden was de trend van uw productie voor dit product:

  16 ☐ 1 stijgend ☐ 5 onveranderd ☐ 9 dalend

  Hou evenwel geen rekening met louter seizoengebonden schommelingen.

- Uw verkoopprijzen voor dit product zijn in september 2018 t.o.v. augustus 2018:

  17 ☐ 1 gestegen ☐ 5 onveranderd ☐ 9 gedaald

  Geef de tendens van uw prijzen aan op basis van uw contracten of uw aanbiedingen.

- Uw huidige voorraad van dit product beschouwt u, voor het seizoen, als:

  18 ☐ 1 hoger dan normaal (te hoog) ☐ 5 normaal (voldoende) ☐ 9 lager dan normaal (te laag)

  Kruis "niet van toepassing" aan indien u nooit voorraad hebt van dit product. ☐ niet van toepassing

  Bij het beantwoorden van de volgende twee vragen (22 en 26), mag u geen melding maken van de zuivere seizoenschommelingen die het verloop van de bestellingen gedurende de maand september 2018 kunnen hebben beïnvloed. De werkelijke tendens van de bestellingen moet dus tot uiting komen.

- Uw ontvangen bestellingen voor dit product vanwege de binnenlandse markt zijn in september 2018 t.o.v. augustus 2018:

  22 ☐ 1 vermeerderd ☐ 5 onveranderd ☐ 9 verminderd

  Hou eveneens rekening met de van andere afdelingen van uw firma ontvangen bestellingen en met loonwerk.

  Kruis "niet van toepassing" aan indien u dit product nooit op de binnenlandse markt levert. ☐ niet van toepassing

- Uw ontvangen bestellingen voor dit product vanwege de buitenlandse markt zijn in september 2018 t.o.v. augustus 2018:

  26 ☐ 1 vermeerderd ☐ 5 onveranderd ☐ 9 verminderd

  Hou eveneens rekening met loonwerk.

  Kruis "niet van toepassing" aan indien u dit product nooit op de buitenlandse markt levert. ☐ niet van toepassing

- Uw huidige gezamenlijke orderpositie voor dit product beschouwt u als:

  27 ☐ 1 hoger dan normaal ☐ 5 normaal ☐ 9 lager dan normaal

  Indien uw onderneming uitsluitend uit voorraad levert, dient u "orderpositie" op te vatten als "het peil van de vraag" naar dit product.

- Indien u het huidige fabricatietempo voor dit product handhaaft, is uw activiteit nog verzekerd voor ongeveer:

  28 ☐☐ , ☐ maand(en) en/of gedeelten van een maand.

  Te ramen op basis van uw orderpositie of, bij gebrek hieraan, op basis van uw productieplannen.

- Uw huidige positie inzake bestellingen uit het buitenland voor dit product beschouwt u als:

  31 ☐ 1 hoger dan normaal ☐ 5 normaal ☐ 9 lager dan normaal

  Indien uw onderneming uitsluitend uit voorraad levert, dient u uw buitenlandse orderpositie op te vatten als "het peil van de buitenlandse vraag" naar dit product.

  Kruis "niet van toepassing" aan indien u dit product nooit uitvoert. ☐ niet van toepassing

Vooruitzichten voor de volgende drie maanden

- Het personeel (arbeiders en technici) tewerkgesteld voor de fabricatie van dit product zal volgens u:

  32 ☐ 1 worden uitgebreid ☐ 5 onveranderd blijven ☐ 9 worden verminderd

  Het invoeren van gedeeltelijke werkloosheid dient als een vermindering van het personeel te worden beschouwd.

- De vraag van uw klanten naar dit product zal volgens u:

  33 ☐ 1 belangrijker ☐ 5 even belangrijk ☐ 9 minder belangrijk

  zijn dan gewoonlijk tijdens die periode van het jaar.

  Geef enkel de tendens van de vraag van de klanten weer en laat derhalve de zuivere seizoenschommelingen buiten beschouwing.

- Uw productie zal voor dit product volgens u:

  36 ☐ 1 toenemen ☐ 5 gelijk blijven ☐ 9 afnemen

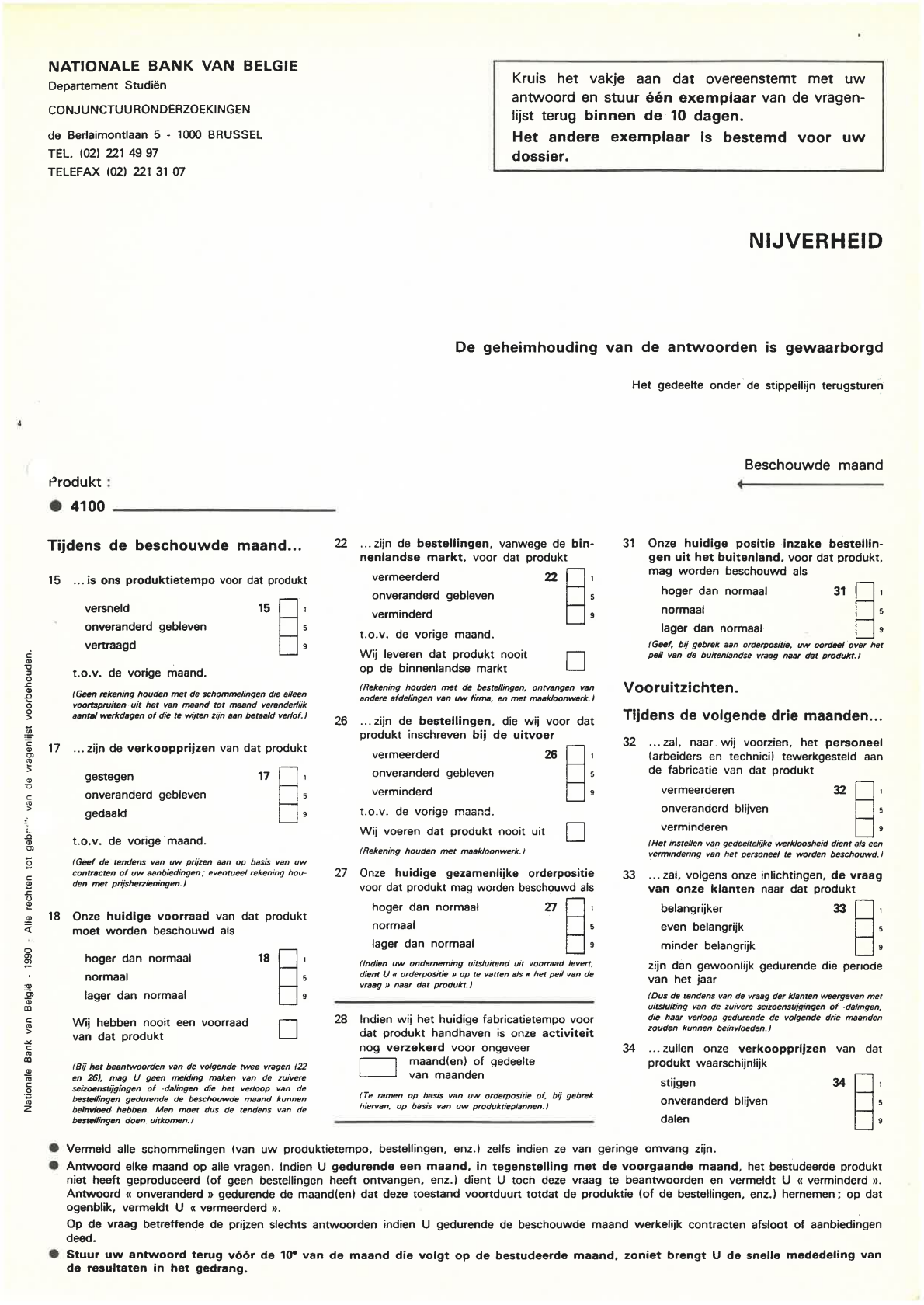
- Uw verkoopprijzen van dit product zullen volgens u:

  34 ☐ 1 stijgen ☐ 5 onveranderd blijven ☐ 9 dalen

4100N

REFERENTIE:
Enquête:

Figure 2: The Business Survey Questionnaire in Dutch for the Industrial Sector in 2018



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Kruis het vakje aan dat overeenstemt met uw antwoord en stuur **één exemplaar** van de vragenlijst terug **binnen de 10 dagen.**
Het andere exemplaar is bestemd voor uw dossier.

NIJVERHEID

De geheimhouding van de antwoorden is gewaarborgd

Het gedeelte onder de stippellijn terugsturen

Beschouwde maand ←

Produkt :
● **4100** _____

Tijdens de beschouwde maand...

15 ... **is ons produktietempo** voor dat produkt
- versneld — **15** — 1
- onveranderd gebleven — 5
- vertraagd — 9

t.o.v. de vorige maand.

(Geen rekening houden met de schommelingen die alleen voortspruiten uit het van maand tot maand veranderlijk aantal werkdagen of die te wijten zijn aan betaald verlof.)

17 ... zijn de **verkoopprijzen** van dat produkt
- gestegen — **17** — 1
- onveranderd gebleven — 5
- gedaald — 9

t.o.v. de vorige maand.

(Geef de tendens van uw prijzen aan op basis van uw contracten of uw aanbiedingen; eventueel rekening houden met prijsherzieningen.)

18 Onze **huidige voorraad** van dat produkt moet worden beschouwd als
- hoger dan normaal — **18** — 1
- normaal — 5
- lager dan normaal — 9

Wij hebben nooit een voorraad van dat produkt ☐

(Bij het beantwoorden van de volgende twee vragen (22 en 26), mag U geen melding maken van de zuivere seizoenstijgingen of -dalingen die het verloop van de bestellingen gedurende de beschouwde maand kunnen beïnvloed hebben. Men moet dus de tendens van de bestellingen doen uitkomen.)

22 ... zijn de **bestellingen**, vanwege de **binnenlandse markt**, voor dat produkt
- vermeerderd — **22** — 1
- onveranderd gebleven — 5
- verminderd — 9

t.o.v. de vorige maand.

Wij leveren dat produkt nooit op de binnenlandse markt ☐

(Rekening houden met de bestellingen, ontvangen van andere afdelingen van uw firma, en met maakloonwerk.)

26 ... zijn de **bestellingen**, die wij voor dat produkt inschreven **bij de uitvoer**
- vermeerderd — **26** — 1
- onveranderd gebleven — 5
- verminderd — 9

t.o.v. de vorige maand.

Wij voeren dat produkt nooit uit ☐

(Rekening houden met maakloonwerk.)

27 Onze **huidige gezamenlijke orderpositie** voor dat produkt mag worden beschouwd als
- hoger dan normaal — **27** — 1
- normaal — 5
- lager dan normaal — 9

(Indien uw onderneming uitsluitend uit voorraad levert, dient U « orderpositie » op te vatten als « het peil van de vraag » naar dat produkt.)

28 Indien wij het huidige fabricatietempo voor dat produkt handhaven is onze **activiteit** nog **verzekerd** voor ongeveer ____ maand(en) of gedeelte van maanden

(Te ramen op basis van uw orderpositie of, bij gebrek hiervan, op basis van uw produktieplannen.)

31 Onze **huidige positie inzake bestellingen uit het buitenland**, voor dat produkt, mag worden beschouwd als
- hoger dan normaal — **31** — 1
- normaal — 5
- lager dan normaal — 9

(Geef, bij gebrek aan orderpositie, uw oordeel over het peil van de buitenlandse vraag naar dat produkt.)

Vooruitzichten.

Tijdens de volgende drie maanden...

32 ... zal, naar wij voorzien, het **personeel** (arbeiders en technici) tewerkgesteld aan de fabricatie van dat produkt
- vermeerderen — **32** — 1
- onveranderd blijven — 5
- verminderen — 9

(Het instellen van gedeeltelijke werkloosheid dient als een vermindering van het personeel te worden beschouwd.)

33 ... zal, volgens onze inlichtingen, **de vraag van onze klanten** naar dat produkt
- belangrijker — **33** — 1
- even belangrijk — 5
- minder belangrijk — 9

zijn dan gewoonlijk gedurende die periode van het jaar

(Dus de tendens van de vraag der klanten weergeven met uitsluiting van de zuivere seizoenstijgingen of -dalingen, die haar verloop gedurende de volgende drie maanden zouden kunnen beïnvloeden.)

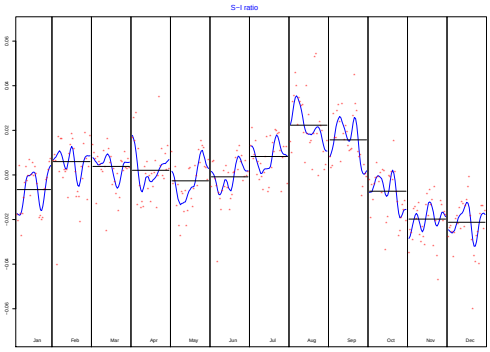
34 ... zullen onze **verkoopprijzen** van dat produkt waarschijnlijk
- stijgen — **34** — 1
- onveranderd blijven — 5
- dalen — 9

● Vermeld alle schommelingen (van uw produktietempo, bestellingen, enz.) zelfs indien ze van geringe omvang zijn.

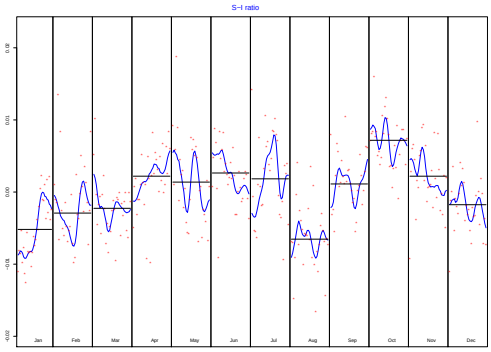
● Antwoord elke maand op alle vragen. Indien U **gedurende een maand, in tegenstelling met de voorgaande maand**, het bestudeerde produkt niet heeft geproduceerd (of geen bestellingen heeft ontvangen, enz.) dient U toch deze vraag te beantwoorden en vermeldt U « verminderd ». Antwoord « onveranderd » gedurende de maand(en) dat deze toestand voortduurt totdat de produktie (of de bestellingen, enz.) hernemen; op dat ogenblik, vermeldt U « vermeerderd ».
Op de vraag betreffende de prijzen slechts antwoorden indien U gedurende de beschouwde maand werkelijk contracten afsloot of aanbiedingen deed.

● **Stuur uw antwoord terug vóór de 10e van de maand die volgt op de bestudeerde maand, zoniet brengt U de snelle mededeling van de resultaten in het gedrang.**

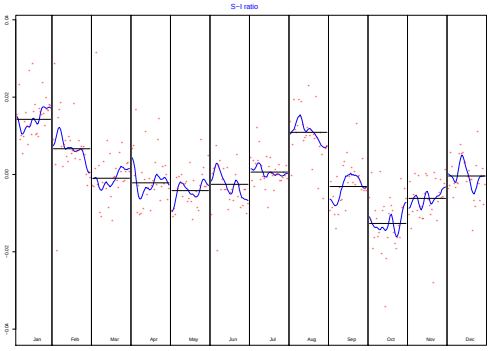
Figure 3: The Business Survey Questionnaire in Dutch for the Industrial Sector in 1990



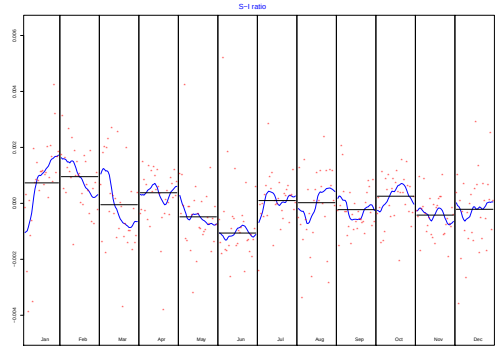
(a) BSI



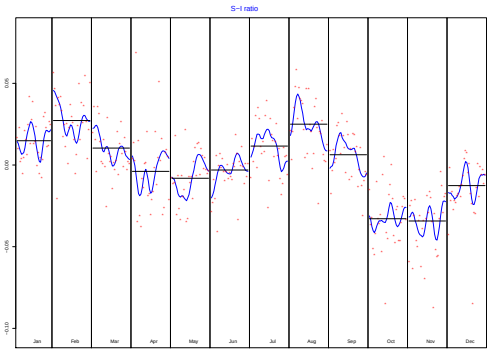
(b) Var(BSI)



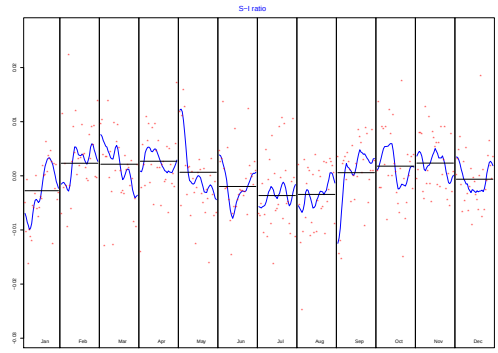
(c) EIR1



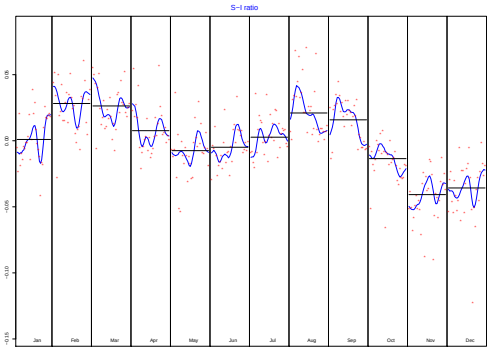
(d) Var(EIR1)



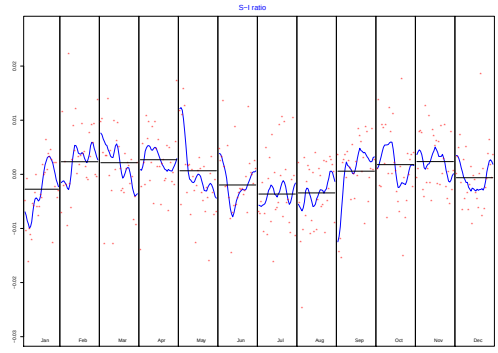
(e) EIR2



(f) Var(EIR2)



(g) EIR3



(h) Var(EIR3)

Figure 4: S-I ratio chart for the different variables

Code

R code for seasonal adjustments

https://github.com/fabricevb/Master-Thesis/blob/master/R Code/Seasonal Correction model data.R

R code for correlation analysis

https://github.com/fabricevb/Master-Thesis/blob/master/R Code/Correlations.R

R code for linear models

https://github.com/fabricevbMaster-Thesis/blob/master/R Code/Linear Models.R

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