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

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"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

CHAPTER 1

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

This year, the Belgian Business Survey is celebrating its 65th anniversary.
In 1954, the National Bank of Belgium started this indicator, that since then

- 1972 results are synthesised in an indicator; the business survey indicator
- Wall Street Journal article "Euroland Discovers A Surprise Indicator: Belgian Confidence" (**?**)
- predictive power for the EU **?**

changes in 2009 see later (section 2.3)

2.1.1 A Business Cycle

2.2 Sampling Method

2.3 Objective and Methodology

sectionObjective and Methodology In 2009 was published "The National Bank of Belgium's new business survey indicator" (**?**)

- 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

Quality Criterion

- high correlation with GDP
- fluctuation that's mostly explained by the conjuncture
- predictive power for the futur months
    more information can be found in **?**
    ...

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

2.5.1   Unweighted Indicator

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

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 π_+ and π_- are the proportion of respondents answering positive and negative. π 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 (π_0) with $\pi_+ + \pi_0 + \pi_- = 1$.

2.5.2 Weighted Indicator

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

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

ω_i is the weight of the company i

Globalisation procedure

Weighting procedure

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:

$$\text{Industry Business Indicator} = \frac{E(X_{Q18}) + E(X_{Q27}) + E(X_{Q32}) + E(X_{Q33})}{4} \tag{2.6}$$

where $E(X_{Q18})$, $E(X_{Q27})$, $E(X_{Q32})$ and $E(X_{Q33})$ are the different averages for question 18, 27, 32 and 33 (can be weighted or unweighted)

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

difference sampling error and variance

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

difference between nominal and continuous variable variance

3.1   Presentation

The (Cochran, 1977)

$$E(X) = \pi_+ - \pi_- \tag{3.1}$$

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

3.1.1   Variance of the Unweighted Indicator

The main variance
cite

$$\begin{aligned} Var(X) &= E\left[(X - E(X))^2\right] \\\\ &= E\left(X^2\right) - E\left(X\right)^2 \\\\ &= \left(\frac{\sum_{i=1}^{n} x_{+i}^2}{n}\right) + \left(\frac{\sum_{i=1}^{n} x_{Ni}^2}{n}\right) + \left(\frac{\sum_{i=1}^{n} x_{-i}^2}{n}\right) - E(X)^2 \\\\ &= \pi_+ + \pi_- - (\pi_+ - \pi_-)^2 \end{aligned} \tag{3.2}$$

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;

$$\begin{aligned} Var(X) &= \pi_+ + \pi_- - (\pi_+ - \pi_-)^2 \tag{3.3} \\\\ &= \pi_+ + \pi_- - E(X)^2 \tag{3.4} \\\\ &= 1 - \pi_n - E(X)^2 \tag{3.5} \end{aligned}$$

Equation 3.3 is interesting Equation 3.4

3.1.2 Variance of the Weighted Indicator

$$Var(X) = \frac{1}{\sum \omega_i p_i} \sum_{i=1}^{N} \omega_i p_i (X_i - \bar{X})^2 \tag{3.6}$$

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

3.1.3 Properties

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

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

Property 3: .....

3.2 Take different questions into account

3.3 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

Best name for this indicator

1. Z indicator

2. Indicator of the Changes in individual answers between t-1 and t

brainstorm evolution volatility change

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

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

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

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

$$E(Z) = \pi_{0+} + \pi_{-0} - \pi_{+0} - \pi_{0-} + 2\pi_{-+} - 2\pi_{+-} \tag{4.1}$$

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

$$E(Z) = \begin{array}{c|ccc} & \textbf{-} & \textbf{0} & \textbf{+} \\ \hline \textbf{-} & 0 & +1 & +2 \\ \textbf{0} & -1 & 0 & +1 \\ \textbf{+} & -2 & -1 & 0 \end{array} \qquad (4.2)$$

$$\pi_{++} + \pi_{+0} + \pi_{+-} + \pi_{0+} + \pi_{00} + \pi_{0-} + \pi_{-+} + \pi_{-0} + \pi_{--} = 1 \qquad (4.3)$$

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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

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

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

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

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

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

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
  - cor(time, var) = 0.5

7.1 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 Small vs Large

8.2 By Sector

8.3 New vs Old participants

8.4 Correlation between questions

8.5 Correlation with GDP

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

8.5.1 lag testing

Linear (Auto-Regressive) Models

lag

9.1 Models

9.1.1 Month vs Quarterly data

Error to aggregate everything to quaterly -¿ lost of information

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
μ	constant
ϕ_j	auto-regressive coefficients
$\beta_{i,j}$	regression coefficients

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	4.2653	0.2138	19.95	0.0000
GDP_year_lag1	6.1137	3.0454	2.01	0.0470
E_2	7.9182	4.0531	1.95	0.0531
E_2_lag1	-3.6618	5.6642	-0.65	0.5192

9.2 Model

9.3 Evaluation

9.3.1 R-square

9.3.2 Mean Square Prediction Error

9.3.3 Diebold-Mariano Test

9.3.4 Out-of-Sample performances

9.3.5 blabla see slides

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 θ

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 ϵ 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
σ_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

Discussion

Recruitment procedure and panel data

not real sampling theory

Z that takes more periods into account

Limitations

Further Research

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

Appendix

List of Abbreviations

BSI Business Survey Indicator
GDP

List of Figures

List of Tables

R code for Seasonal Adjustment

R code for Creating Lags

R code for Linear (Auto-Regressive) Models

R code for Markov Switching Models