# The Variability of the Belgian Business Survey Indicator and its Predictive Power

**Fabrice VAN BOECKEL**

Co-Supervisor: Prof. G. Molenberghs
KU Leuven

Co-Supervisor: L. Van Belle
National Bank of Belgium

Thesis presented in
fulfillment of the requirements
for the degree of Master of Science
in Statistics

Academic year 2018-2019

# Acknowledgement

Thanks my family and friends -
    the National Bank of Belgium Laurent, ... -
    KULeuven
    *"Statistics are the heart of democracy."*
- Simeon Strunsky

# Abstract

This Master Thesis explores the Variance of the Belgian Business Survey. Several finding concerning the nature and properties of the Variance are found as the bounds and relation with the mean.

In a second part, the predictive power of the variance is examined and it's found that ...

It's also the first time that à Markov Switching model is used in this context. It was showed that ...

## Keywords

Business Surveys - Business Barometer - Survey Variance - Markov Switching -

# Contents

## 12 Discussion 33

# Introduction

?

Business Survey Indicator / Business Barometer / Business Confidence Indicator

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 BSB

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

# The Business Survey Indicator

This first chapter is a more general description of the Belgian Business Survey Indicator, that we will also call the Business Barometer. We will present it different calculations, the weighting that are applied and

explain the two types of weightings

## 2.1  History

In 1954 started the Business Survey of the National Bank of Belgium.

At the European level, in 1961, is launched the launched by the Commission decision of 15 November 1961. The first survey was the harmonised business survey in the manufacturing industry conducted in 1962. Since then, the sector coverage of the programme has widened considerably. The BCS programme was extended to the construction sector and to investment plans in the manufacturing sector in 1966, to consumers in 1972, to the retail trade in 1984, and to the services sector in 1996. More info see (**?**)

Almost 20 years later, in 1972, results where first synthesised in an indicator. It has since then been well known for been a very informative and useful indicator. For example in 1999 an article was published in the Wall Street Journal titled *"Euroland Discovers A Surprise Indicator: Belgian Confidence"* (**?**) that noted the accuracy and of it predictions.

Today, Nowcasting is a well studied subject and very important for public and private organisation to have an as clear as possible view of the state of the economy.

With the study of business cycles, that will be looked at more in details in part ...., nowcasting are two important objectives that will be looked at in this work.

Due to the structure of Belgian economy and ... it was also shown as been a good predictor for the European economy **?**

changes in 2009 see later (section 2.3)

## 2.2  Sampling Method

...
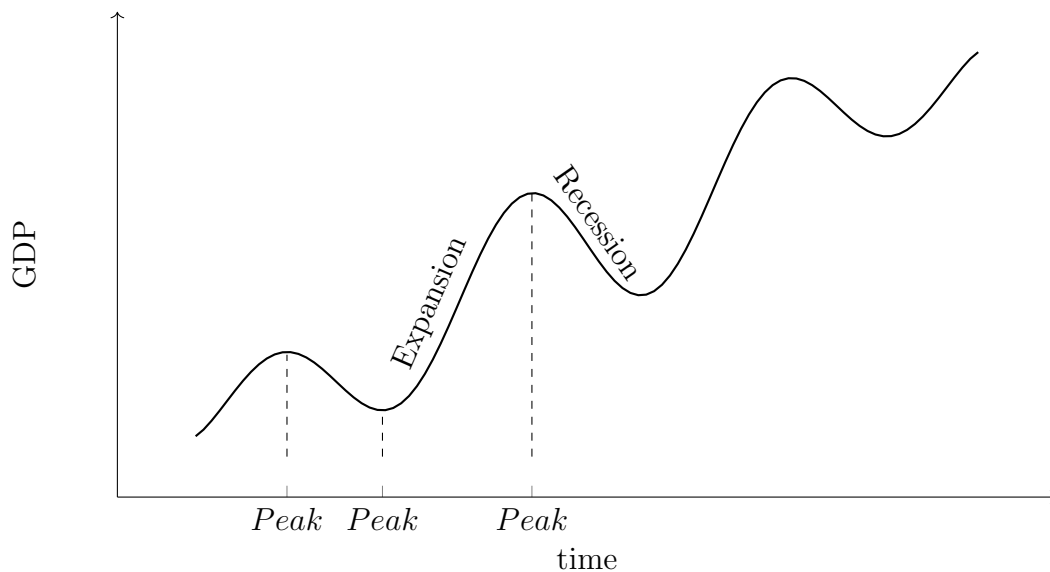
Figure 2.1: The GDP

## 2.3 Objective and Methodology

A large improvement of the indicator happened in 2009 which was explained in a working paper untitled "The National Bank of Belgium's new business survey indicator" (**?**)

Objectives :

Using specific questions to identify the business cycles and turning points

It can be included in what's now called nowcasting, which is now and short time forecasting of the evolution of the economy.

- only take a limited amount of questions into account, the most relevant ones (3-4 questions)
- inclusion of the services in the global indicator
- lighten smoothing method

**A Business Cycles theory**

As already said, an important role of the Business Survey Indicator, is to identify business cycles.

A business cycle is

**Quality Criterion**

- high correlation with Economical Indicators
- fluctuation that's mostly explained by the conjuncture
- predictive power for the future months

more information can be found in **?**

### 2.3.1 Weighting procedure

According to the size of the company, measured different ways depending on the sector
........

### 2.3.2 Globalisation procedure

## 2.4 Questionnaire

.... questionnaire can be found in appendix

Questions taken into account for RS975: ....

originally question Q18, 27, 32 and 33, for simplicity numbered here as 1, 2, 3 and 4.

## 2.5    Calculation of the Indicator

This section presents the method for calculating the indicator. The calculation in itself is standard, but the different ways to write it are important for interpretation and to better understand the following chapters.

### 2.5.1    Unweighted Indicator

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

$$E(X) = \frac{\sum_{i=1}^{n} x_i}{n} \tag{2.1}$$

where

$x_i$ is the answer of the respondent i and can each take value -1, 0 and 1
$n$ is the total of respondents

Since x can only take three different values, we can decompose it into

$$E(X) = \frac{\sum_{i=1}^{n} x_{+i} + \sum_{i=1}^{n} x_{Ni} + \sum_{i=1}^{n} x_{-i}}{n} \tag{2.2}$$

where
$x_{+i}$, $x_{Ni}$ and $x_{-i}$ are the positive(+), neutral (N) and negative (-) answers of the respondent i
$n$ is the total of respondents
We know that $\sum_{i=1}^{n} x_{Ni} = 0$ so we can write

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

$\sum_{i=1}^{n} x_{+i}/n$ is the proportion of positive answers and $\sum_{i=1}^{n} x_{-i}/n$ is the negative proportion of negative answer so for simplicity we write it

$$E(X) = \pi_+ - \pi_- \tag{2.4}$$

where $\pi_+$ and $\pi_-$ are the proportion of respondents answering positive and negative. $\pi$ is use here also in the probabilistic way as it can also be seen as the probability that a respondent answers positive, negative or neutral ($\pi_0$) with $\pi_+ + \pi_0 + \pi_- = 1$.

## 2.5.2 Weighted Indicator

**Globalisation procedure**

**Weighting procedure**

**Calculation**

$$E(X) = \frac{\sum_{i=1}^{n} (\omega_i p_i x_i)}{\sum_{i=1}^{n} \omega_i p_i} \tag{2.5}$$

where
$x_i$ is the answer of the respondent i and can each take value -1, 0 and 1
$p_i$ is the weight of the globalisation of the company i
$\omega_i$ is the weight of the company i

$$E(X) = \frac{\sum_{i=1}^{n} \omega_{+i} p_{+i} x_{+i} + \sum_{i=1}^{n} \omega_{Ni} p_{Ni} x_{Ni} + \sum_{i=1}^{n} \omega_{-i} p_{-i} x_{-i}}{n} \tag{2.6}$$

$$E(X) = \frac{\sum_{i=1}^{n} \omega_{+i} p_{+i} x_{+i}}{n} + \frac{\sum_{i=1}^{n} \omega_{-i} p_{-i} x_{-i}}{n} \tag{2.7}$$

$$E(X) = \pi_+ - \pi_- \tag{2.8}$$

where $\pi_+$ and $\pi_-$ are the **weighted** proportion of respondents answering positive and negative. $\pi$ is use here also in the probabilistic way as it can also be seen as the probability that a respondent answers positive, negative or neutral ($\pi_0$) with $\pi_+ + \pi_0 + \pi_- = 1$.

## 2.5.3 Properties

E(X) has -1 as lower bound and 1 as upper bound

## 2.5.4 Take different questions into account

The previous calculations where specific to each 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 that have all the same weight:

$$\text{Industry Business Indicator} = \frac{E(X_{Q1}) + E(X_{Q2}) + E(X_{Q3}) + E(X_{Q4})}{4} \tag{2.9}$$

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)

can also been seen as the mean of the answers for each participant at each period then combined together

$$\text{Industry Business Indicator} = \frac{\sum_{i=1}^{n} (x_{iQ1} + x_{iQ2} + x_{iQ3} + x_{iQ4})/4}{n} \tag{2.10}$$

# Variance of the Indicator

The variance is, with the mean, one of the first tool for Statisticians to study a certain variable.

In the context of the Business Survey, the variance haven't been used much.

**The added info of the variance**

**variance as a measure of the dispersion of the responses**

In statistics, the variance has two m

Here we want to know to what extend respondents agree with each others.
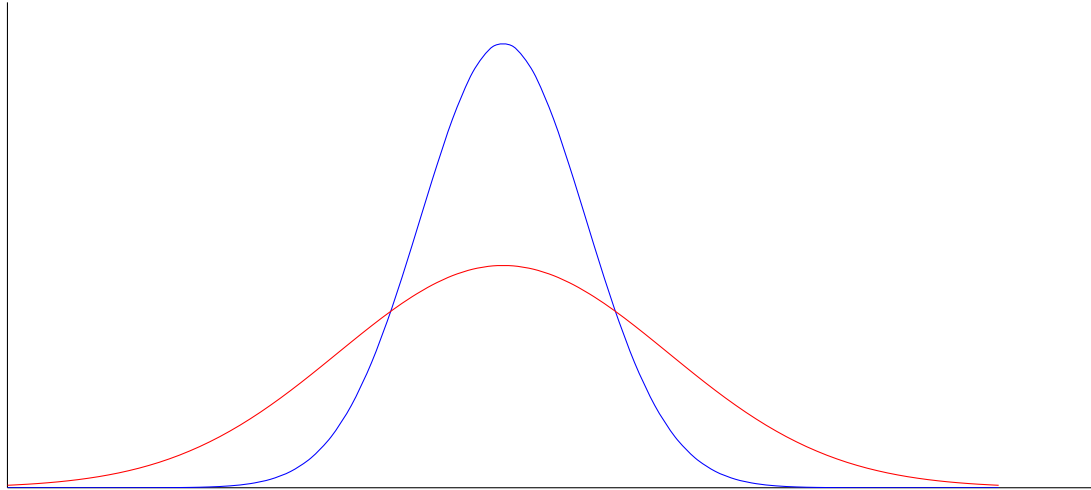
**difference sampling error and variance**

here variance is a measure of the "dispersion" of the answers.

**difference between nominal and continuous variable variance**

As done for the Indicator, two different variances will be take into account here, the weighted and the unweighted variance of the indicator.

## 3.1   Variance of the Unweighted Indicator

The main variance
    cite

$$
\begin{aligned}
Var(X) &= E\left[(X - E(X))^2\right] \\[2mm]
&= E\left(X^2\right) - E\left(X\right)^2 \\[2mm]
&= \left(\frac{\sum_{i=1}^{n} x_{+i}^2}{n}\right) + \left(\frac{\sum_{i=1}^{n} x_{Ni}^2}{n}\right) + \left(\frac{\sum_{i=1}^{n} x_{-i}^2}{n}\right) - E(X)^2 \\[2mm]
&= \pi_+ + \pi_- - (\pi_+ - \pi_-)^2 \tag{3.1}
\end{aligned}
$$

Since $\left(\frac{\sum_{i=1}^{n} x_{Ni}^2}{n}\right) = 0$ , $x_{+i}^2 = x_{+i}$, $x_{-i}^2 = x_{-i}$ and $E(X) = \pi_+ - \pi_-$
We then have several different ways to write the previous equation;

$$
\begin{aligned}
Var(X) &= \pi_+ + \pi_- - (\pi_+ - \pi_-)^2 \\
&= \pi_+ + \pi_- - E(X)^2 \tag{3.2} \\
&= 1 - \pi_n - E(X)^2 \tag{3.3}
\end{aligned}
$$

Equation 3.1 is interesting
Equation 3.2
Equation 3.3

## 3.2   Generalization for Weighted Indicators / Variance of the Weighted Indicator

$$
Var(X) = \frac{1}{\sum \omega_i p_i} \sum_{i=1}^{N} \omega_i p_i (X_i - \bar{X})^2 \tag{3.4}
$$

$$
\begin{aligned}
Var(X) &= \pi_+ + \pi_- - (\pi_+ - \pi_-)^2 \tag{3.5} \\
&= \pi_+ + \pi_- - E(X)^2 \tag{3.6} \\
&= 1 - \pi_0 - E(X)^2 \tag{3.7}
\end{aligned}
$$

### 3.2.1 Properties
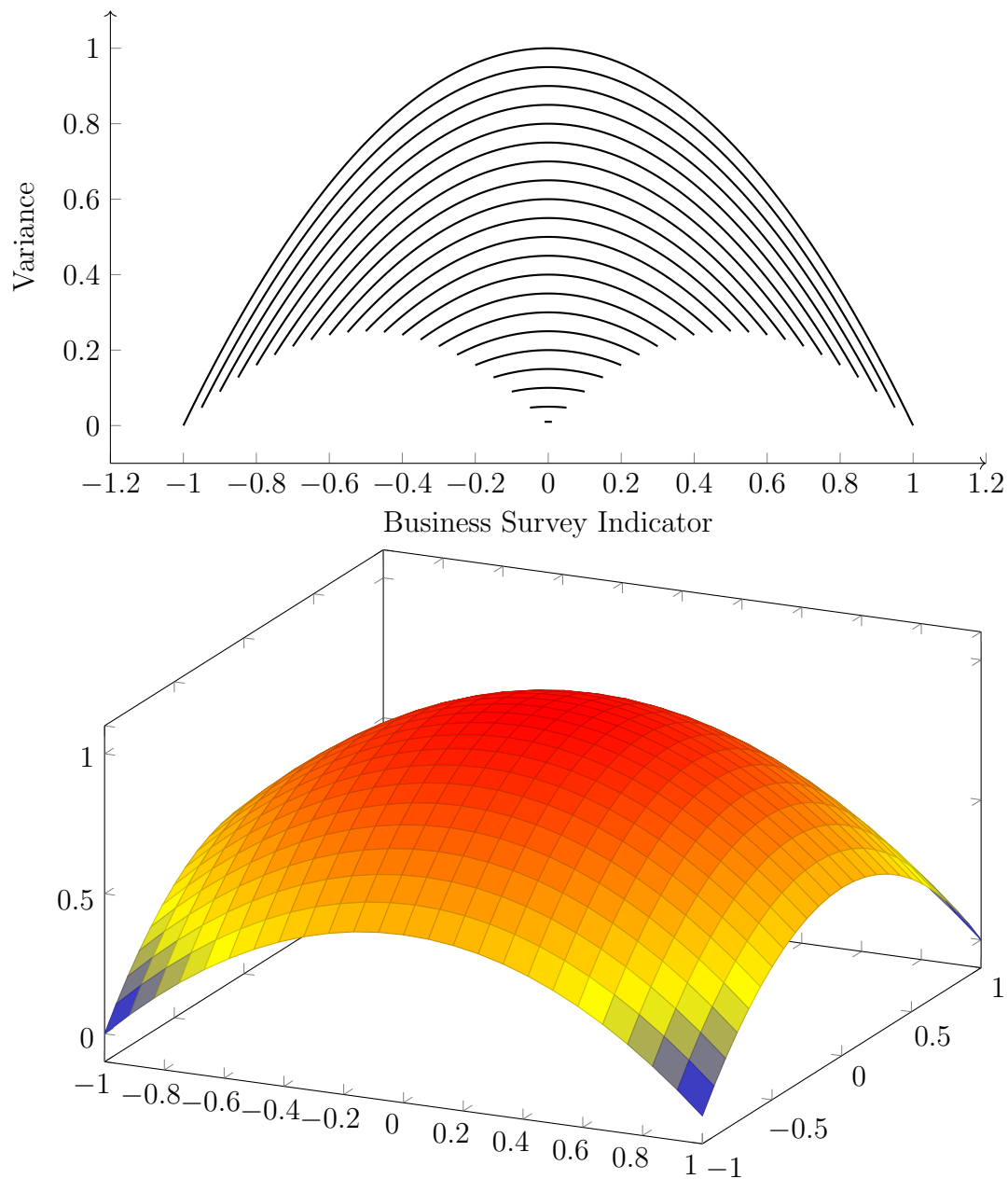


**Property 1: The variance of X is bounded between -1 and 1**

**Property 2: The variance = A5 and E(X)**

**Property 3: .....**

## 3.3 Take different questions into account

## 3.4 Discussion regarding the 'true variance'

There is another way to calculate the variance that have been ignored for, that is calculating the variance for each lowest group of globalisation, and then combine those calculated

variances.

Interestingly, it have been calculated for several Questions of the business barometer, and it is approximately 10 times smaller than the variance based on all the answer a ones.

The reasons why it will not be used here - losing information - weight of globalisation taken into account in the weighted variance

## Indicator of the Evolution of Individual Responses

**Why this new indicator**

Also Called Z indicator

Can be better understood as the indicator of the Changes in individual answers between t-1 and t

cite the paper by INSEE

An issue for this indicator was to find an optimal name for it so that it would be easily understand by the largest number.

**The Indicator of the Evolution of Individual Responses**

**Explain the new indicator**

|  |  | $t$ | | |
|---|---|---|---|---|
|  |  | **-** | **0** | **+** |
| | **-** | $\pi_{--}$ | $\pi_{-0}$ | $\pi_{-+}$ |
| $t-1$ | **0** | $\pi_{0-}$ | $\pi_{00}$ | $\pi_{0+}$ |
| | **+** | $\pi_{+-}$ | $\pi_{+0}$ | $\pi_{++}$ |

where

$$\pi_{++} + \pi_{+0} + \pi_{+-} + \pi_{0+} + \pi_{00} + \pi_{0-} + \pi_{-+} + \pi_{-0} + \pi_{--} = 1 \tag{4.1}$$

The Indicator of the evolution of the individual responses can be obtained by

$$E(Z) = \pi_{0+} + \pi_{-0} - \pi_{+0} - \pi_{0-} + 2\pi_{-+} - 2\pi_{+-} \tag{4.2}$$

where $\pi$ is the proportion/probability of respondent answering (-,0,+) at $t-1$ and $t$

$$E(Z) = \pi_{0+} + \pi_{-0} - \pi_{+0} - \pi_{0-} + 2\pi_{-+} - 2\pi_{+-} = \begin{array}{c|ccc} & \textbf{-} & \textbf{0} & \textbf{+} \\ \hline \textbf{-} & 0 & +1 & +2 \\ \textbf{0} & -1 & 0 & +1 \\ \textbf{+} & -2 & -1 & 0 \end{array} \tag{4.3}$$

**Interpretation**

# Variance of the Evolution of Individual Responses / Volatility of Responses

That we will also call the **volatility of the indicator**, in the sens that the variance of the evolution of the indicator account for the dispersion of the difference in answers over a two times period.

In this case, the highers variance of Z, will be obtained when half of the companies went from a negative answer to a positive answer and the other half did the opposite and changed from a positive answer at t-1 to a negative answer at t.

waza see Chapter 5

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

## 5.1 Presentation

$$\pi_{++} + \pi_{+0} + \pi_{+-} + \pi_{0+} + \pi_{00} + \pi_{0-} + \pi_{-+} + \pi_{-0} + \pi_{--} = 1 \tag{5.1}$$

$$
\begin{aligned}
Var(Z) &= \pi_{0+} + \pi_{-0} + \pi_{+0} + \pi_{0-} + 4\pi_{-+} + 4\pi_{+-} \\
&\quad - (\pi_{0+} + \pi_{-0} - \pi_{+0} - \pi_{0-} + 2\pi_{-+} - 2\pi_{+-})^2 \\
&= \pi_{0+} + \pi_{-0} + \pi_{+0} + \pi_{0-} + 4\pi_{-+} + 4\pi_{+-} - E(Z)^2 \\
&= 1 - \pi_{++} - \pi_{00} - \pi_{--} + 3\pi_{+-} + 3\pi_{-+} - E(Z)^2 \tag{5.2}
\end{aligned}
$$

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

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

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

### 5.1.1 Properties

**Property 1: the variance of Z is bounded between -1 and 1**

**Property 2:**

CHAPTER 6

---

# Seasonal Effects

---

The National Bank, before publishing the Business Survey Indicator, applies a X11 seasonal correction

The literature about seasonal effects is very rich and variate

- NBB developed JDemetra+ and has since been recommended by the ECB and Eurostat for all NSI in Europe.

at the same time the department of Business Survey uses as a X11 adapted method to correct for seasonality because don't want to correct for previous publications.

Methodology
- test for seasonality
- run the analysis without corrections
- apply corrections and see if more accurate

## 6.1   JDemetra+

## 6.2   X11

### 6.2.1   Seasonal correction of the Indicator

### 6.2.2   Seasonal correction of the Variance

### 6.2.3   Seasonal correction of the Indicator of the Evolution

### 6.2.4   Seasonal correction of the Variance of Z

### 6.2.5   Seasonal correction of the Proportions

## 6.3   Limitations

explain the issue of seasonal correction on "future data"

# Non-Response, Dropout and Attrition

Aside of Seasonal effect, there are three main biases that could arise in the context of the BSI; non-reponse, dropout and attrition

Table 7.1: Correlation Between Time and different variables

|  | GDP | YoY GDP | BSI | Var | Z_I | Var_Z_I |
|---|---|---|---|---|---|---|
| Time | −0.223 | −0.352 | 0.148 | −0.775 | 0.060 | −0.728 |
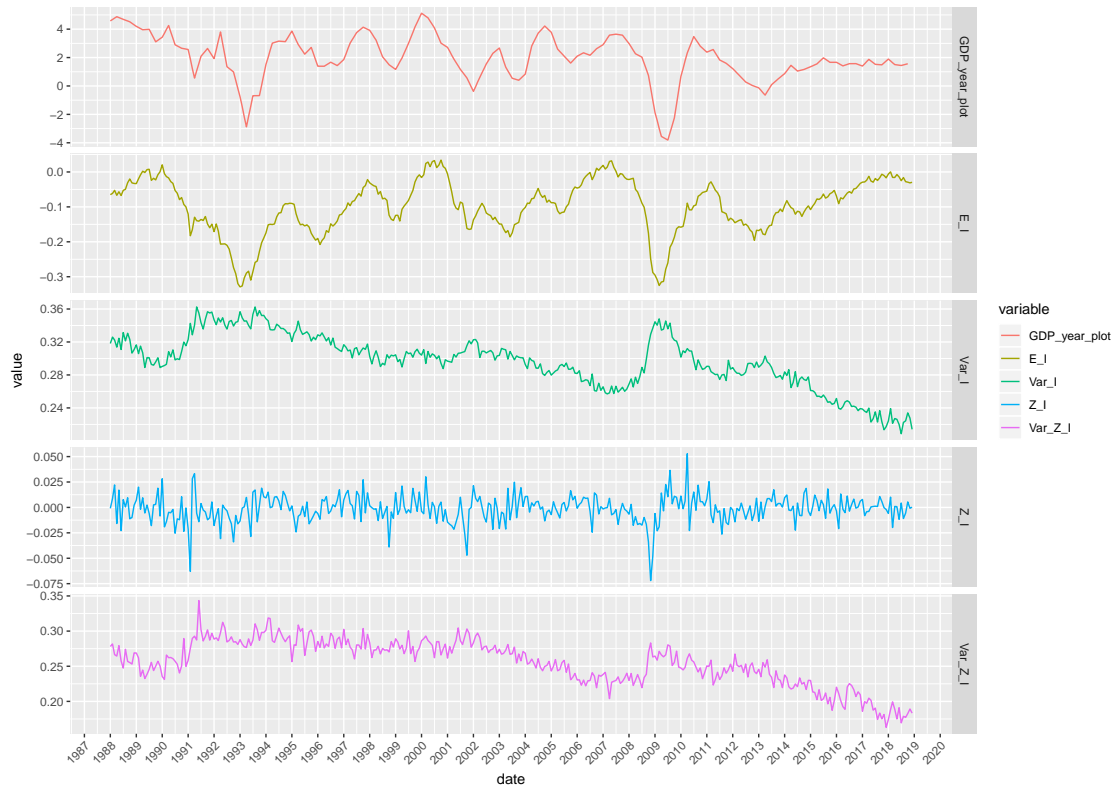
Figure 7.1: Plot

## 7.1 Non-Response

plot non-response

## 7.2 Dropout

Non parametric test ?

## 7.3 Attrition

Attrition / Panel Conditioning Master Thesis done about the Belgian Labor Force Survey, where attrition was studied ?

Non parametric test ?

limitation: only some periods of

CHAPTER 8

Exploratory Analysis

## 8.1   Data At hand

Four questions
 1988 - 2018

## 8.2   Small vs Large

## 8.3   By Sector

## 8.4   Correlations

There are three different correlations that need to be looked at

## 8.5   Correlation between questions

Table 8.1: Correlation Matrix

|      | E_1   | E_2   | E_3   | E_4   |
|------|-------|-------|-------|-------|
| E_1  | 1     | 0.262 | 0.412 | 0.416 |
| E_2  | 0.262 | 1     | 0.939 | 0.876 |
| E_3  | 0.412 | 0.939 | 1     | 0.938 |
| E_4  | 0.416 | 0.876 | 0.938 | 1     |

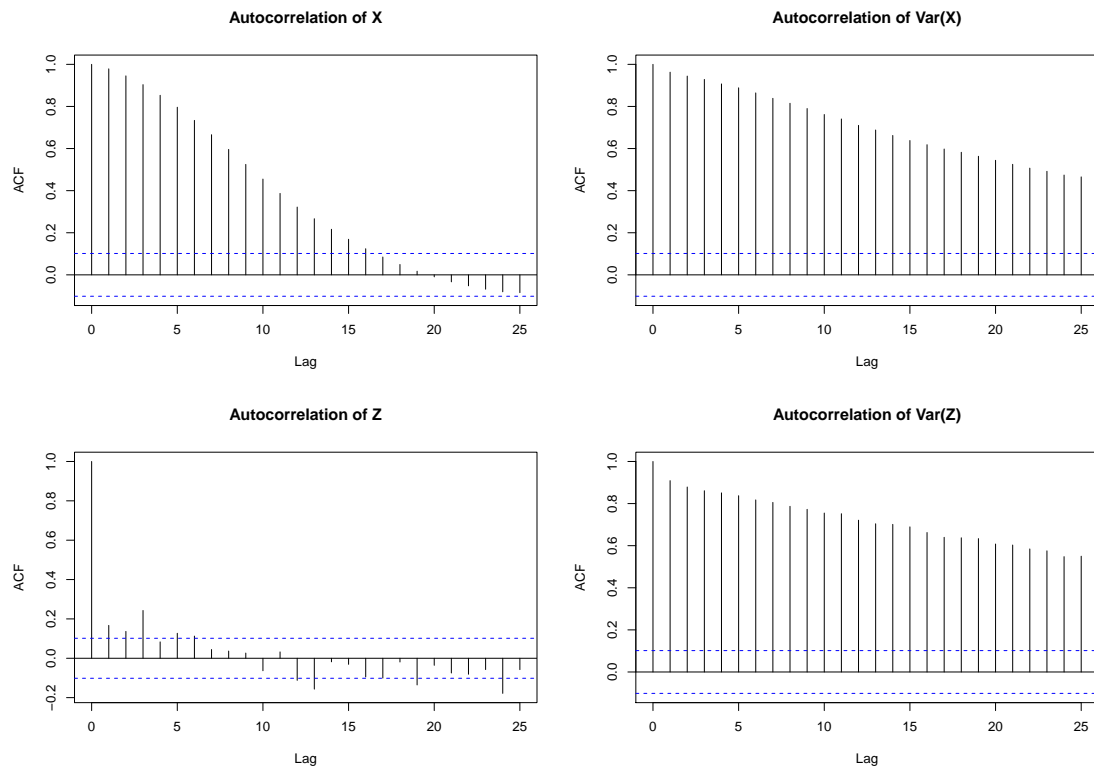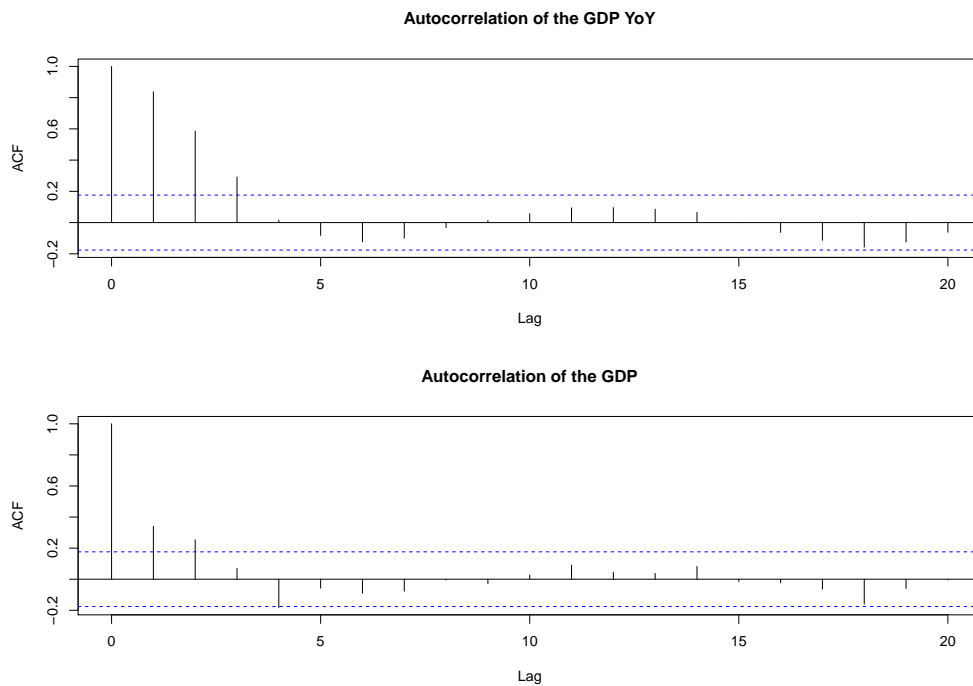# 8.6  Auto-Correlation



Figure 8.1: Plot



Figure 8.2: Plot

19

## 8.7 Correlation with GDP

Belgian industry claims 25% of the labour force in Belgium and have been shown as been the best indicator to predict the year to year GDP citeAlain Quartier and Isabelle

### GDP vs GDP YoY

Table 8.2: Correlation Matrix

|         | GDP   | GDP_year | E_I   | E_1   | E_2   | E_3   | E_4   |
|---------|-------|----------|-------|-------|-------|-------|-------|
| GDP     | 1     | 0.628    | 0.502 | 0.222 | 0.439 | 0.473 | 0.556 |
| GDP_year| 0.628 | 1        | 0.707 | 0.092 | 0.729 | 0.703 | 0.717 |
| E_I     | 0.502 | 0.707    | 1     | 0.483 | 0.952 | 0.982 | 0.963 |
| E_1     | 0.222 | 0.092    | 0.483 | 1     | 0.266 | 0.414 | 0.406 |
| E_2     | 0.439 | 0.729    | 0.952 | 0.266 | 1     | 0.942 | 0.886 |
| E_3     | 0.473 | 0.703    | 0.982 | 0.414 | 0.942 | 1     | 0.938 |
| E_4     | 0.556 | 0.717    | 0.963 | 0.406 | 0.886 | 0.938 | 1     |
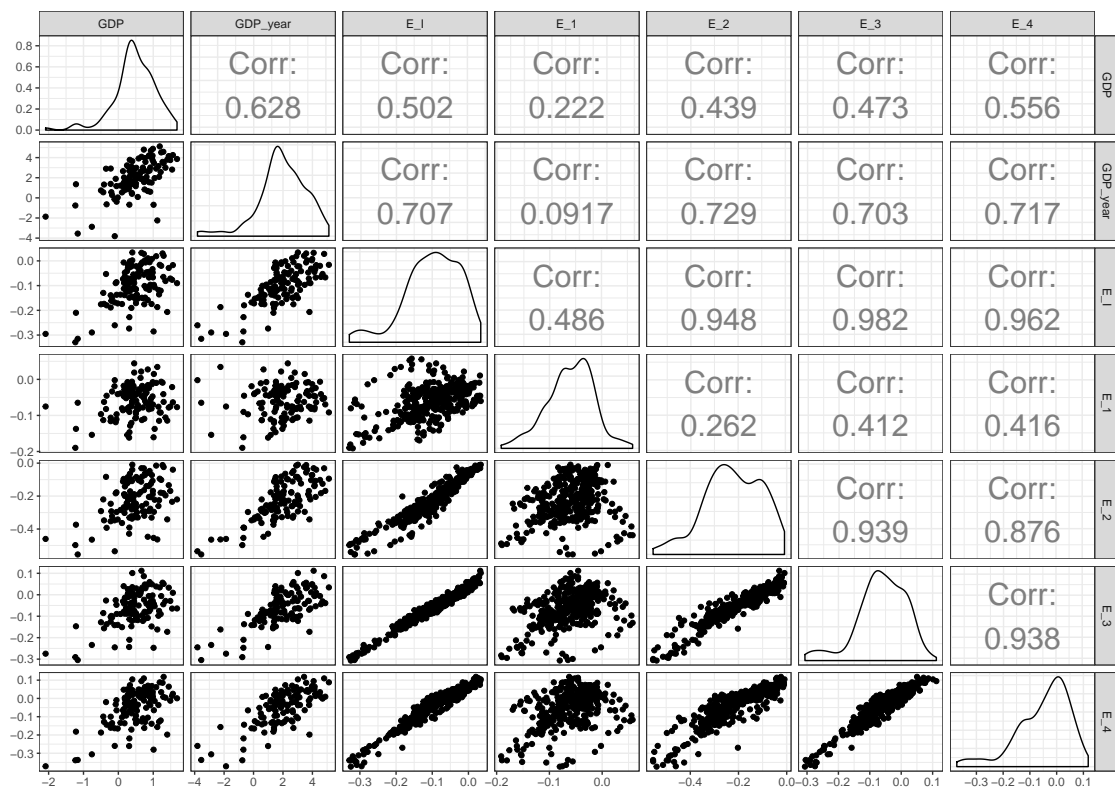


Figure 8.3: Plot

## 8.8 GDP vs Explanatory Indicators

Table 8.3: Correlation Matrix

|  | GDP | GDP_year | E_I | Var_I | Z_I | Var_Z_I |
|---|---|---|---|---|---|---|
| GDP | 1 | 0.628 | 0.502 | −0.074 | 0.151 | 0.021 |
| GDP_year | 0.628 | 1 | 0.707 | −0.101 | −0.058 | 0.011 |
| E_I | 0.502 | 0.707 | 1 | −0.615 | 0.166 | −0.484 |
| Var_I | −0.074 | −0.101 | −0.615 | 1 | −0.045 | 0.887 |
| Z_I | 0.151 | −0.058 | 0.166 | −0.045 | 1 | −0.072 |
| Var_Z_I | 0.021 | 0.011 | −0.484 | 0.887 | −0.072 | 1 |



Figure 8.4: Plot

**GDP vs Indicator**

**GDP vs Var**

**GDP vs Z**

**GDP vs Var Z**

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

Table 8.4: Correlation Matrix

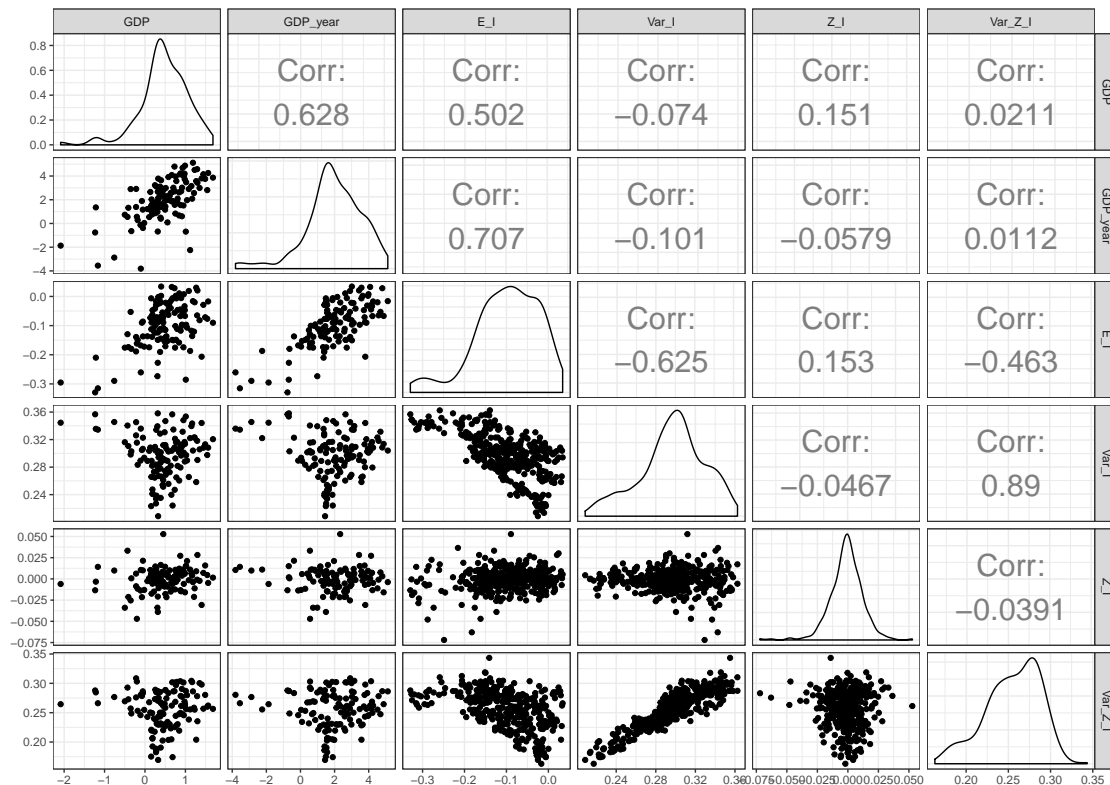|  | GDP | GDP_year | E_3 | E_3_lag1 | E_3_lag2 | E_3_lag3 | E_3_lag4 |
|---|---|---|---|---|---|---|---|
| GDP | 1 | 0.628 | 0.477 | 0.520 | 0.545 | 0.546 | 0.531 |
| GDP_year | 0.628 | 1 | 0.707 | 0.679 | 0.673 | 0.628 | 0.560 |
| E_3 | 0.477 | 0.707 | 1 | 0.969 | 0.948 | 0.906 | 0.846 |
| E_3_lag1 | 0.520 | 0.679 | 0.969 | 1 | 0.975 | 0.940 | 0.892 |
| E_3_lag2 | 0.545 | 0.673 | 0.948 | 0.975 | 1 | 0.974 | 0.933 |
| E_3_lag3 | 0.546 | 0.628 | 0.906 | 0.940 | 0.974 | 1 | 0.969 |
| E_3_lag4 | 0.531 | 0.560 | 0.846 | 0.892 | 0.933 | 0.969 | 1 |

Table 8.5: Correlation Matrix

|  | GDP | GDP_year | E_4 | E_4_lag1 | E_4_lag2 | E_4_lag3 | E_4_lag4 |
|---|---|---|---|---|---|---|---|
| GDP | 1 | 0.628 | 0.558 | 0.555 | 0.591 | 0.566 | 0.536 |
| GDP_year | 0.628 | 1 | 0.719 | 0.650 | 0.647 | 0.593 | 0.501 |
| E_4 | 0.558 | 0.719 | 1 | 0.959 | 0.941 | 0.890 | 0.804 |
| E_4_lag1 | 0.555 | 0.650 | 0.959 | 1 | 0.970 | 0.928 | 0.863 |
| E_4_lag2 | 0.591 | 0.647 | 0.941 | 0.970 | 1 | 0.970 | 0.917 |
| E_4_lag3 | 0.566 | 0.593 | 0.890 | 0.928 | 0.970 | 1 | 0.959 |
| E_4_lag4 | 0.536 | 0.501 | 0.804 | 0.863 | 0.917 | 0.959 | 1 |

# Linear (Auto-Regressive) Models

## 9.1 Method

### 9.1.1 Month vs Quarterly data

Error to aggregate everything to quarterly - lost of information

### 9.1.2 Timing of the Data

The quaterly GDP and the Quaterly YoY GDP is set at t. This is the common way to go..
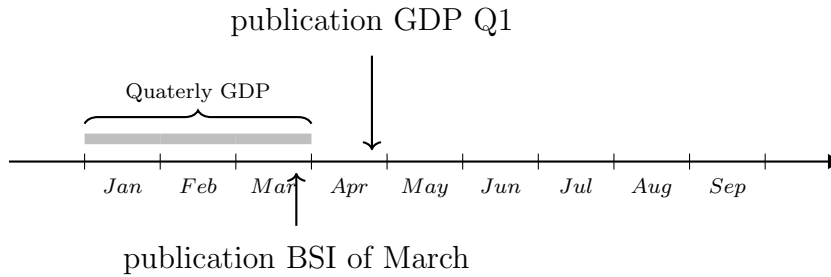


## 9.2 Linear Model

$$GDP_t = \mu + \sum_{i=1}^{n} \sum_{j=0}^{q} \beta_{1,j} X_{i,t-j} + \epsilon_t \tag{9.1}$$

Auto-Regressive model

$$GDP_t = \mu + \sum_{j=1}^{p} \phi_j GDP_{t-j} + \sum_{i=1}^{n} \sum_{j=0}^{q} \beta_{1,j} X_{i,t-j} + \epsilon_t \tag{9.2}$$

where
$GDP_t$    GDP growth over the last semester
$X_{i,t}$    monthly predictors
$\mu$    constant
$\phi_j$    auto-regressive coefficients
$\beta_{i,j}$    regression coefficients

## 9.3   Model

| | Linear Regression | | | |
|---|---|---|---|---|
| | Year on Year GDP (in %) | | | |
| | (1) | (2) | (3) | (4) |
| Constant | 3.434*** | 1.114*** | −1.829** | −4.052*** |
| | (0.170) | (0.255) | (0.867) | (0.922) |
| | | | | |
| 3 months lag of YoY GDP | | 0.690*** | 0.525*** | |
| | | (0.066) | (0.078) | |
| | | | | |
| BSI | 15.053*** | 4.957*** | 10.621*** | 22.080*** |
| | (1.364) | (1.387) | (2.079) | (1.392) |
| | | | | |
| Variance | | | 12.831*** | 27.506*** |
| | | | (3.628) | (3.349) |
| | | | | |
| Observations | 124 | 123 | 123 | 124 |
| R$^2$ | 0.499 | 0.743 | 0.767 | 0.679 |
| Adjusted R$^2$ | 0.495 | 0.738 | 0.761 | 0.673 |
| Residual Std. Error | 1.172 | 0.847 | 0.809 | 0.943 |
| F Statistic | 121.753*** | 173.266*** | 130.755*** | 127.781*** |
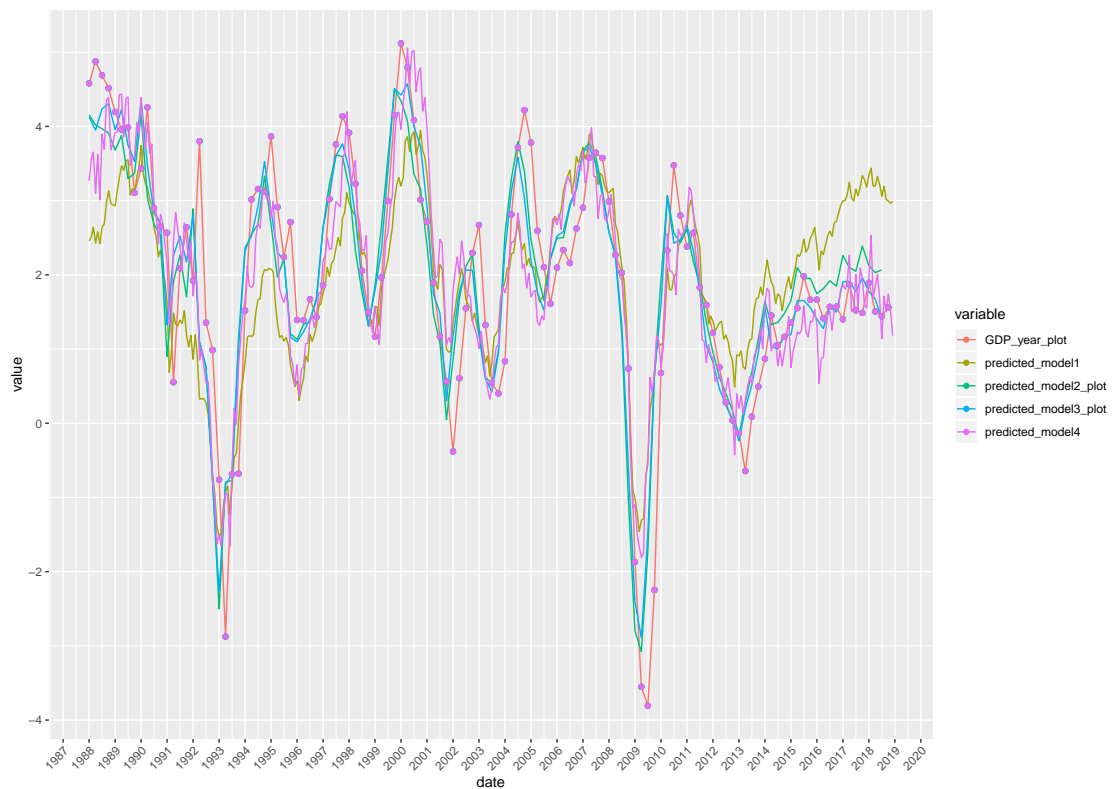


Figure 9.1: Plot

|  | GDP_year | | | |
| --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) |
| Constant | 3.364*** | −4.052*** | −3.993*** | −0.985 |
|  | (0.173) | (0.922) | (0.917) | (0.797) |
| E_I | 14.491*** | 22.080*** | 21.579*** | 5.629*** |
|  | (1.390) | (1.392) | (1.421) | (2.091) |
| E_I_diff | 11.538* |  | 8.181 | 24.063*** |
|  | (6.560) |  | (5.309) | (4.488) |
| Var_I |  | 27.506*** | 27.105*** | 7.179** |
|  |  | (3.349) | (3.340) | (3.433) |
| GDP_year_lag1 |  |  |  | 0.687*** |
|  |  |  |  | (0.076) |
| $R^2$ | 0.512 | 0.679 | 0.685 | 0.813 |
| Adjusted $R^2$ | 0.504 | 0.673 | 0.677 | 0.806 |
| Residual Std. Error | 1.162 | 0.943 | 0.938 | 0.729 |
| F Statistic | 63.468*** | 127.781*** | 86.947*** | 128.113*** |



Figure 9.2: Plot

26
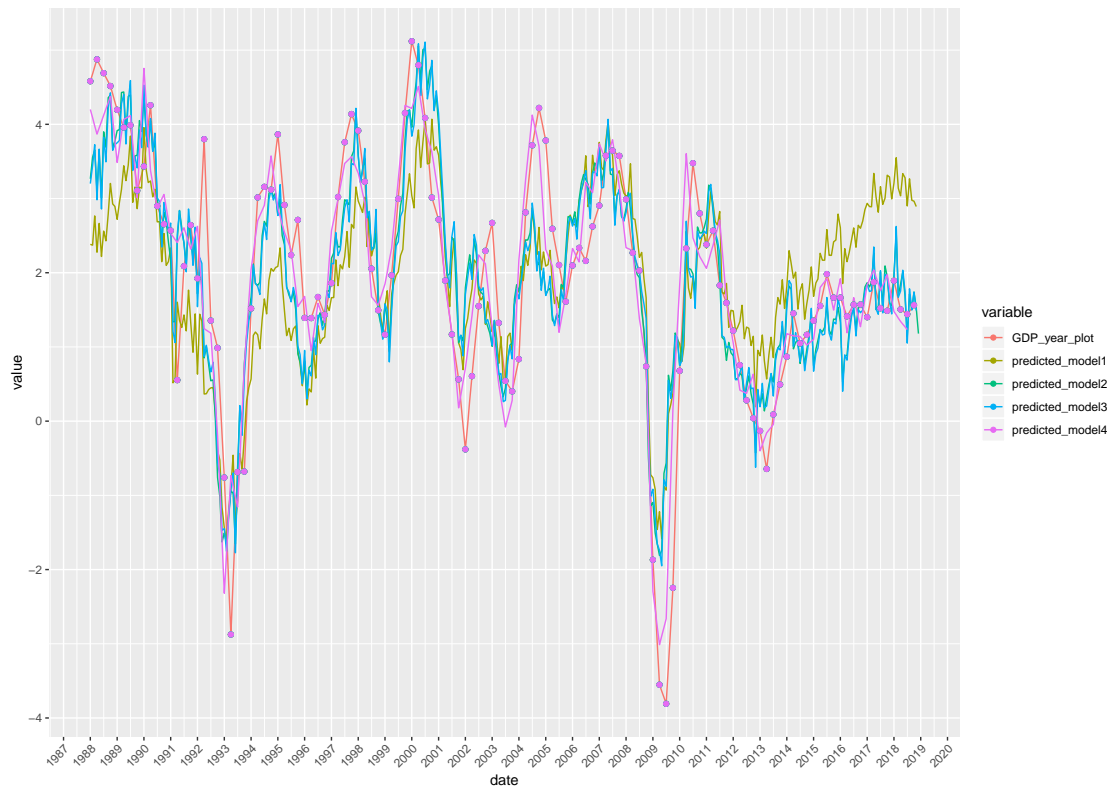
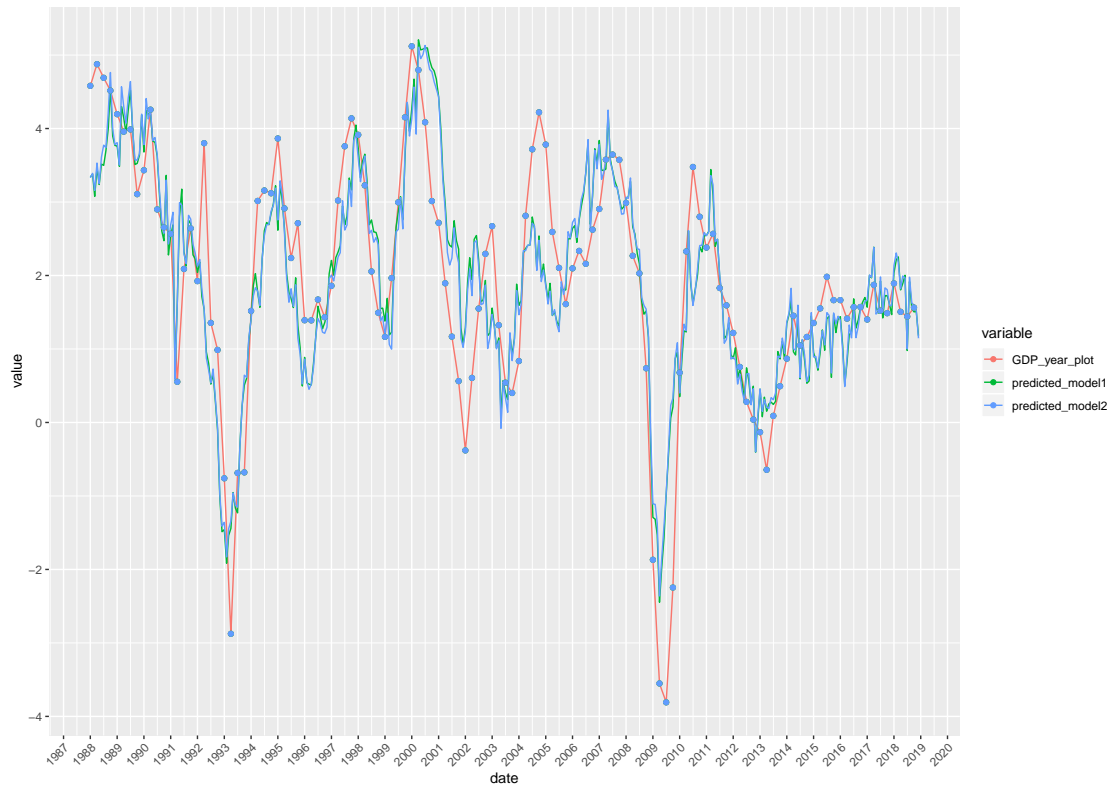|  | GDP_year | |
| --- | :---: | :---: |
|  | (1) | (2) |
| E_I | 22.783*** | 23.088*** |
|  | (1.340) | (1.319) |
|  |  |  |
| Var_I | 22.151*** | 28.508*** |
|  | (6.050) | (3.133) |
|  |  |  |
| Z_I | −24.279*** | −25.008*** |
|  | (5.765) | (5.746) |
|  |  |  |
| Var_Z_I | 6.609 |  |
|  | (5.383) |  |
|  |  |  |
| Constant | −4.090*** | −4.265*** |
|  | (0.871) | (0.861) |
|  |  |  |
| $R^2$ | 0.726 | 0.722 |
| Adjusted $R^2$ | 0.717 | 0.716 |
| Residual Std. Error | 0.878 (df = 119) | 0.880 (df = 120) |
| F Statistic | 78.806*** (df = 4; 119) | 104.133*** (df = 3; 120) |



Figure 9.3: Plot

## 9.4 Evaluation

### 9.4.1 R-square

### 9.4.2 AIC and BIC

### 9.4.3 Mean Square Prediction Error

### 9.4.4 Diebold-Mariano Test

### 9.4.5 Out-of-Sample performances

# Markov Switching Models

**Small Introduction + why are we using it**

Since the pioneer work by **?**, Markov Switching models have been largely used to model business cycles.

Markov Switching models have been very popular since **?** to model business cycles and predict Turning points (see **?**, ...).

Able to predict the 2008 financial crisis if used MS-VAR model **?**

## 10.1 Model(s) Specification

### 10.1.1 Notation

| | |
|---|---|
| $S_t = \{0, 1\}$ | states |
| $N = 2$ | number of states (2) |
| $T = 372$ | number of observations |
| $x_{t=1...T}$ | (hidden) state at time t |
| $y_{t=1...T}$ | Change of the Industrial production indices at time t |
| $p_{i=1...n, j=1...n}$ | probability of transition from state $i$ to state $j$ |
| $F(y|\theta)$ | probability distribution of an observation, parametrized on $\theta$ |

### 10.1.2 Model

**Model**

$$y_t = \begin{cases} \mu_0 + \sum_{j=1}^{p} \phi_j GDP_{t-j} + \epsilon_t & \text{if } S_t = 0 \\ \mu_1 + \sum_{j=1}^{p} \phi_j GDP_{t-j} + \epsilon_t & \text{if } S_t = 1 \end{cases} \tag{10.1}$$

where $\epsilon$ is $N(0, \sigma_s)$

| | |
|---|---|
| $\mu_s = \beta_0 = c_s = \alpha_s$ | regime-specific mean |
| $\beta_s = \phi_s$ | regime-specific auto-regressive parameter |
| $\sigma_s$ | regime-specific variance |

**Transition equation/probability**

$$P = P(S_t = s_t \mid S_{t-1} = s_{t-1}) = \begin{bmatrix} 1 - p_t & p_t \\ q_t & 1 - q_t \end{bmatrix} \tag{10.2}$$

We have then,

$P(S_t = 1 \mid S_{t-1} = 1) = p_t$
$P(S_t = 0 \mid S_{t-1} = 1) = 1 - p_t$
$P(S_t = 0 \mid S_{t-1} = 0) = q_t$
$P(S_t = 1 \mid S_{t-1} = 0) = 1 - q_t$

or

$$P = P(S_t = s_t \mid S_{t-1} = s_{t-1}) = \begin{bmatrix} 1 - p_t & p_t............... \\ q_t............ & 1 - q_t \end{bmatrix} \tag{10.3}$$

# CHAPTER 11

## Conclusion

A large
It was seen that

Discussion

## 12.1 Recruitment procedure and panel data

not real sampling theory

## 12.2 Z that takes more periods into account

## 12.3 Limitations

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

## 12.4 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

## 12.5 Further Research

More complex Nowcasting model with Space space models / MIDAS ....
Combine mixed models and Markov Chain for Panel Data (**?**)
State Space Model
Bayesian estimation **?**

# List of Abbreviations

BSI Business Survey Indicator
GDP

# List of Figures

# List of Tables

# Further Explanation of the Evolution of the responses ...

| Notation | $x_{t-1}$ | $x_t$ | $z_t$ |
|:---:|:---:|:---:|:---:|
| $\pi_{--}$ | -1 | -1 | 0 |
| $\pi_{-0}$ | -1 | 0 | 1 |
| $\pi_{-+}$ | -1 | 1 | 2 |
| $\pi_{0-}$ | 0 | -1 | -1 |
| $\pi_{00}$ | 0 | 0 | 0 |
| $\pi_{0+}$ | 0 | 1 | 1 |
| $\pi_{+-}$ | 1 | -1 | -2 |
| $\pi_{+0}$ | 1 | 0 | -1 |
| $\pi_{++}$ | 1 | 1 | 0 |

# 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:

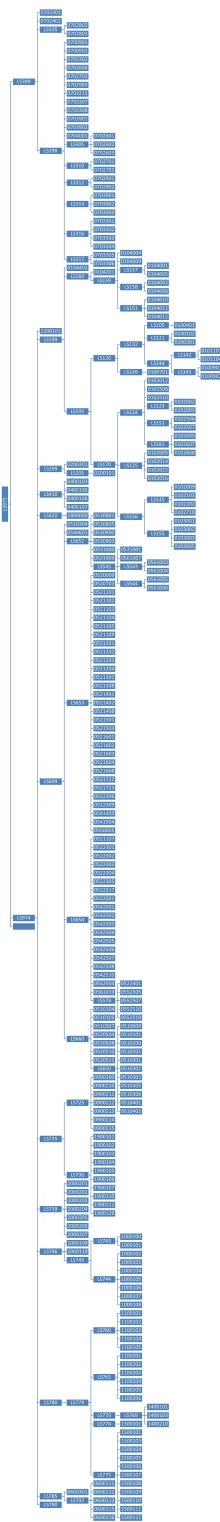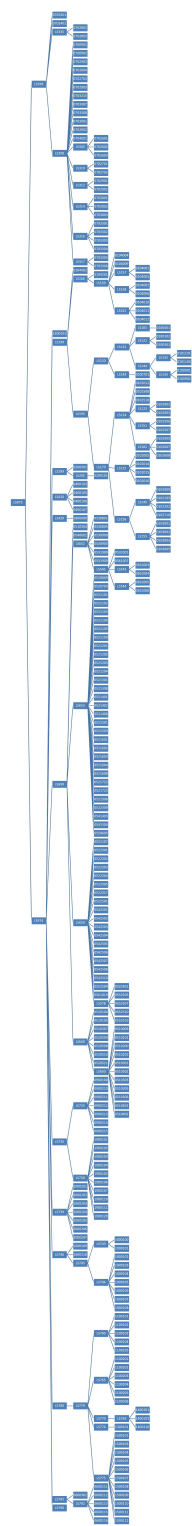Figure 1: The Business Survey Questionnaire in Dutch for the Industrial Sector

Figure 2

Figure 3

**R code for Seasonal Adjustment**

**R code for Creating Lags**

**R code for Linear (Auto-Regressive) Models**

**R code for Markov Switching Models**