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The Variability of the Belgian Business Survey Indicator

Analysis and Predictive Power

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"Statistics are the heart of democracy."
Simeon Strunsky

Abstract

Abstract

This Master Thesis explores the variance of the Belgian business survey.

Several finding concerning the nature and properties of the variance wher found as the bounds and relation with the mean.

An indicator, called the evolution of individual responses, was explored and developed.

In a second part, the predictive power of the variance and the new indicator of evolution in individual responses is examined and it's found that, the variance of the indicator improves the fit of a linear model and it's predictions

Samenvatting

Keywords

Business Surveys - Business Barometer - Trichotomous Observations - Survey Variance - Survey Volatility -

List of Abbreviations

BSI	Business Survey Indicator/Barometer
Cor	Correlation
Cov	Covariance
ECB	European Central Bank
EIR	Evolution in individual Responses
Eurostat	The European Statistical Office
GDP	Gross Domestic Product
INSEE	Institut national de la statistique et des études économiques (France)
NBB	The National Bank of Belgium
NBER	The National Bureau of Economic Research (US)
NSI	National Statistics Institutes
Var	Variance
YoY	Year on Year

Contents

CHAPTER 1

Introduction

The business survey is organised within the National Bank of Belgium. Each month the business survey indicator is published based on around 3000 respondents who are part of a large panel of companies.

The publication is important for public and private organisation to have a direct idea of the evolution of the Belgian economy since most of the quantitative macroeconomic indicators are published with a lag of at least a month.

A widespread method to predict the evolution of National Economies is the survey-based business indicator. Belgium have been collecting this indicator for more than 60 years. This long evolution

- Talk about tradition of improving BSI

This Thesis is included in the continuity of a long tradition of papers proposing improvement and ways to add value to the Business Barometer (.....) will propose ways to add information to the Belgian Business Barometer, that could also be applied to others

Since 1968, the National Bank of Belgium publishes each month the national

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CHAPTER 2

The Business Survey Indicator

This first 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 by 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, small by small 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 2.4.

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 got 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, it's indicator is on the homepage of the National Bank website and is used in several predictive models.

2.2 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 the 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 trees of sub-sectors, sub-sub-sectors, and more. For example, the industry sector is divided into more than 300 sub-sectors / branches 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 section 2.4.2 more in detail, companies are weighted by there size (profit, number of employees, ...) and the size of the sector/branch 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 that 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 have 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 aren't publicly distributed. This can give them

economical information regarding there 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 work/collaborate with them. New companies can be included in the survey outside of this procedure but this happens more 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 in it until they decide to leave, there are no participants removed from the survey by the National Bank, what can happen is that if participants don't answer for three months, contact will be taken with the company to see if they want to continue to participate.

There are resources put by the National Bank to make sure companies answer to the survey, and stay in it. This means that some companies are part of the survey for a very long time. To have an idea, if we look at the survey for the industry and trace respondents back to 30 years ago (1989), we can see 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 over 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 that it is representing. Therefore stratification is used at a quite advanced level as explained before. We could call this recruitment method: 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 doesn't have interest on its own. Indeed having a BSI equal to 0.5 or 0.1 doesn't mean much, 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 we can forecast an increase of GDP over the month. On the other hand, if it's now equal to 0.1, it means a decrease in economic confidence among businesses and we can anticipate a deceleration or decline of the economy over the month.

2.3 Objectives of the Business Survey

The main objective of the business survey barometer is to have a feeling of how the economy is now and how it will evolve in the short term. We will here decompose the main objectives of the business survey into 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 in common the importance, the need, of only capturing the real evolution of the economy, without taking into account short term noise/variation as seasonal effects or bias that could erupt due to the survey method. This will be looked into in chapter 6 where seasonal effects, dropout, non-response, and attrition will be discussed.

2.3.1 Belgian economy and sector-specific short term evolution

The business survey indicators are published at the end of each month (around the 21-25 of the month) and give a fast capture 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, can take a very long time before been published.

2.3.2 Nowcasting

Also called "flash" estimation, nowcasting has increasingly gain importance in the last decade. it consists of 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 indicator's 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 24-25th of each month), while the GDP is published with a lag of 3 to 4 weeks and is subject to revision.

If we look at Figure 2.1 we can see that at the end of the month of January, the GDP is published for the last quarter of the previous month, so the information is already out-dated of some weeks, when the business survey indicator is published for the month of January around the same date. After the publication end of January, observers of the economy have to way three months to have new information about the GDP, while each month, the BSI is published and available for everyone.

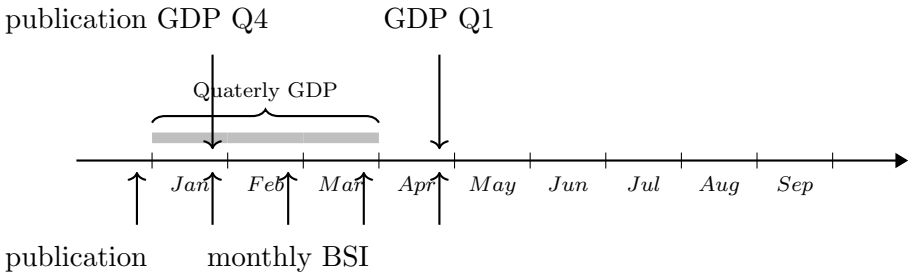

Figure 2.1: Timeline of the period and the publication of the business survey indicator (BSI) and the Gross Domestic Product (GDP)

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.

A good example of nowcasting is the model explained in de Antonio Liedo (2014) which is a State-Space model developed at the NBB. It takes into account a lot of different predictive variables to predict the actual state of

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.

2.3.3 Business Cycles

In 1946, Mitchell and Burns defined a business cycle 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 follow

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

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

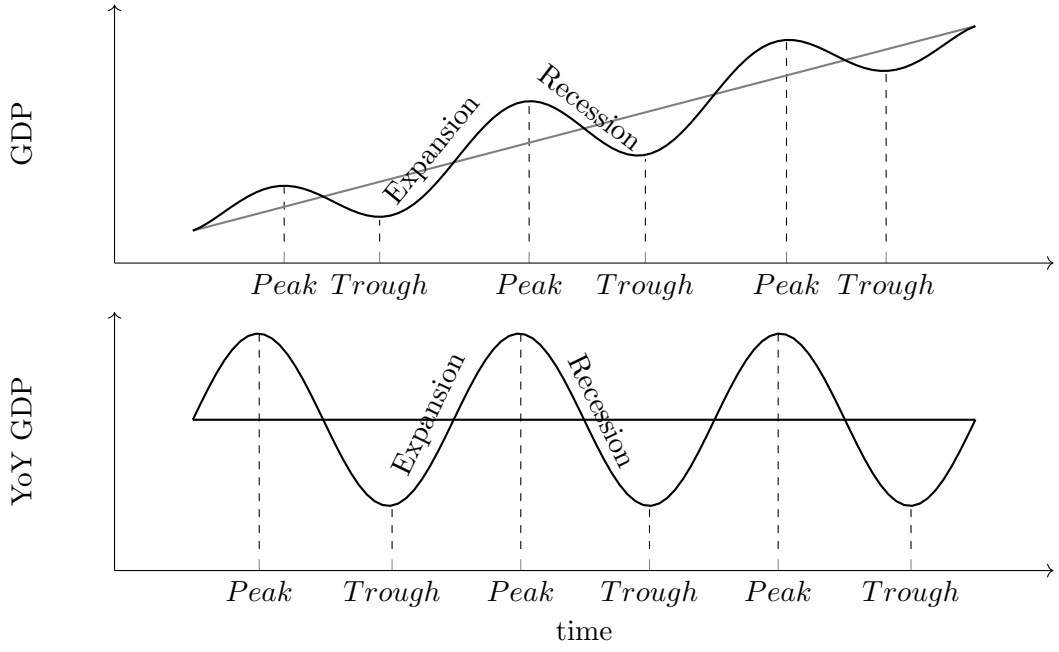

Figure 2.2: The Business Cycle theory of GDP and Year on Year GDP

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.

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 where done even though business cycles are rather empirically defined than theory based. Therefore let 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) dated precisely and methodologically 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.

We can see from Figure 2.3, which represent 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. We can notice that periods of economic growth, usually last longer than economical decrease.

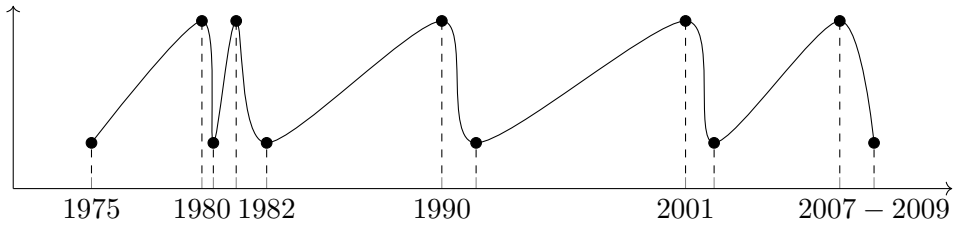

Figure 2.3: Business cycles from 1975 to 2009 of the American Economy according to the NBER

2.4 Methodology of the Business Survey

Since 65 years of existence, the business survey was able to evolve without losing in long term comparability.

Three main methodology revisions since the launch of the business survey, in 1983, 1990 and 2009 (see De Greef and Van Nieuwenhuyze (2009)). The most significant changes brought in 2009 where 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.

2.4.1 Questionnaire

The questionnaire exists in two languages, french and dutch (see Appendix page 48). It can be answered by mail, email, over the phone or by fax. It is divided into two part: (1) questions concerning there current production and level of activity (*"verloop en beoordeling"*) and (2) questions concerning their predictions, how they expect their level of activity to evolve 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 confidence companies are in the Belgian economy. Almost all the questions have only three possible answers. Each time the answers can be interpreted as a negative, neutral or positive and are later treated so as will be seen when calculating the indicator.

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 page 49) and can be compared to a more recent version (see appendix page 48).

The layout was modified, and the phrasing of the questions changed over this long period. It was before 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 would 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, we will leave this study to future research. What we can say, 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.

A further look into the four questions taken into account for the calculation of the industry business survey indicator (the NS975) can be found in the appendix (see page 44).

2.4.2 Weighting procedure

The different companies participating in the business survey have all two weights; (1) according to the size of the company and (2) according to the size of the sector branch which the company is part of.

The weight size 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.

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. Ones the new weight is calculated, the transition between the old and new weight is smoothened over a year.

Regarding the globalisation weighting procedure, the National Bank of Belgium developed an elaborate division of the Belgian economic activity. This means that for example, the industry is subdivided into different sub-sectors, that they self 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 need to be multiply.

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 taking the two weighting procedures into account (ω_i), is obtained by dividing its weight coefficient by the total of weight coefficients within the lowest level of globalisation and multiply it with the weight of globalisation it's part of.

2.5 Calculation of the 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 to better understand of the indicator and the following chapters. We first present the calculation taking into account one question unweighted and then

weighted. After we will present how different questions are combined together to obtain a business survey indicator.

2.5.1 Unweighted 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;

$$E(X) = \frac{\sum_{i=1}^{n} x_i}{n} \tag{2.3}$$

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, we can decompose it into

$$E(X) = \frac{\sum_{i=1}^{n_+} x_{+i} + \sum_{i=1}^{n_0} x_{0i} + \sum_{i=1}^{n_-} x_{-i}}{n} \tag{2.4}$$

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

Since we know that $\sum_{i=1}^{n} x_{0i} = 0$, we can write

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

$\sum_{i=1}^{n} x_{+i}/n$ is the proportion of positive answers and $\sum_{i=1}^{n} x_{-i}/n$ is the negative proportion of negative answer. We can write, for simplicity

$$E(X) = \pi_+ - \pi_- \tag{2.6}$$

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

2.5.2 Weighted Indicator

As described in section 2.4.2, each respondent has two different weights: one according to its size, one according to the size of the sector it's part of. Those weights are then combined and we end up with a specific weight ω_i. We have now the following equation for the indicator

$$E(X) = \sum_{i=1}^{n} \omega_i x_i \quad \text{where } \sum_{i=1}^{n} \omega_i = 1 \tag{2.7}$$

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 here standardised so there sum is equal to one.

As for the unweighted indicator, we can decompose the equation by the three possible answers with, in this case, their according weights.

$$E(X) = \sum_{i=1}^{n_+} \omega_{+i} x_{+i} + \sum_{i=1}^{n_0} \omega_{0i} x_{0i} + \sum_{i=1}^{n_-} \omega_{-i} x_{-i} \tag{2.8}$$

and again we know that $\sum_{i=1}^{n} \omega_{0i} x_{0i} = 0$, so we can write

$$E(X) = \sum_{i=1}^{n_+} \omega_{+i} x_{+i} + \sum_{i=1}^{n_-} \omega_{-i} x_{-i} \tag{2.9}$$

We also know that $x_{+i} = 1$ and $x_{-i} = -1$

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

That we will write as follow

$$E(X) = \Omega\pi_+ - \Omega\pi_- \tag{2.11}$$

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

$\Omega\pi$ is used here also in the probabilistic way as it can also be seen as the probability that a respondent answers positive, negative or neutral ($\Omega\pi_0$) with $\Omega\pi_+ + \Omega\pi_0 + \Omega\pi_- = 1$. Here we speak of weighted proportions/probabilities.

From Equation 2.6 and Equation 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 everyone has a negative answer, and is the largest when every answer is positive.

2.5.3 Take 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 we will be interested in is composed of four questions:

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

where $E(X_{Q1})$, $E(X_{Q2})$, $E(X_{Q3})$ and $E(X_{Q4})$ are the different averages for question 18, 27, 32 and 33 (can be weighted or unweighted).

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

$$\begin{aligned} \text{Unweighted industry BSI} &= (\pi_{Q1+} + \pi_{Q2+} + \pi_{Q3+} + \pi_{Q4+} \\ &\quad -\pi_{Q1-} - \pi_{Q2-} - \pi_{Q3-} - \pi_{Q4-}) \end{aligned} \tag{2.13}$$

and regarding the weighted indicator, it can be written as

$$\begin{aligned} \text{Weighted Industry BSI} &= 1/4(\pi_{Q1+} + \Omega\pi_{Q2+} + \Omega\pi_{Q3+} + \Omega\pi_{Q4+} \\ &\quad -\Omega\pi_{Q1-} - \Omega\pi_{Q2-} - \Omega\pi_{Q3-} - \Omega\pi_{Q4-}) \end{aligned} \tag{2.14}$$

The general formula for the weighted business survey indicator when taking several questions into account is

$$\text{Unweighted BSI} \quad = \quad 1/n(\pi_{1+} + \pi_{2+} + \ldots + \pi_{n+} - \pi_{1-} - \pi_{2-} - \pi_{Qn-}) \tag{2.15}$$

While the formula for the weighted business survey indicator when taking several questions into account is

$$\text{Weighted BSI} \quad = \quad 1/n(\pi_{1+} + \Omega\pi_{2+} + \ldots + \Omega\pi_{n+} - \Omega\pi_{1-} - \Omega\pi_{2-} - \ldots - \Omega\pi_{Qn-}) \tag{2.16}$$

CHAPTER 3

The Variance of the Indicator

The variance is, with the mean, one of the first tool for statisticians to study 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 people (dis)agree on the present state of the Belgian economy", a piece of important information that we can extract 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. It will then be looked into its properties and specificities. The last section will present the method of calculation when different questions are taken into account.

3.1 Variance of the Unweighted Indicator

The formula of the variance can be written as

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

In the case of one question of the business survey indicator, we decompose and develop the equation as follow

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

Since the positive and negative answers take value -1 and 1, which means that $x_{+i}^2 = x_{+i}$ and $x_{-i}^2 = |x_{-i}|$. We also know that $\left(\frac{\sum_{i=1}^{n_0} x_{0i}^2}{n}\right) = 0$. With this information, we can further simplify the equation to

$$\text{Var}(X) = \pi_+ + \pi_- - E(X)^2 \tag{3.3}$$

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.

Since $\text{E}(X) = \pi_+ - \pi_-$, and $\pi_+ + \pi_- = 1 - \pi_0$ (from $\pi_+\pi_0 + \pi_- = 1$). It's possible to write the variance in several different ways;

$$\begin{aligned} \text{Var}(X) &= \pi_+ + \pi_- - E(X)^2 \\ &= \pi_+ + \pi_- - (\pi_+ - \pi_-)^2 \qquad (3.4) \\ &= 1 - \pi_0 - E(X)^2 \qquad (3.5) \end{aligned}$$

3.2 Variance of the Weighted Indicator

We can now do the same for the weighted indicator. The equation is very similar to the variance of the unweighted variance;

$$\begin{aligned} \text{Var}(X) &= E\left(X^2\right) - E\left(X\right)^2 \\ &= \sum_{i=1}^{n_+} \omega_i x_{+i}^2 + \sum_{i=1}^{n_0} \omega_i x_{0i}^2 + \sum_{i=1}^{n_-} \omega_i x_{-i}^2 - E(X)^2 \end{aligned} \tag{3.6}$$

As we did for the indicator, we will develop the equation by taking into account weighted proportion and write the equation the same way as for the unweighted variance. Again the variance can be written in different ways;

$$\begin{aligned} \text{Var}(X) &= \Omega\pi_+ + \Omega\pi_- - (\Omega\pi_+ - \Omega\pi_-)^2 \qquad (3.7) \\ &= \Omega\pi_+ + \Omega\pi_- - E(X)^2 \qquad (3.8) \\ &= 1 - \Omega\pi_0 - E(X)^2 \qquad (3.9) \end{aligned}$$

3.3 Properties

Based on the previous development of the equation of the variance of the indicator, we can make some observations.

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 3.5 and see that π_0 and $\text{E}(X)^2$ can only take positive values, π_0 because it's a proportion

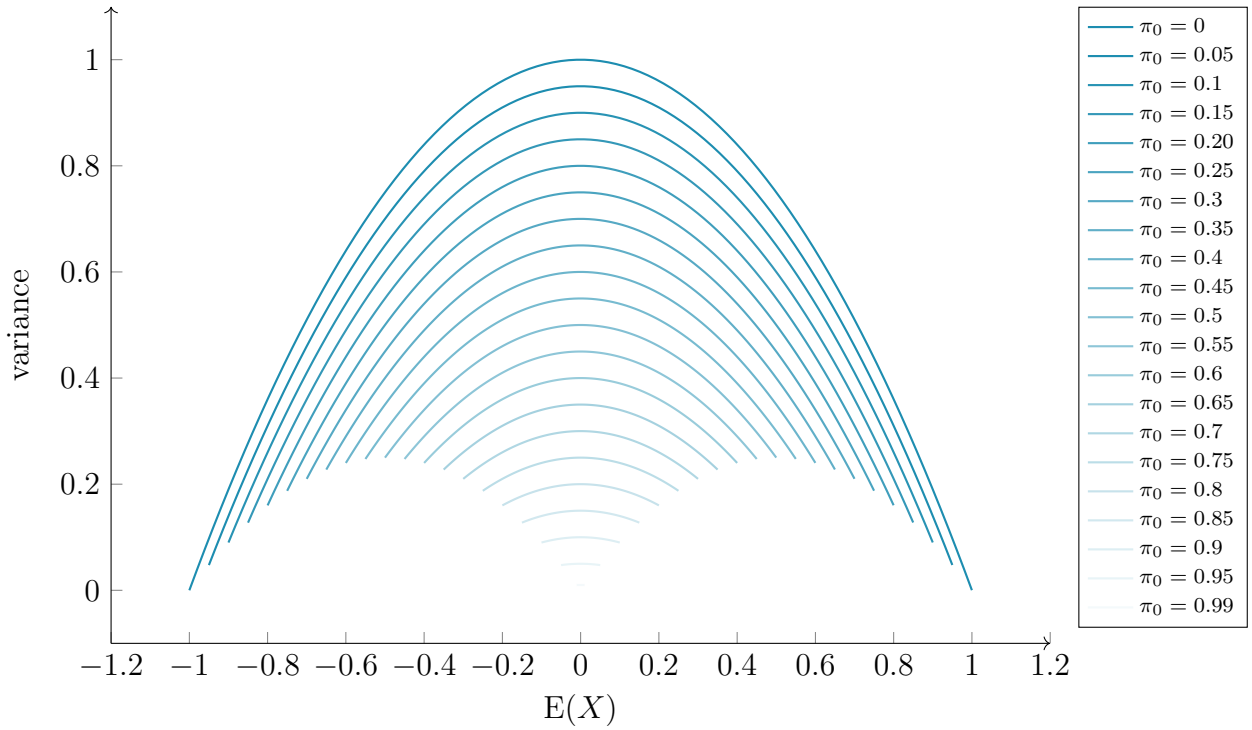

Figure 3.1: Plot of the possible values of the indicator (X axis) and variance (Y axis) for different values of π_0

and $\mathrm{E}(X)^2$ since it's 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 answer "neutral" and the BSI is equal to 0. This only happens if half of the respondent's answers "positive", and the other half "negative". It corresponds to the interpretation since it's the situation with the most disagreement among respondents. In 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 3.5 or Equation 3.9. 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 indicators ($\mathrm{Var}(X)$, π_0 and $\mathrm{E}(X)$), it's very easy to calculate the third. This means that the three variables are correlated.

3.4 Take different questions into account

As already seen, the published indicator take 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

$$\mathrm{Var}\left(\sum_{i=1}^{n} X_i\right) = \sum_{i=1}^{n}\sum_{j=1}^{n} \mathrm{Cov}\left(X_i, X_j\right) = \sum_{i=1}^{n} \mathrm{Var}\left(X_i\right) + 2\sum_{1\leq i<j\leq n} \mathrm{Cov}\left(X_i, X_j\right) \quad (3.10)$$

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

$$\begin{aligned}\mathrm{Var}\left(\frac{X_{Q1}+X_{Q2}+X_{Q3}+X_{Q4}}{4}\right) &= \frac{1}{16}[\mathrm{Var}(X_{Q1})+\mathrm{Var}(X_{Q2})+\mathrm{Var}(X_{Q3})+\mathrm{Var}(X_{Q4}) \\ &\quad +2\,\mathrm{Cov}(X_{Q1},X_{Q2})+2\,\mathrm{Cov}(X_{Q1},X_{Q3})+2\,\mathrm{Cov}(X_{Q1},X_{Q4}) \\ &\quad +2\,\mathrm{Cov}(X_{Q2},X_{Q3})+2\,\mathrm{Cov}(X_{Q2},X_{Q4})+2\,\mathrm{Cov}(X_{Q3},X_{Q4})] \end{aligned} \quad (3.11)$$

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, we can write it as follow

$$\begin{aligned}\mathrm{Var}\left(\frac{X_{Q1}+X_{Q2}+X_{Q3}+X_{Q4}}{4}\right) &= \frac{1}{16}\,\mathrm{Var}\left(\frac{\sum_{i=1}^{n}\left(x_{iQ1}+x_{iQ2}+x_{iQ3}+x_{iQ4}\right)}{n}\right) \\ &= \frac{1}{16}\,\mathrm{Var}\left(\pi_{1+}+\pi_{2+}+\pi_{3+}+\pi_{4+}-\pi_{1-}-\pi_{2-}-\pi_{3-}-\pi_{4-}\right)\end{aligned} \quad (3.12)$$

The generalisation of the previous equation can be written as follow for the variance of the unweighted indicator

$$\begin{aligned}\mathrm{Var}\left(\frac{X_{Q1}+X_{Q2}+\ldots+X_{Qn}}{n_Q}\right) &= \frac{1}{n_Q^2}\,\mathrm{Var}\left(\frac{\sum_{i=1}^{n}\left(x_{iQ1}+x_{iQ2}+...+x_{iQn}\right)}{n}\right) \\ &= \frac{1}{n_Q^2}\,\mathrm{Var}\left(\pi_{1+}+\pi_{2+}+\ldots+\pi_{n+}-\pi_{1-}-\pi_{2-}-\ldots-\pi_{n-}\right)\end{aligned} \quad (3.13)$$

and as follow for the variance of the weighted indicator

$$\begin{aligned}\mathrm{Var}\left(\frac{X_{Q1}+X_{Q2}+\ldots+X_{Qn}}{n_Q}\right) &= \frac{1}{n_Q^2}\,\mathrm{Var}\left(\sum_{i=1}^{n}\omega_i\left(x_{iQ1}+x_{iQ2}+...+x_{iQn}\right)\right) \\ &= \frac{1}{n_Q^2}\,\mathrm{Var}(\Omega\pi_{1+}+\Omega\pi_{2+}+\ldots+\Omega\pi_{n+} \\ &\quad -\Omega\pi_{1-}-\Omega\pi_{2-}-\ldots-\Omega\pi_{n-})\end{aligned} \quad (3.14)$$

CHAPTER 4

The Indicator of the Evolution of Individual Responses

In the same logic as for the variance, a proposition is done here of a way to extract more information out of the business survey. As explained in the first chapter, the business survey is answered by the same companies over time. Some new participants join and some companies leaving 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 all 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).

Explanation

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

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

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

The same as for the business survey indicator, the evolution of individual responses take different 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 certain time and the previous answer,

$z_i = 0$. 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". We will here use z rather than x to make a clear distinction between the BSI and the EIR.

$$\text{????????????voir article INSEE } z_i = x_t - x_{t-1} \tag{4.1}$$

the value of the different observations of z_i can be seen in Table 4.2.

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

Table 4.2: Values of the different observations of z_i

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

$$\mathrm{E}(Z) = \frac{\sum_{i=1}^{n} z_i}{n} \tag{4.2}$$

$$= \left(\frac{\sum_{i=1}^{n_{--}} z_{--i}}{n}\right) + \left(\frac{\sum_{i=1}^{n_{-0}} z_{-0i}}{n}\right) + \left(\frac{\sum_{i=1}^{n_{-+}} z_{-+i}}{n}\right) + \left(\frac{\sum_{i=1}^{n_{0-}} z_{0-i}}{n}\right) + \left(\frac{\sum_{i=1}^{n_{00}} z_{00i}}{n}\right) + \left(\frac{\sum_{i=1}^{n_{0+}} z_{0+i}}{n}\right) + \left(\frac{\sum_{i=1}^{n_{+-}} z_{+-i}}{n}\right) + \left(\frac{\sum_{i=1}^{n_{+0}} z_{+0i}}{n}\right) + \left(\frac{\sum_{i=1}^{n_{+-}} z_{+-i}}{n}\right) \tag{4.3}$$

As for the indicator, we will now move from individual responses to proportions, that can be seen in Table 4.3.

		t		
		-	**0**	**+**
$t-1$	**-**	π_{--}	π_{-0}	π_{-+}
	0	π_{0-}	π_{00}	π_{0+}
	+	π_{+-}	π_{+0}	π_{++}

Table 4.3: Proportion of answers for each of the possible combination of answers at time t and t-1

The EIR can now be calculated with the following expression after taking out π_{--}, π_{00} and π_{++} (since $z_{--} = z_{00} = z_{++} = 0$).

$$\mathrm{E}(Z) = \pi_{0+} + \pi_{-0} - \pi_{+0} - \pi_{0-} + 2\pi_{-+} - 2\pi_{+-} \tag{4.4}$$

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

?Interpretation

4.2 Indicator of the Weighted Evolution of Individual Responses

$$\begin{aligned} \mathrm{E}(Z) &= \sum_{i=1}^{n} \omega_i z_i && (4.5) \\ &= \sum_{i=1}^{n_{--}} \omega_i z_{--i} + \sum_{i=1}^{n_{-0}} \omega_i z_{-0i} + \sum_{i=1}^{n_{-+}} \omega_i z_{-+i} + \sum_{i=1}^{n_{0-}} \omega_i z_{0-i} + \sum_{i=1}^{n_{00}} \omega_i z_{00i} \\ &\quad + \sum_{i=1}^{n_{0+}} \omega_i z_{0+i} + \sum_{i=1}^{n_{+-}} \omega_i z_{+-i} + \sum_{i=1}^{n_{+0}} \omega_i z_{+0i} + \sum_{i=1}^{n_{+-}} \omega_i z_{+-i} && (4.6) \end{aligned}$$

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

$$\mathrm{E}(Z) = \Omega\pi_{0+} + \Omega\pi_{-0} - \Omega\pi_{+0} - \Omega\pi_{0-} + 2\Omega\pi_{-+} - 2\Omega\pi_{+-} \quad (4.7)$$

4.3 Generalisation for n time frames

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, of a very specific sector. The idea of only taking a certain month and the previous month can seem non-sufficient, it's 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. We rather propose here a simple generalisation; use t-n rather than t-1. You compare than that period t-n with the answer at time t, without taking the between answers into account.

t-n vs t

come up to the same except that you use a larger period into account

4.4 Take different questions into account

$$\text{Industry evolution of individual responses } = \frac{\sum_{i=1}^{n} \left(z_{iQ1} + z_{iQ2} + z_{iQ3} + z_{iQ4}\right)}{4n} \quad (4.8)$$

weighted

$$\text{Weighted Industry EIR } = \frac{\sum_{i=1}^{n} \omega_i \left(z_{iQ1} + z_{iQ2} + z_{iQ3} + z_{iQ4}\right)}{4} \tag{4.9}$$

$$\text{Industry evolution of individual responses} = \Omega\pi_{0+} + \Omega\pi_{-0} - \Omega\pi_{+0} - \Omega\pi_{0-} + 2\Omega\pi_{-+} - 2\Omega\pi_{+-} \tag{4.10}$$

$$\mathrm{E}(Z) = \Omega\pi_{Q10+} + \Omega\pi_{-0} - \Omega\pi_{+0} - \Omega\pi_{0-} + 2\Omega\pi_{-+} - 2\Omega\pi_{+-} \tag{4.11}$$

$$\text{Industry BSI } = \frac{\pi_{Q1+} + \pi_{Q2+} + \pi_{Q3+} + \pi_{Q4+} - \pi_{Q1-} - \pi_{Q2-} - \pi_{Q3-} - \pi_{Q4-}}{4} \tag{4.12}$$

$$\begin{aligned} \text{Weighted Industry BSI} \quad &= \quad 1/4(\pi_{Q1+} + \Omega\pi_{Q2+} + \Omega\pi_{Q3+} + \Omega\pi_{Q4+} && (4.13) \\ &\quad -\Omega\pi_{Q1-} - \Omega\pi_{Q2-} - \Omega\pi_{Q3-} - \Omega\pi_{Q4-}) && (4.14) \end{aligned}$$

CHAPTER 5

The Variance of the Evolution of Individual Responses

The new indicator, the evolution of individual responses, also has a variance that has some interpretation interest. While the EIR is a measure of the direction companies changes there answer(s), the variance of the EIR can be understood as the measure of changes in answers. Therefore 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.

difference var(BSI) & var(EIR)

The idea is that this variance of EIR is complementary to the estimation of Z since they have two very interesting but different interpretations. Further interpretation will be

5.1 Variance of the Unweighted Evolution of Individual Responses

$$\begin{aligned} Var(Z) &= \pi_{0+} + \pi_{-0} + \pi_{+0} + \pi_{0-} + 4\pi_{-+} + 4\pi_{+-} \\ &\quad -(\pi_{0+} + \pi_{-0} - \pi_{+0} - \pi_{0-} + 2\pi_{-+} - 2\pi_{+-})^2 \\ &= \pi_{0+} + \pi_{-0} + \pi_{+0} + \pi_{0-} + 4\pi_{-+} + 4\pi_{+-} - E(Z)^2 \\ &= 1 - \pi_{++} - \pi_{00} - \pi_{--} + 3\pi_{+-} + 3\pi_{-+} - E(Z)^2 \end{aligned} \tag{5.1}$$

$$
\begin{aligned}
Var(Z) &= \left(\begin{array}{c|ccc} & \textbf{-} & \textbf{0} & + \\ \hline \textbf{-} & 0 & +1 & +4 \\ \textbf{0} & +1 & 0 & +1 \\ + & +4 & +1 & 0 \end{array}\right) - \left(\begin{array}{c|ccc} & \textbf{-} & \textbf{0} & + \\ \hline \textbf{-} & 0 & +1 & +2 \\ \textbf{0} & -1 & 0 & +1 \\ + & -2 & -1 & 0 \end{array}\right)^2 \\
&= \left(\begin{array}{c|ccc} & \textbf{-} & \textbf{0} & + \\ \hline \textbf{-} & 0 & +1 & +4 \\ \textbf{0} & +1 & 0 & +1 \\ + & +4 & +1 & 0 \end{array}\right) - (E(Z))^2 \\
&= 1 + \left(\begin{array}{c|ccc} & \textbf{-} & \textbf{0} & + \\ \hline \textbf{-} & -1 & 0 & +3 \\ \textbf{0} & 0 & -1 & 0 \\ + & +3 & 0 & -1 \end{array}\right) - (E(Z))^2
\end{aligned}
$$

5.2 Variance of the Weighted Evolution of Individual Responses

5.3 Properties

The quite similar to Var(BSI)

Property 1: the variance of Z is bounded between 0 and ?

upper bound:

$$
\begin{aligned}
Var(Z) &= 1 - \pi_{++} - \pi_{00} - \pi_{--} + 3\pi_{+-} + 3\pi_{-+} - E(Z)^2 \\
&= 1 - 0 - 0 - 0 + 3 * 0.5 + 3 * 0.5 - 0 = 2.5
\end{aligned}
$$

$$
1 + 0.5 * 3 + 0.5 * 3 - 0 = 2.5 \tag{5.2}
$$

Property 2:

5.4 Take different questions into account

CHAPTER 6

Non-Response, Dropout, Attrition and Seasonal Effects

Before we model the data, it's important to look at the different effects that could mislead the outcome of the analysis. After exploring the data and doing a literature review, four main effects could mislead the results. Three are due to the survey and one to external effects; seasonal effects. We will first look into seasonal effects and apply a well know correction to the data to eliminate, as good as possible, the seasonal effects from the data. It will then be looked into the three survey based issues; non-response, dropout and attrition.

As already mentioned before, for this analysis the data at hand is the unweighted indicators of the business survey, for the period of 1988 to 2018.

Eight variables will be used for the analysis; the business survey indicator, Var(BSI), EIR, Var(EIR)

6.1 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 variate. Without going too much into details, there are today two methods which are the most widely used and recommended which are X12/X13-ARIMA (XXXXX) developed by the US Census Bureau and TRAMO/SEATS (Gómez y Maravall, 1996) developed by the Bank of Spain. The two methods are divided into two part, first .....

JDemetra+

The Department of Research and development of the NBB developed JDemetra+ which is recommended by the European Central Bank (ECB) and the European Statistical Office (Eurostat) for all National Statistics Institutes (NSI) of the European Union.

JDemetra+ is used by the National Bank to apply seasonal corrections to the business survey indicator. it will be used here, to test for seasonality and apply corrections to the data.

Tests for seasonality were done with JDemetra+ (see appendix page 46) and it was concluded that there was seasonal effect for each of the variables at hand (see Table 6.1)

Seasonality Test	BSI	Var(BSI)	EIR	Var(EIR)	EIR2	Var(EIR2)	EIR3	Var(EIR3)
Auto-correlations at seasonal lags	YES	YES	YES	YES	YES	YES	YES	YES
Friedman (non parametric)	YES	YES	YES	YES	YES	YES	YES	YES
Kruskall-Wallis (non parametric)	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

Table 6.1: Seasonality Tests

The seasonal correction is done with RJDemetra, the R package based on JDemetra+. The results can be seen in Figure 6.1

It's interesting here to notice that there is no need for Year on Year GDP of been seasonally corrected since by definition, it's eliminating all its seasonality.

6.2 Non-Response

Non-response is a large domain of research when it comes to surveys. The theory converges to agree that there are three different ways non-response can be present. Responses can be missing completely at random, missing at random, or missing not at random.

Missing completely at random is usually hard to assume while missing not at random can be hard solve.

The non-response of the business survey can be decomposed into two; non-participation to the survey and participating but not answering.

Non-participation to 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 tries the best it can to take into account the population at study. Also, the fact that we have panel data limits the bias created by non-participant.

Non-response of participants is another issue. The solution applied in case of non-response is assuming that the respondent would have answered the same as the previous month, the method is called "Last Observation Carried Forward" (LOCF).

The response rate is usually around 95% for the business survey. We could from there say that non-response is not very important. Before concluding it, since the mean study is the evolution rather than the indicator in itself, we plotted the non-response with the evolution of the Year on Year GDP to see if there seems to be a relation between the two. For example, we could expect more or less non-response during crises or in certain economic situations. Since the main interest of the BSI is to explain business cycles,

plot non-response

6.3 Dropout and Attrition

Those two issues are related to the structure and organisation of the survey. As explain in section 2.2, one's participants are recruited to participate in the business survey, they stay as long as they want. This brings two potential issues: dropout and attrition.

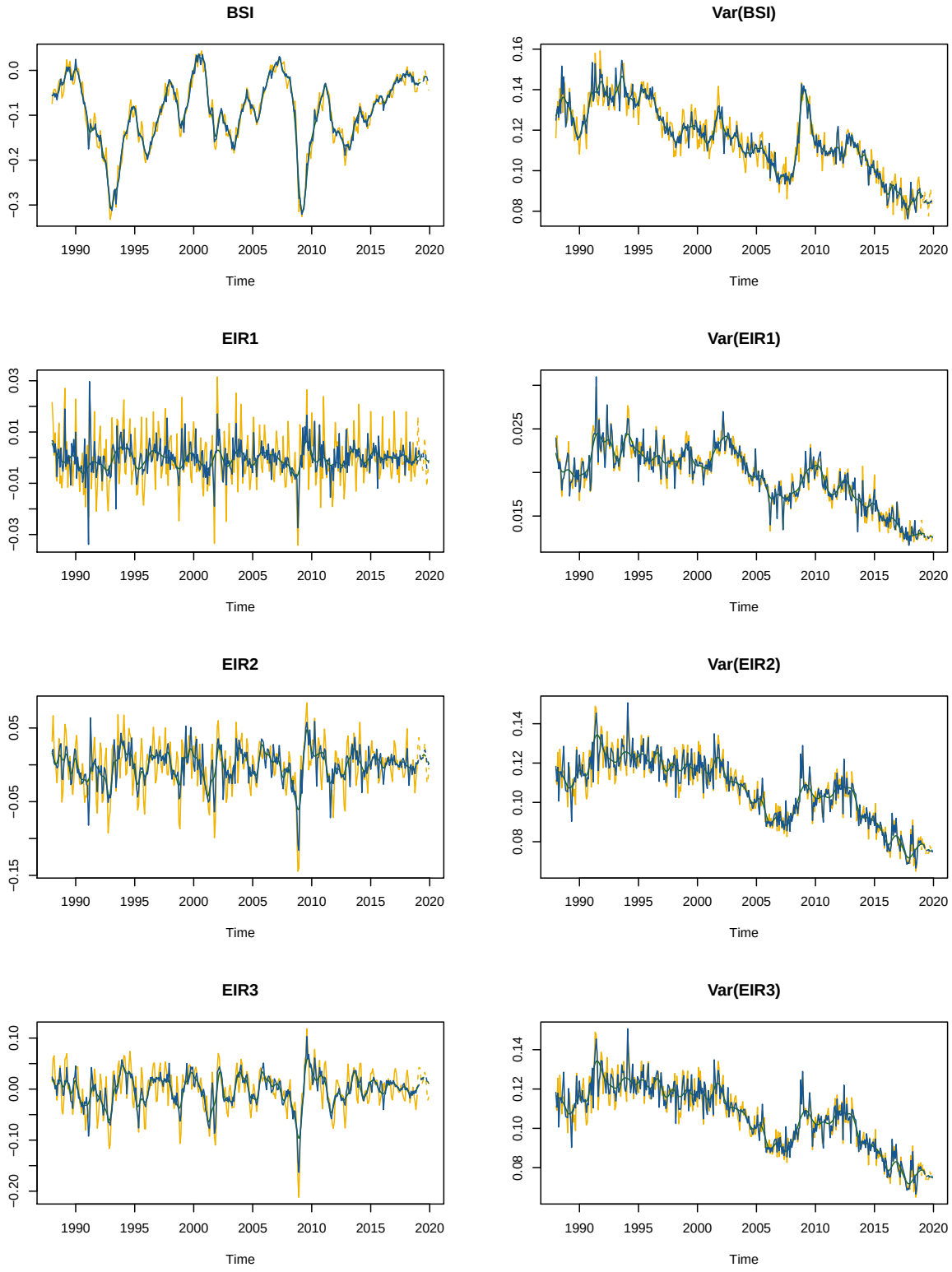

Figure 6.1: Plot of the industry business survey indicator (NS975), the indicator of the evolution of individual responses with the previous month (EIR1), two months (EIR2) and three months earlier (EIR3), with for each of them, their variance. The yellow lines are the raw data, the blue lines the seasonally corrected data and the green line is the trend of the variable.

6.3.1 Dropout

The National Bank doesn't keep track from reasons why participants leave the survey. From discussions with the responsible persons for the survey at the NBB, the two mean 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 companies that leave the survey. If this type of profile has a different opinion or respond differently than the remaining companies this will create bias.

Participants leaving the survey, are they different from

This is the case

plot of

It could be argued that the bias is very diffused due to the small number of companies leaving the survey each month. Again the fact that the evolution is important, means that we have a very small bias for each month (if we take a long period into account then the bias become larger) we are only comparing month to month evolution, and when the business survey is published, the 3-4 last year are showed.

It's not the subject of this work, so will not dive more into this bias, but we would recommend having a closer look into this.

6.3.2 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.

In the case of the business survey, it's a harder to test for it since we have only two major periods of recruitment for the period at interest (1988 - 2018); in the early 1990 and between around 2000 with some companies been recruited.

plot of the amount of recruited over time participation = 1

Table 6.2: Correlation of time with different indicators

	GDP_year	BSI	Var(BSI)	EIR	Var(EIR)
Time	−0.339	0.121	−0.811	0.040	−0.733

An interesting way to explore attrition is by looking at the correlations of the variances over time. In Table 6.2 it can be seen that

Same can be observed if we look at the evolution of the variance over time in Figure 6.1 where, aside of the peak of variance during the economic crises of 2008, there is a general tendency of decreasing of

It would be very interesting to dive more into deep of 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. It's also interesting to notice that the variance of the BSI and the variance the EIR can be a good indicator of those potential issues.

CHAPTER 7

Exploratory Analysis

The previous chapter already did some of the exploratory analysis. We will here have some further observations based on the time trends of the different variables at hand. In a second time, it will be looked into the correlations among the questions taken into account in the calculation of the industry BSI.

Data At hand

It's important to have a little reminder of the data at hand. Some descriptive statistics can be seen in Table 7.1.

The indicators come from the industry business survey and take into account the four questions explained on page 44.

The survey is monthly and the data is taken over a 30 year period (1988 - 2018). The different indicators are - BSI, var BSI, EIR and EIR2

The data that is used from now on is unweighted. Due to the long period, the weighted indicators could only be obtained

The data is also seasonally corrected as explained in section 6.1.

Some things have to be looked at before starting the modelling process

Table 7.1: Descriptive Statistics

Variables	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
BSI	−0.094	0.075	−0.321	−0.141	−0.033	0.037
Var(BSI)	0.116	0.017	0.076	0.107	0.129	0.154
EIR1	−0.0003	0.006	−0.034	−0.004	0.003	0.030
Var(EIR1)	0.020	0.003	0.012	0.017	0.022	0.031
EIR2	−0.001	0.024	−0.116	−0.013	0.013	0.064
Var(EIR2)	0.107	0.016	0.067	0.095	0.119	0.151
EIR3	−0.002	0.031	−0.163	−0.018	0.018	0.103
Var(EIR3)	0.107	0.016	0.067	0.095	0.119	0.151

7.1 The industry business survey indicator, the individual evolution in responses and their variances

7.2 Correlations Analysis

Three different correlations need to be looked at; (1) between questions of the industry BSI, (2) between YoY GDP and the different indicators and their variance and (3) the autocorrelation.

7.2.1 Correlation between questions

7.2.2 Correlation with GDP

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)

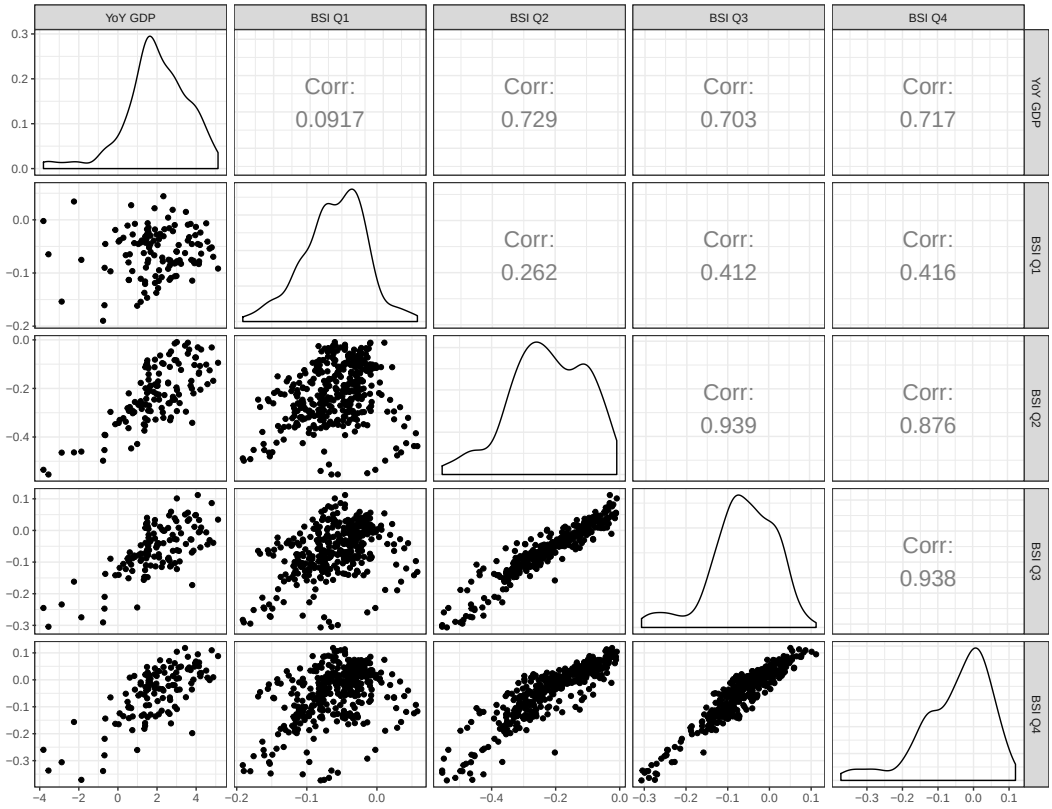

Figure 7.1: Correlation plot of YoY GDP and the indicator of the different questions taken into account in the calculation of the industry BSI

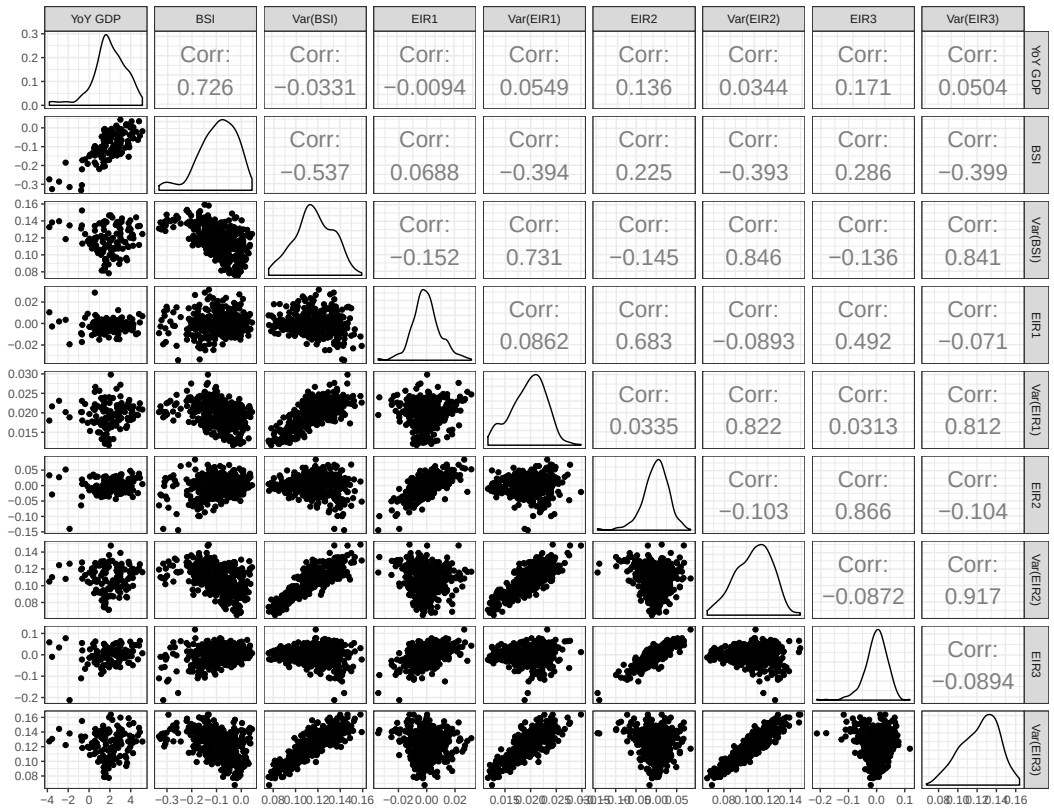

Figure 7.2: Correlation plot of the YoY GDP, the business survey indicator and its variance, and the evolution of individual responses for 1,2 and three months lag and its according variances

GDP vs Indicator

GDP vs Var

GDP vs Z

GDP vs Var Z

Correlation between Z, Z2, Z3 and var(Z) and var(Z2)

7.3 Auto-Correlation

Test stationarity of the time series (ADF) To test the stationarity of the time series, let's run the Augmented Dickey-Fuller Test using the adf.test() function from the tseries R package.

First set the hypothesis test:

The null hypothesis H0 : that the time series is non-stationary The alternative hypothesis HA : that the time series is stationary

adf.test(candyts)

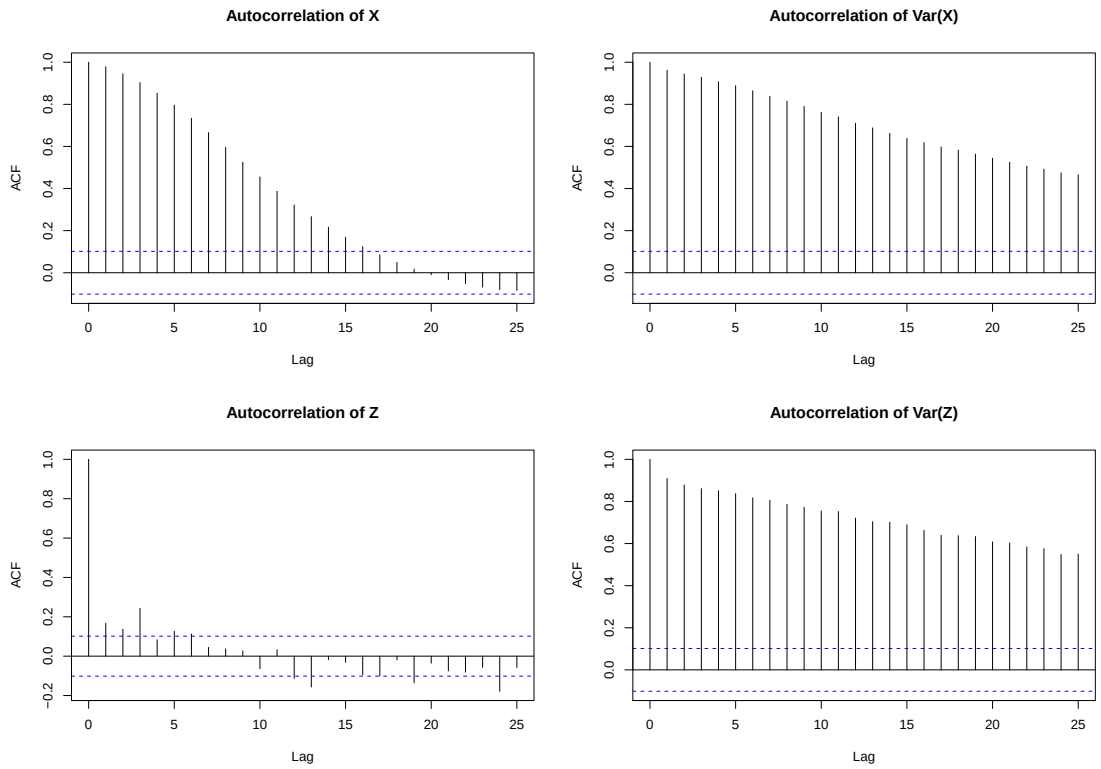

Figure 7.3: Autocorrelation plots for the BSI, Var(BSI), EIR and Var(EIR)

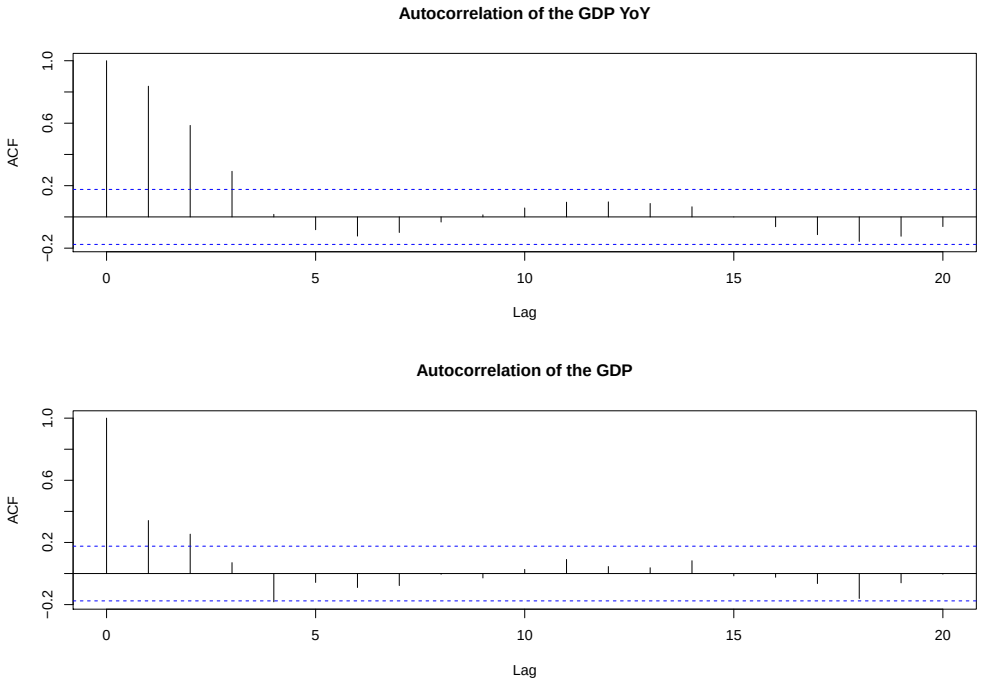

Figure 7.4: Autocorrelation plot for YoY GDP

add AR plots of EIR2 ... in appendix

7.4 Specificity of question 3 and 4, are peoples predictions correct ?

Table 7.2: Correlation Matrix of different lags of the BSI of **question 3** with YoY GDP

	YoY GDP	BSI	lag1(BSI)	lag2(BSI)	lag3(BSI)	lag4(BSI)
YoY GDP	1	0.707	0.679	0.673	0.628	0.560
BSI		1	0.969	0.948	0.906	0.846
lag1(BSI)			1	0.975	0.940	0.892
lag2(BSI)				1	0.974	0.933
lag3(BSI)					1	0.969
lag4(BSI)						1

Table 7.3: Correlation Matrix of different lags of the BSI of **question 4** with YoY GDP

	YoY GDP	BSI	lag1(BSI)	lag2(BSI)	lag3(BSI)	lag4(BSI)
YoY GDP	1	0.719	0.650	0.647	0.593	0.501
BSI		1	0.959	0.941	0.890	0.804
lag1(BSI)			1	0.970	0.928	0.863
lag2(BSI)				1	0.970	0.917
lag3(BSI)					1	0.959
lag4(BSI)						1

CHAPTER 8

Linear Models

The interest of this chapter is to use a model to test the pertinence of the variance of the indicator, the evolution of the individual responses and its variance, in the short term prediction of the evolution of GDP.

As mention in section 2.3.2, were nowcasting was discussed, there exist 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 uses for example a State-Space model available in JDemetra+ de Antonio Liedo (2014). Other well-known methods are ARIMA models, MIDAS and much more.

Better model could be used as Linear AR models, ARIMA, State Space Models, ... but here interest is to ...

The interest of this paper is to explore the utility of the variance of the business survey indicator and the evolution of individual responses and its variance. To achieve this objective, it's important to choose a model that account easily for the interest of each variable. For those reasons, the linear model is applied here.

8.1 Method

The quarterly GDP and the Quarterly Year on Year GDP are set in the last month of the quarter. F This is the common way to go.

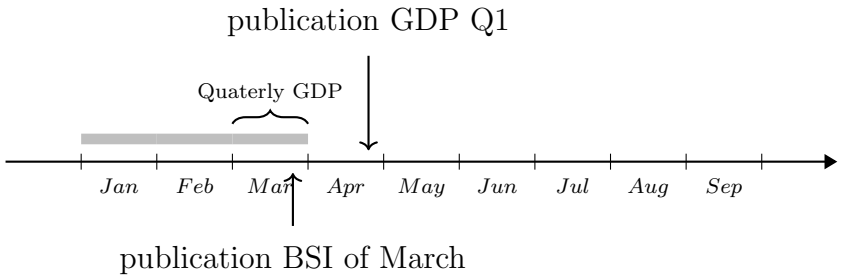

Figure 8.1: Timing of the observations

8.2 Linear Model

$$YoY\ GDP_t = \beta_0 + \sum_{i=1}^{n} \beta_i X_t + \epsilon_t \tag{8.1}$$

Where

GDP_t	GDP growth over the last semester
X_t	monthly predictors
β_0	constant
β_i	regression coefficients

The model proposed here is the simplest model possible.

Table 8.1

	Linear Regression				
	Year on Year GDP (in %)				
	(1)	(2)	(3)	(4)	(5)
Constant	3.429***	−1.740***	−1.821***	−1.756***	−1.761***
	(0.160)	(0.631)	(0.615)	(0.635)	(0.634)
BSI	15.773***	21.443***	21.548***	21.310***	21.116***
	(1.317)	(1.252)	(1.224)	(1.306)	(1.310)
Var(BSI)		49.102***	36.477***	40.631***	39.874***
		(5.869)	(8.089)	(11.895)	(11.844)
EIR1			−28.718**		
			(13.792)		
Var(EIR1)			78.555**		
			(35.187)		
EIR2				−0.709	
				(3.878)	
Var(EIR2)				9.213	
				(11.207)	
EIR3					1.248
					(2.615)
Var(EIR3)					9.944
					(11.141)
Observations	124	124	124	124	124
R^2	0.540	0.709	0.728	0.711	0.711
Adjusted R^2	0.537	0.704	0.719	0.701	0.701
Residual Std. Error	1.112	0.889	0.866	0.894	0.893
F Statistic	143.463***	147.283***	79.773***	73.079***	73.247***
Note:					*p<0.1; **p<0.05; ***p<0.01

8.3 Evaluation / Model selection

8.3.1 R-square

8.3.2 AIC and BIC

8.3.3 Mean Square Prediction Error

8.3.4 Diebold-Mariano Test

8.3.5 Out-of-Sample performances

ME: Mean Error
RMSE: Root Mean Squared Error
MAE: Mean Absolute Error
MPE: Mean Percentage Error
MAPE: Mean Absolute Percentage Error
MASE: Mean Absolute Scaled Error
ACF1: Autocorrelation of errors at lag 1.

8.4 Relative Importance

Table 8.2

Z3_sa	Z2_sa	Z_sa	Var_Z2_sa	Var_Z3_sa	Var_Z_sa	Var_sa	E_sa
0.010	0.018	0.027	0.029	0.039	0.094	0.095	1.006

Table 8.3

Z2_sa	Z3_sa	Z_sa	Var_Z2_sa	Var_Z3_sa	Var_sa	Var_Z_sa	E_sa
−0.003	−0.002	0.0003	0.002	0.035	0.038	0.046	0.882

8.5 Variance(X) VS Variance(Z) VS Variance(Z2)

8.6 E(Z) VS E(Z2)

8.7 Take Question 1 out of the calculation of the Indicator

8.8 until 2012 to see if variance still significant, not attrition creating effect

8.9 Model with before 2000 data

Table 8.4

	Linear Regression					
	Year on Year GDP (in %)					
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	3.429***	−1.740***	−1.821***	4.437***	0.660	−0.519
	(0.160)	(0.631)	(0.615)	(0.211)	(1.899)	(2.041)
BSI	15.773***	21.443***	21.548***	17.374***	19.212***	20.327***
	(1.317)	(1.252)	(1.224)	(1.547)	(1.758)	(1.813)
Var(BSI)		49.102***	36.477***		30.545*	31.371**
		(5.869)	(8.089)		(15.269)	(14.992)
EIR1			−28.718**			−37.120**
			(13.792)			(17.899)
Var(EIR1)			78.555**			53.535
			(35.187)			(52.433)
Observations	124	124	124	48	48	48
R^2	0.540	0.709	0.728	0.733	0.754	0.779
Adjusted R^2	0.537	0.704	0.719	0.727	0.744	0.758
Res. Std. Error	1.112	0.889	0.866	0.851	0.825	0.801
F Statistic	143.463***	147.283***	79.773***	126.060***	69.144***	37.845***
Note:						*p<0.1; **p<0.05; ***p<0.01

Table 8.5

	Linear Regression					
	Year on Year GDP (in %)					
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	3.429***	−1.740***	−1.821***	3.903***	−1.068	−1.764
	(0.160)	(0.631)	(0.615)	(0.180)	(1.102)	(1.163)
BSI	15.773***	21.443***	21.548***	17.494***	21.469***	22.103***
	(1.317)	(1.252)	(1.224)	(1.379)	(1.518)	(1.505)
Var(BSI)		49.102***	36.477***		43.809***	38.891***
		(5.869)	(8.089)		(9.608)	(10.307)
EIR1			−28.718**			−38.430**
			(13.792)			(17.020)
Var(EIR1)			78.555**			63.393
			(35.187)			(46.225)
Observations	124	124	124	88	88	88
R^2	0.540	0.709	0.728	0.652	0.720	0.740
Adjusted R^2	0.537	0.704	0.719	0.648	0.714	0.727
Residual Std. Error	1.112	0.889	0.866	1.083	0.977	0.954
F Statistic	143.463***	147.283***	79.773***	161.027***	109.438***	58.910***

Note: *p<0.1; **p<0.05; ***p<0.01

CHAPTER 9

Conclusion

A large

It was seen that

High correlation between var(BSI) and var(EIR) -¿ people seems to change in the same direction

CHAPTER 10

Discussion

10.1 Recruitment procedure and panel data

not real sampling theory

10.2 Z that takes more periods into account

10.3 Limitations

Variance influence by drop-out, attrition, ...

10.4 Improve the business survey

Change participants

Mo

From a statisticians point of view, a more sampling theory Including SRS or else would be more optimal

leave question 18 out of NS975

10.5 Further Research

More complex Nowcasting model with Space space models / MIDAS ....

Combine mixed models and Markov Chain for Panel Data (de Haan-Rietdijk et al., 2017)

State Space Model

Bayesian estimation Bialowolski et al.

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Appendix

Questions NS975

Questions taken into account for NS975: ....
originally question Q18, 27, 32 and 33, for simplicity numbered here as 1, 2, 3 and 4.

Verloop en beoordeling

1. Uw huidige voorraad van dit product beschouwt u, voor het seizoen, als:
   □ hoger dan normaal (te hoog) □ normaal (voldoende) □ lager dan normaal (te laag)

2. Uw huidige gezamenlijke orderpositie voor dit product beschouwt u als:
   □ hoger dan normaal □ normaal □ lager dan normaal

Vooruitzichten voor de volgende drie maanden

3. Het personeel (arbeiders en technici) tewerkgesteld voor de fabricatie van dit product zal volgens u:
   □ worden uitgebreid □ onveranderd blijven □ worden verminderd

4. De vraag van uw klanten naar dit product zal volgens u:
   □ belangrijker □ even belangrijk □ minder belangrijk
   zijn dan gewoonlijk tijdens die periode van het jaar.

Further Explanation of the Evolution of the responses ...

Notation	x_{t-1}	x_t	z_t
π_{--}	-1	-1	0
π_{-0}	-1	0	1
π_{-+}	-1	1	2
π_{0-}	0	-1	-1
π_{00}	0	0	0
π_{0+}	0	1	1
π_{+-}	1	-1	-2
π_{+0}	1	0	-1
π_{++}	1	1	0

Test for seasonality

Further Explanation of the Markov Switching model ...

CONJUNCTUURONDERZOEKINGEN - NIJVERHEID

TEL. + 32 (0)2 221 49 97 E-mail: nationalbanksurveys@nbb.be

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

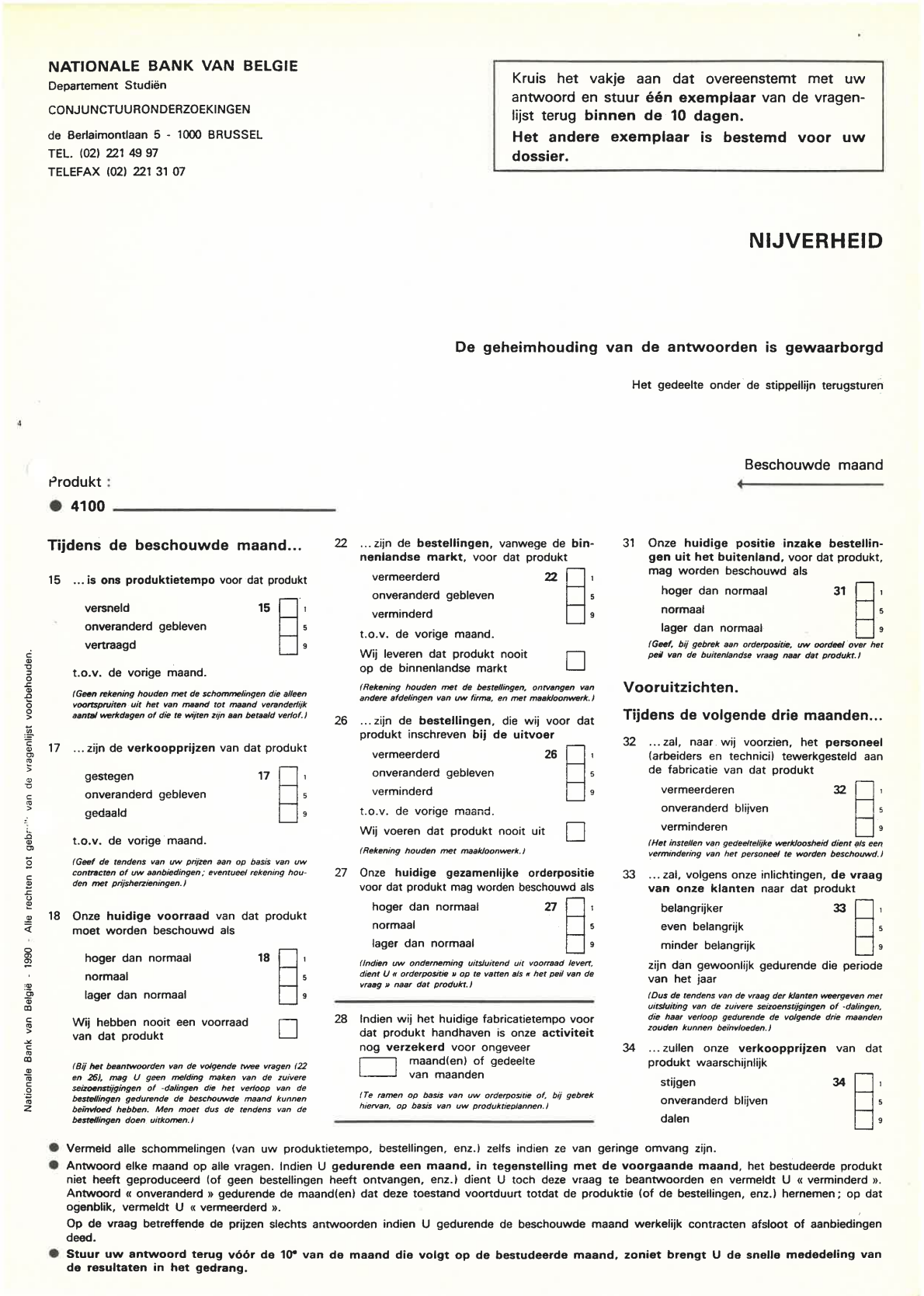
- Uw verkoopprijzen van dit product zullen volgens u:

  34 ☐ 1 stijgen ☐ 5 onveranderd blijven ☐ 9 dalen

4100N

REFERENTIE:
Enquête:

Figure 1: 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...

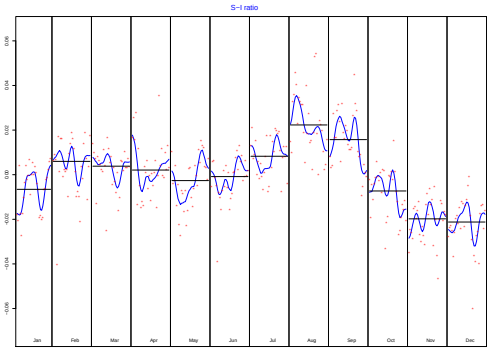
32 ... zal, naar wij voorzien, het **personeel** (arbeiders en technici) tewerkgesteld aan de fabricatie van dat produkt
vermeerderen 32 ☐ 1
onveranderd blijven ☐ 5
verminderen ☐ 9
(Het instellen van gedeeltelijke werkloosheid dient als een vermindering van het personeel te worden beschouwd.)

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.)

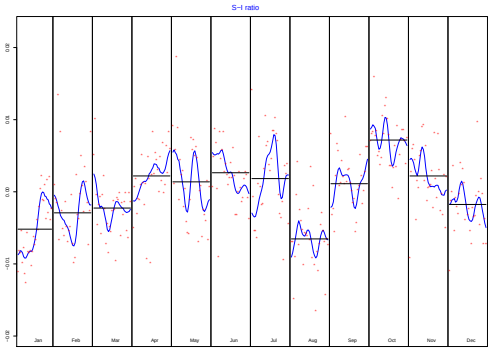
34 ... zullen onze **verkoopprijzen** van dat produkt waarschijnlijk
stijgen 34 ☐ 1
onveranderd blijven ☐ 5
dalen ☐ 9

● 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.**

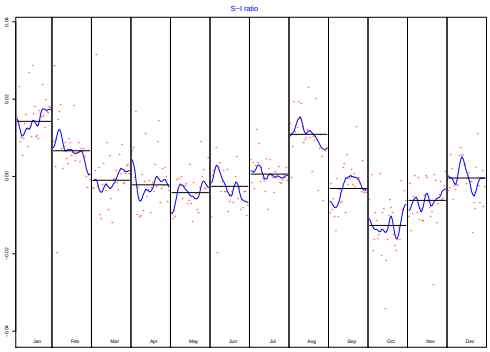
Figure 2: The Business Survey Questionnaire in Dutch for the Industrial Sector in 1990



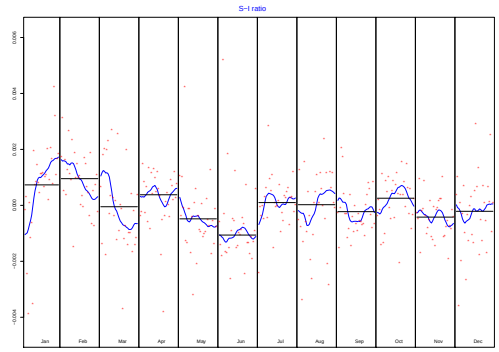
(a) BSI



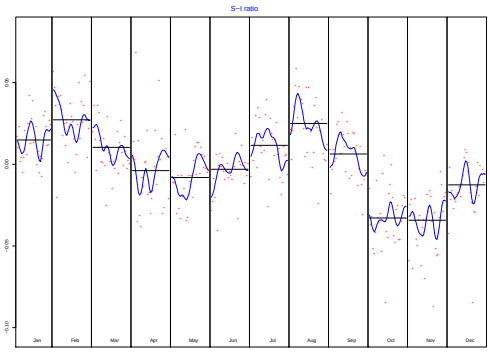
(b) Var(BSI)



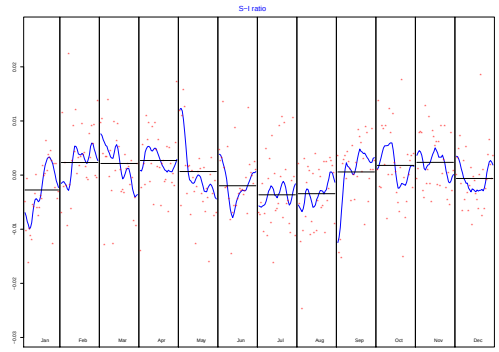
(c) EIR1



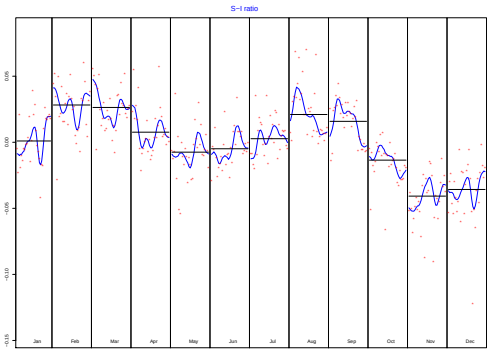
(d) Var(EIR1)



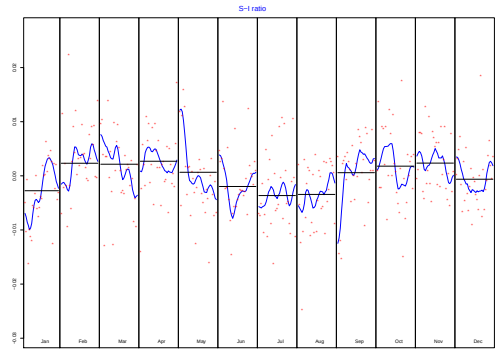
(e) EIR2



(f) Var(EIR2)



(g) EIR3



(h) Var(EIR3)

Figure 3: S-I plots for the different variables

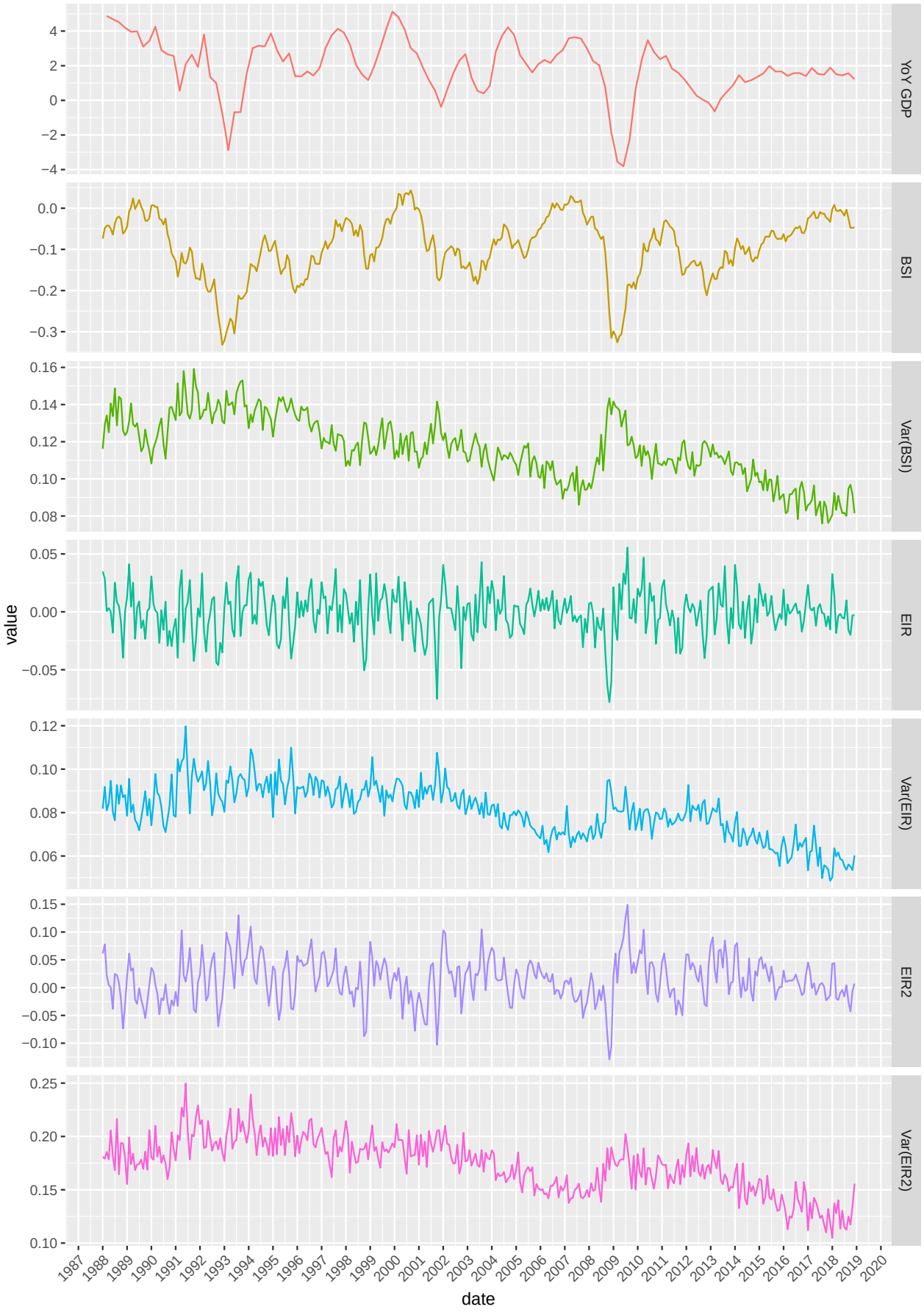


Figure 4: Plot

Code

R code for Seasonal Adjustment

R code for Creating Lags

R code for Linear (Auto-Regressive) Models

Code for Linear Models on https://github.com/fabricevb/Master-Thesis

R code for Markov Switching Models

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