# Master Thesis

## Measurement Matters in the Risk Balancing Model

*Exploring alternative specifications of risk balancing behaviour*

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# Preface

Before you lies my thesis "Measurement Matters in the Risk Balancing Model" which was written to fulfil the requirements of the Master Management, Economics and Consumer studies at Wageningen University and Research. I was engaged in researching and writing about risk balancing from March till August, 2017.

With Yann de Mey as my supervisor, the overall process of writing my thesis went smooth. He provided a perfect balance between helping me and self-education. He taught me all there is to know regarding risk balancing. He was always available, in person and on Skype and even e-mailed me back during lunch breaks. Hence, I would like to thank Yann for his excellent guidance and support during this process. Kirsten de Klein deserves a particular note of thanks: your moral support was always helpful.

Leander van Berkel

Wageningen, 15 August, 2017

# Abstract

**Objective.** The aim of this paper is to explore the interactions between financial risk and business risk on farm level using alternative specifications and determinants. Exploring the expected business risk measured using a subjective scale, comparing the Gabriel and Baker method with the Collins method and testing risk aversion are also pursued. **Design.** A literature study and linear, fixed and random effects regression is conducted using the FADN panel data of the Flemish part of Belgium for the year 2005-2015. **Results.** Measuring business risk on a subjective manner resulted in risk balancing results comparable to measuring business risk using the objective manner. When a large data sample is used, it is advised to derive the financial risk focusing on solvency, thus using the Collins model, otherwise the Gabriel and Baker method is advised. Using a direct scale and a psychometric scale to measure risk aversion, setting non-significance aside, it showed that risk averse farmers are less exposed to financial risk (-0.21). The random effect model showed that there is evidence of weak balancing behaviour for the Flemish farmers for 2005-2015 (-0.143$^{***}$) when controlling for risk aversion, cost of debt and assets profitability. **Scientific relevance.** The scientific relevance of this study is to provide policy makers with awareness of what business risk lowering policies may have as a consequence, namely risk balancing behaviour. Additionally, to give other researchers a theoretical framework when working with risk balancing models concerning the choice of method and using alternative specifications and determinants. **Originality.** It is the first time, to the best of my knowledge, that the Gabriel and Baker, and Collins methods of risk balancing are compared side by side. Measuring business risk on a subjective scale and adding risk aversion as a continuous variable are also a first.

**Key words: Risk balancing, Financial risk, Business risk, Risk aversion, Behaviour, FADN database, ILVO, Belgium**

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# Abbreviations

| | |
|---|---|
| AP | Assets profitability |
| ARCH | Autoregressive conditional heteroskedastic model |
| BR | Business risk |
| $BR_C$ | Business risk Collins method |
| $BR_{GB}$ | Business risk Gabriel and Baker method |
| DSP | Discrete stochastic programming |
| FADN | Farm accounting data network |
| FE | Fixed effects |
| FR | Financial risk |
| $FR_C$ | Financial risk Collins method |
| $FR_{GB}$ | Financial risk Gabriel and Baker method |
| ID | Cost of Debt |
| ILVO | Institute for agriculture and fisheries research |
| L.BR | Lagged value of business risk |
| NOI | Net operating income |
| OLS | Ordinary least squares |
| RA | Risk aversion |
| RE | Random effects |
| SD | Standard deviation |
| TR | Total risk |
| VAR | Variance |

# 1. Introduction

It is essential for the European Union to make underpinned decisions regarding policies and regulations. The consequences of those policy has to be predicted as accurate as possible. To optimally predict the consequences, the behaviour of all the stakeholders has to be predicted, thus knowledge regarding farm management decision making is required. The chance of a policy having unforeseen effects, especially when an unforeseen effect has a bad influence on other factors, has to be minimalized. An unforeseen effect in the case of this study is risk compensation behaviour, also known as risk balancing behaviour. Risk compensation implies when there is a perceived change in riskiness in a situation or activity, a person will alter their actions or choices to obtain a balanced risk and reward combination. Risk compensation behaviour in traffic is for example, when individuals began to wear safety belts as required by law, as a result individuals began to drive more riskier (e.g., drive faster, brake later) (Vrolix, 2006). In theory, the individuals drove with more risk to balance their risk and reward compensation. However the hypothesis of risk balancing is usually hard to test since it is generally tested indirectly. In the case of the riskier driving, only the implications are measured, namely the crashes.

Looking at risk balancing behaviour in the agriculture sector, the balancing of financial and business risk is studied, where farmers try to reach the optimal level of total risk. Total risk consists of financial risk and business risk (Fig. 1). Business risk is defined as the risk a farmer faces due to changes in the market environment (e.g. production, price , institutional and policy risk) and is not influenced by the financial risk. Thus, the business risk is the risk that is exogenous to the firm (Collins, 1895). Financial risk is defined as the additional risk a farmer faces due to use of debt financing (Gabriel and Baker, 1980). Risks such as interest rate risk or credit risk are financial risks. There is an interest in decreasing the business risk to which farmers are exposed. Those business risk lowering policies might unintentionally increase the financial risk farmers are facing because of risk balancing behaviour. Looking for empirical evidence regarding risk balancing, de Mey et al. (2014) showed that there is no evidence of strong-form risk balancing in Europe, while there was evidence for weak-form risk balancing. Strong-form risk balancing is here defined as keeping total risk at a constant level, so business risk and financial risk move in opposite direction.


**Figure 1. Overview of the risk balancing formula**

## 1.1 Theoretical background

Gabriel and Baker (1980) came with the theoretical seminal paper showing the concept of business and financial risk balancing behaviour. They suggested that there is a financial response to business risk modifications. The concept of a trade off in the decisions a farmer makes regarding risk behaviour was created. The theoretical paper proposed that if business risk would decrease, it would lead to the acceptance of greater financial risk.

Collins (1985) has made theoretical support for the risk balancing hypothesis, however the paper uses other parameters than the original risk balancing hypothesis since the paper focuses on the return on assets and leverage factor, and not on interest over net operating income as Gabriel and baker did. Building on this model, Ahrendsen et al. (1994) incorporated depreciations, taxes and investments in the model. Also using data from the United States, they found evidence for risk balancing behaviour. However the strategic management decision process is likely to be slow. Turvey and Baker (1989) showed a connection between hedging and risk balancing behaviour. Hedging increased, as farm debt relative to assets increased. The reason for this result is that the farmers use the futures, which decreases business risk due to the leverage affect. This leverage effect offsets the increase in financial risk in accordance to the risk balancing hypothesis of Gabriel and Baker. However, when the hedge lowers the return on assets, financial risk could increase due to the decreased returns, which would bring a decrease in financial leverage.

Empirical evidence for risk balancing comes from the U.S. by using an autoregressive conditional heteroskedastic model (ARCH). Moss et al. (1990) uses the ARCH model to investigate the debt farmers have in the U.S. The model finds empirical support in favour of the risk balancing hypothesis. The risk balancing paradox is a definition that was first introduced by Featherstone et al. (1988). It is the paradox that income supporting or risk reducing policies can increase the chance farmers losing part of their equity or going bankrupt. This due to increased leveraging by farmers. For a full timeline of published literature regarding risk balancing behaviour, see Figure 3.

Where Gabriel and Baker (1980) and Collins (1985) lay the foundation for the risk balancing hypothesis with their theoretical model, abundant literature is available adding to the theory of the paper, theoretically as empirical. Most empirical studies regarding risk balancing behaviour are U.S. based, where de Mey et al. (2014) was the first to show weak balancing behaviour in Europe using the FADN database. They followed the model of Gabriel and Baker (1980) and followed the correlation relationship analysed by Escalante and Barry (2003). Half over the farm observations showed signs of risk balancing. The coefficient estimate in the analysis suggests that a one percent decrease in business risk increases financial risk by 0.043 percent. The result also showed that the adjustment process is slow, as Ahrendsen et al. (1994) already showed.

## 1.2 Research problem

As mentioned before, the chance that policies have an adverse effect must be minimalised. For policymakers to see the consequences of their policies, risk behaviour must be understood. Abundant data is available regarding risk management since there is an increased interest in tools and decision aids on the part of farmers and policy makers (Richardson et al., 2000). What the farmers behavioural reactions are to changes in economic and policy environment receives special attention. Since farmers goals are multidimensional and not easy to understand, predicting behavioural responses is not straightforward (Patrick et al., 1983). When the behavioural reactions to changes in economic and policy environment are understood, personalized policies per region or sector can be made.

Provided with the data of the FADN database and the Flemish survey data, a unique opportunity exists to build further on the risk balancing conclusion of de Mey et al. (2014) in Europe. While research is already done on empirically proving risk balancing in Europe (de Mey et al., 2014) China (Turvey and Kong, 2009) and the US (Escalante and Barry, 2003), this study focuses on exploring new measurement specifications for the parameters used in the risk balancing model. Focusing on financial risk, business risk and risk aversion, this study explores different views on measurement and reruns the model with new data and new measurements looking for empirical evidence on risk balancing in the Flemish part of Belgium.

Changes in financial risk are considered strategic adjustments because of changes in the expected business risk (Gabriel and Baker, 1980). That is why financial risk is at the left side of the risk balancing model and business risk at the right hand side, see equation 1.

$$FR = BR + \cdots + \varepsilon \qquad (1)$$

The majority of the risk balancing studies make the assumption that the objective of the farmer is to maximize expected utility. However, the prospect theory of Kahneman and Tversky (1979) presents a critique on the expected utility model. They call on inconsistencies in the expected utility model, especially when people under weigh outcomes that are merely probable in comparison with outcomes that are obtained with certainty. To follow previous studies and to make the results of this study comparable with previous studies, the prospect theory will be disregarded is this study and a maximum utility goal of the farm is assumed.

### *Business risk*

When looking at risk balancing, the variable business risk is used. It is assumed that business risk can be objectively measured, and that the individual risk perception regarding risk differ. However risk perception can also be conceptualized as subjective probability, influence and impact. Furthermore, the subjective impact is considered more important than the objective impact in decision making and driving people's behaviour (Sjöberg, 2000). Probability assessment in the subjective approach is the more important analytical tool (Hardaker and Lien, 2010). The objective method, also known as the frequentist approach, to assess business risk is still widely used since the data gathering is more convenient and cheaper than the subjective method. When the data sample of a study uses a large geographical area is collected over multiple years, the frequentist approach is preferred by researchers while Hardaker and Lien (2010) prefer the subjective approach. Survey data provides an opportunity to subjectively measure the expected business risk**.** The subjective method is also preferred as the expected utility hypothesis often fails to explain why people act in a manner. This can be appointed to loss aversion where people place more weight on avoiding losses than they do to comparable winnings (Robin and Thaler, 2001). A difference is expected in the objective business risk compared to the subjective business risk since historical data cannot capture all the expected business risk a farmer experiences. For example, if a farmer knows that a farmer right next to him is going to start a new business and competing with him, that expected business risk is not captured in the variation of the historical net operating income. However, the expected business risk that is not captured in the variation of net operating income, could be captured in the survey. Thus, the first concrete research problem is that the objective business risk is widely used in risk balancing models while there are literature studies that support subjective methods for measuring business risk (e.g. Gabriel and Baker, 1980; Bampasidou et al., 2017; Hardaker and Lien, 2010).

### *Financial risk*

Different considerations exist when computing financial risk. The leverage position chosen can be regarded as financial risk (Collins, 1985). Financial risk encompasses the risk of cash insolvency (Van Horne, 1974). Gabriel and Baker (1980) and then later de Mey et al. (2014) use a method called the interest coverage ratio. It shows the amount of times a farmer can make the required fixed debt interest payments. A high ratio indicates a greater debt service and thus a greater financial risk. It is the leverage choice component the farmers make regarding debt payments compared to income. See equation 2 used by de Mey et al. (2014) focusing on the liquidity of a farm

$$FR = \frac{I}{\mu_{NOI} - I} \qquad (2)$$

where $FR$ represents the financial risk, $NOI$ the net operating income and $I$ represent fixed debt servicing obligations. While the interest coverage ratio does not take the assets ratio into account, the leverage factor does (δ). Too much debt can be dangerous for a farm. However when the farm operations can generate a higher return than the interest rates, the debt is fuelling the profits of the farm. Only the farmer is exposed to a higher level of financial risk. The leverage factor is the debt to asset ratio and shows how much debt financing the farmer uses in relationship to his or her assets. It determines the financial structure of a company. Understanding which method captures financial risk as accurate as possible is crucial since financial risk is treated in the risk balancing model as de dependent variable. Which method is most accurate or suited to assess financial risk for the risk balancing behaviour is unknown. The second research problem is that both methods are used in literature since no comparison is ever been made between the two models (Gabriel and Baker, 1980; Collins, 1985).

### *Risk aversion*

Risk aversion is hard or even impossible to measure using agriculture data. To really asses the structure of risk aversion, more is needed than only the production data, especially when the samples are small (Lence, 2009). Risk aversion is a parameter used for years now, determining how much utility an individual can obtain from a good or experience. The utility function that quantifies how much utility we derive, is shaped by the risk aversion. In the past there have been disagreements whether you can regard risk aversion as a constant or not (Thomas, 2016). Knowledge regarding the structure of risk aversion is of interest since it determines responses to risk (Gollier, 2001). In the model of Gabriel and Baker (1980) and de Mey et al. (2014), risk aversion is reflected in the fixed effects of the model. The risk balancing hypothesis is as follows

$$\alpha \leq TR = BR + FR = \frac{\sigma_{NOI}}{\mu_{NOI}} + \frac{\sigma_{NOI}}{\mu_{NOI}} \frac{I}{\mu_{NOI} - I} \leq \beta \qquad (3)$$

where α represents the minimum amount of TR and β the risk constraint consisting of, for example, farm size, age, risk aversion and economic conditions. Where de Mey excluded risk aversion from the model and considered it as a fixed effect, risk aversion could be included in the model since it is not a constant and is person specific (Thomas, 2016). Expected is to see that the lower the value of risk aversion, thus risk seeking, a farmer will operate with a higher financial risk. When there is observed variation in the risk aversion of the Belgium farmers, maybe even per region or per farmer type, tailor made policy changes could help prevent risk balancing behaviour of Belgium farms. The third research problem is here that is unknown what kind of difference it makes regarding the risk balancing results when risk aversion is included in the model as a continuous variable and of the coefficient estimate is as hypothesized. Additionally, to examine if there is still risk balancing present in the Flemish part of Belgium when risk aversion is not considered a constant.

## 1.3 Objective of this study

This research will explore the interactions between financial risk and business risk on farm level using alternative specifications and determinants. Two different methods of measuring financial risk will be compared. Provided with new data, the business risk can be assessed using a subjective method, and the risk aversion using a direct scale and a psychometric scale. The goal is to understand the interactions and the responses to changes in expected risk of farmers which in time will lead to an improved risk management for agricultural companies in the Flemish part of Belgium.

## 1.4 Research questions

Looking at the problem statement and the knowledge gap regarding different measurement methods concerning the risk balancing hypothesis, the following main research question was defined;

> *Have Flemish farmers made strategic financial risk adjustments in response to perceived changes in the level of business risk based on revised risk balancing models?*

This question can be further decomposed into the following sub-questions;

1) *How can different empirical measures of financial risk and business risk be linked to alternative theoretical risk balancing models?*
2) *What theoretical role does risk aversion play in risk balancing formulations?*
3) *To what extent does measuring the business risk on a subjective manner versus an objective manner make a difference?*
4) *Which method captures financial risk as accurate as possible and which manner is most accurate for the risk balancing model?*
5) *What are the implications of explicitly incorporating an empirical measure of risk aversion in risk balancing models?*

The research questions are answered using literature study, regression models using unbalanced time panel data, fixed effects models and random effects models. The first two research questions are not included in the results of this study. This for the reason that the answers of the first two questions are used to develop the econometric design for the rest of the study. The results then consist of the regression results which are used to answer question three till five.

# 2. Data and methodology

Here a description can be found of the data used in this study as well as the descriptive statistics. An overview of all the variables used in the models can be found in Table 1. A graphical overview of the conceptual framework can be found at the beginning of the methodology (Chapter 2.2). In the methodology part, the regression equations and methods are explicated. Followed by a timeline accompanied by explanations of all the relevant studies concerning risk balancing. Then an extensive commentation regarding risk aversion and how to include it in the risk balancing model is given. This chapter is finished with the econometric design of the three methods which in turn will test the different parameters, namely business risk, financial risk and risk aversion.

## 2.1 Data

The Farm Accounting Data Network (FADN) and the Institute for Agriculture and Fisheries research (ILVO) have provided the data for this research for the years 2005-2015. The FADN is compiled by the European Union and every country is obliged to participate. The European Union endeavours to collect a database where the data collection and bookkeeping principles are in one line across every country. When the bookkeeping principles are equal for every country, the data becomes comparable. This study uses the Flemish sample of the FADN database.

Additional to the FADN database, this study uses a survey done in the Flemish part of Belgium provided by the ILVO. The ILVO survey will be called the survey from now on. The survey investigates the attitude towards risk, the perceived usefulness of risk management studies and other perceptions of farmers. Regardless of someone's risk perception, everyone has a different risk attitude, and that attitude causes people to react differently (Wauters et al., 2014). Bearing that hypothesis in mind, it suggests that every farmer will react differently and risk balancing behaviour is different for every individual farmer. The survey was executed by Wauters et al. (2014) where they tested risk perception in different ways. People were asked to give a probability for a certain event to happen, as well as people's subjective impact regarding a series of events, and finally, what kind of influence the farmers could have on the series of events. The survey was sent by post which made quantification of risk preferences based on an expected utility framework troublesome. The survey uses a psychometric method to measure risk perception. A direct measurement scale was used as well by Bard and Barry (2000). With a response rate of 81 percent, the sample size is considerably large and representative (n = 614). The database complemented with the survey data gives that unique possibility to measure business risk, financial risk and risk aversion using different specifications.

Table 1. Definitions and expected signs of the regression variables

| *Variable* | Abbreviation | Definition (unit) | Expected sign |
|---|---|---|---|
| *Financial risk* | $FR_{GB}$ | Using the net operating income I/NOI-I | |
| *Financial risk* | $FR_C$ | Using the Leverage factor Assets/Debt | |
| *Business risk* | $BR_{GB}$ | The coefficient of variation using three lagged years of net operating income | - |
| *Business risk* | $BR_C$ | The variance using three lagged years of the return on assets | - |
| *Business risk* | $BR_{sub}$ | The subjective probability and the subjective impact | - |
| *Business risk* | $BR_{inf}$ | The BRsub including the subjective influence | - |
| *Cost of debt* | *I/D* | The ratio of interest paid over outstanding debt | + |
| *Asset profitability* | *NOI/A* | Ratio of net operating income over average assets used | - |
| *Risk aversion* | $RA_{dir}$ | Risk aversion measured on a direct scale | - |
| *Risk aversion* | $RA_{psych}$ | Risk aversion measured on a psychometric scale | - |
| *Farm area* | *Area* | Total utilized agricultural area in hectare | + |
| *Farm type* | *Type* | 1 = "Field crops"; 2 = "Horticulture"; 3 = "Fruit"; 4 = "Milk"; 5 = "Granivore"; 6 = "Mixed field crops"; 7 = "Mixed livestock"; 8 ="Field crops and livestock" (dummy, field crops as reference) | ± |

In this study a distinction can be made between the dependent variables, main independent variables and the covariates. The dependent variables are the $FR_{GB}$ and $FR_C$, the main dependent variables are the $BR_{GB}$, $BR_{sub}$, $BR_{inf}$, $RA_{dir}$, and *RApsych.* The covariates used in the analysis are *I/D, NOI/A, Area* and *type.* An overview of all the variables can be found in Table 1.

First the two dependent variables are elucidated. The financial risk using the Gabriel and Baker method, $FR_{GB}$, is derived as *interest paid/(NOI-interest paid).* Interest paid is the total amount that farmers spend on short and long term loans. The *NOI* is calculated as the operating receipts minus the costs. The costs consist of operational costs, depreciation, wages paid and rent paid for land. The fictional costs for family labour, land used under property, taxes and interest costs are excluded from the cost calculation. This to reduce the problematic negative *NOI* observations. For all observations of $FR_{GB}$ that were larger than ten or below zero, the value was recoded to a value of 10, which happened in 15 and 461 of the 5356 (<1%, 8%) cases respectively. Financial risk derived using the Collins method, $FR_C$, is the leverage factor of a farm. No negative observations or outliers were observed here. The leverage factor here is the debt over assets. Where debt and assets are the average of the opening and closing valuation of the total debt and assets of a farm. Averaging is used out to rule out the differences between different accounting principles. When the value of assets increases during a book year, it is unknown when this occurred. By averaging, you overcome this uncertainty.

Next the main independent variables are discussed. The business risk, $BR_{GB}$, is derived using the coefficient of variation of the *NOI* over a three-year window *(SD(NOI)/μ(NOI))*. Observations with a negative mean value for *NOI* for a three year window were recoded. The mean of the *NOI* over the whole observed period is to replace the negative mean value over a three year period. For our sample, 113 observations had a negative mean *NOI* over a three year period and were replaced with the mean of the whole observed period. This is less than three percent of the sample but business risk can be considered underestimated because of this procedure. However, It is necessary since there can be no coefficient of variation using negative values. It is not feasible for the value of $BR_{GB}$ to be negative, hence all the negative values were transformed to equal a value of zero. Of the whole dataset, 44 observations were recoded which equals less than one percent. Since OLS regression is sensitive to outliers, $BR_{GB}$ above the value of ten were recoded to equal the value of ten. Also here, less than one percent was recoded, namely 49 observations. The business risk using the Collins method, $BR_C$, is the variance of Return on Assets over a three-year window. Where *ROA* is the net operating income over assets. There can be no negative return on assets, therefore every negative value of *ROA* is transformed to a value of zero. In the whole dataset, 331 values of *ROA* were negative and were transformed which is less than six percent of the whole dataset. The consequence of this procedure is that risk is again underestimated since every negative value of *ROA*, which implies high levels of risk, is transformed. Using the subjective probability, impact and influence the two different subjective business risk values are derived ($BR_{sub,}$ $BR_{inf}$). A more elaborate explanation can be found in chapter 2.5.1. Risk aversion measured on a direct scale, $RA_{dir}$, is measured using one direct question from the survey. Risk aversion measured on a psychometric scale, $RA_{psych}$, is also measured using different constructs from the survey which are elaborated in chapter 2.5.3.

The following variables are considered the covariates of this study. The cost of debt, *I/D*, is a ratio that is calculated using interest paid per year divided by the debt. All values that were larger than 0.15, thus farmers paying more than fifteen percent interest over their debt, were transformed to be equal to 0.15. Of the whole sample, 271 values were transformed which is five percent of the whole dataset. The transformations of the ROA are performed since a value larger than 0.15 is unlikely and and can cause unstable OLS results. Asset profitability, *NOI/A*, is the ratio of *NOI* over total assets. *Area* is the area a farmer has available for agricultural production. Thus excluding the area used by e.g. tracks and buildings. Farm type is a categorical value which is assessed using the farming types defined at the EU (FADN, 2008). See Table 2 for all the different farm types. The variables used in the model are calculated as ratio's or are non-monetary values. Thus there is no need for deflation as we are working with panel data. In Table 2 and 3 descriptive statistics can be found of the data used.

**Table 2. Descriptive statistics variable type**

| *Category* | Frequency | Percent | Cumulative |
|---|---|---|---|
| *1. Field crops* | 366 | 6.83 | 6.83 |
| *2. Horticulture* | 1.047 | 19.55 | 26.38 |
| *3. Fruit* | 496 | 9.26 | 35.64 |
| *4. Milk* | 1.488 | 27.78 | 63.42 |
| *5. Granivore* | 921 | 17.20 | 80.62 |
| *6. Mixed field crops* | 105 | 1.96 | 82.58 |
| *7. Mixed livestock* | 420 | 7.84 | 90.42 |
| *8. Field crops and livestock* | 513 | 9.58 | 100.00 |
| *Total* | 5.356 | 100.00 | |

**Table 3. Descriptive statistics (* = values on a Likert scale from 1 – 5)**

| *Variable* | Mean (SD) | Min | Max |
|---|---|---|---|
| *Financial Risk Collins* | 0.285 (0.228) | 0 | 1.644 |
| *Financial risk Gabriel* | 1.077 (2.836) | 0 | 10 |
| *Business risk Collins* | 0.012 (0.012) | 0 | 1.632 |
| *Business risk Gabriel* | 2.823 (4.065) | 0 | 10 |
| ** Business risk subjective method – probability and impact* | 3.574 (0.464) | 1.889 | 5 |
| ** Business risk subjective method – probability impact and influence* | 3.148 (0.409) | 1.889 | 4.815 |
| ** Risk aversion psychometric scale* | 2.766 (0.572) | 1 | 4.556 |
| ** Risk aversion direct scale* | 3.353 (0.998) | 1 | 5 |
| *Cost of debt (I/D)* | 0.049 (0.036) | 0 | 0.15 |
| *Asset profitability* | 0.139 (0.132) | 0 | 2.616 |

## 2.2 Methodology

The risk balancing model as seen in Figure 2 gives an graphical overview of the measurement decisions that are revising the model. Regarding financial risk a choice is made to focus on solvability or liquidity. Thus a choice between following Gabriel and Baker or Collins when assessing the financial risk. For the business risk the frequentist approach will be contested by the subjective method. Risk aversion will be put into the model, not as a fixed effect but as a continuous and categorical variable. The risk aversion will be put into the model measured with a direct method and a psychometric method. The plusses and minus signs on the arrows indicate the expected effect of the change in measurement method on the risk balancing result.

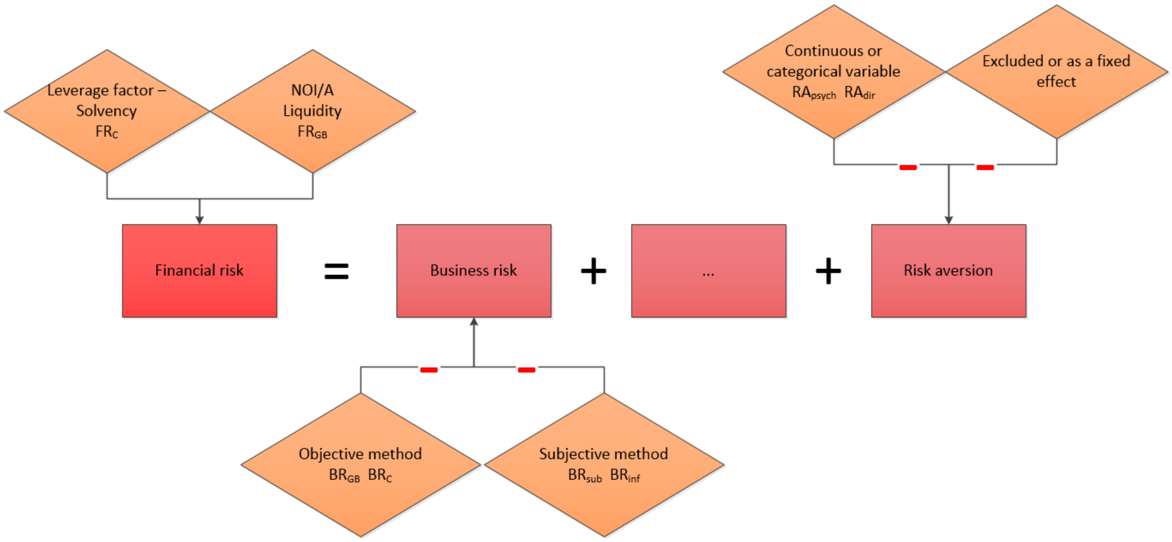


**Figure 2. Conceptual model of the alternative specification and their expected signs**

### *Business risk*

The expected business risk on a subjective manner consist of three elements namely the subjective probability, subjective impact and subjective influence (Wauters et al., 2014). Those three elements are present in the survey and will be combined to make the expected business risk. Thus, the expected business risk will consist of different elements. First of all, the risk perception is often seen as the subjective probability (Sjöberg, 2000). That is the reason why the subjective probability is included when deriving the expected business risk of a farmer. The farmers risk management strategies are guided by the subjective probabilities of adverse events (Hardaker et al., 1997). Risk is also seen as the impact when an adverse event occurs. And last of all, the people's behaviour is influenced by the locus of control over something (Elkind, 2008). That is why the expected business risk is a combined value of the subjective probability, subjective impact and subjective influence of an event. This study compares measuring the expected business risk using the subjective probability, subjective impact and subjective influence, but also runs the model excluding the subjective influence. Hence, conceptualizing risk perception using the probability of the shock happening and the perception of the impact of the shock once it happens is used before in different studies (e.g. Smith et al. 2000; Quinn et al. 2003). That is why subjective influence is also excluded. It will be compared to the business risk derived by using the standard deviation of the net operating income, as used by previous literature (de Mey, 2014)

### *Financial risk*

Financial risk can be measured using different methods. To test which method is most suited for the risk balancing model, not only the *NOI* is used in an OLS model but the leverage factor as well. This will give an alternative financial performance image of the farmers since the assets of the farmer is taken into account. Thus, the Gabriel and Baker method will be compared to the Collins method. The assumption is made that financial risk decisions made in the current period are based on the expectation that a farmer has on the development of business risk in future periods. De Mey et al. (2014) follows previous literature and uses historical experiences as the basis for the expectations. In the econometric design is shown exactly how financial risk is measured (Chapter 2.5.2).

### *Risk aversion*

Risk aversion is also studied using extracted data from the survey. Wauters et al. (2014) measured the risk aversion of the farmers in two manners; a direct measurement and a psychometric measurement based on a scale. The direct method was adapted from Bard and Barry (2000) and is simply a question where farmers can indicate to what extent they are willing to take risks. Answering to what extent farmers agree with nine statements was the measurement method for the psychometric method. It was measured on a 1 to 5 Likert-scale. The direct measurement as well as the psychometric method will be tested in the model and added as a variable in the risk balancing regression hypothesis. Since the direct method consist of one question, it will be handled as a categorical variable in the equation. The psychometric scale will be verified for his reliability and validity using the Cronbach alpha. Expected is that the more risk seeking a farmer is, thus a lower value on the Likert scale, the higher the financial risk. From the psychometric method, the outcomes of the nine statements will determine the risk perception and will be included in the model as a continuous variable. Also a regression will be run where the risk aversion measured using a psychometric scale is cut up in four different categories. It is then analysed per category to study differences in risk balancing behaviour with different levels of risk aversion.

To answer the main research question of this study, a random effects model is run based on the model of de Mey et al. (2014). Differences in the model will be the revised measurements of business risk, financial risk and risk aversion. The full model can be found under 'Econometric design'.

## 2.3 Different empirical measures

Where most of the risk balancing models try to explain the same phenomenon, namely the balancing between financial risk and business risk to achieve the optimal amount of risk, there is a lot of variation between the risk balancing models. Below a timeline (Figure 3) and a table (Table 5) can be found where an overview is given for all the relevant published risk balancing models. The letters in the table correspond with the figures in the timeline.

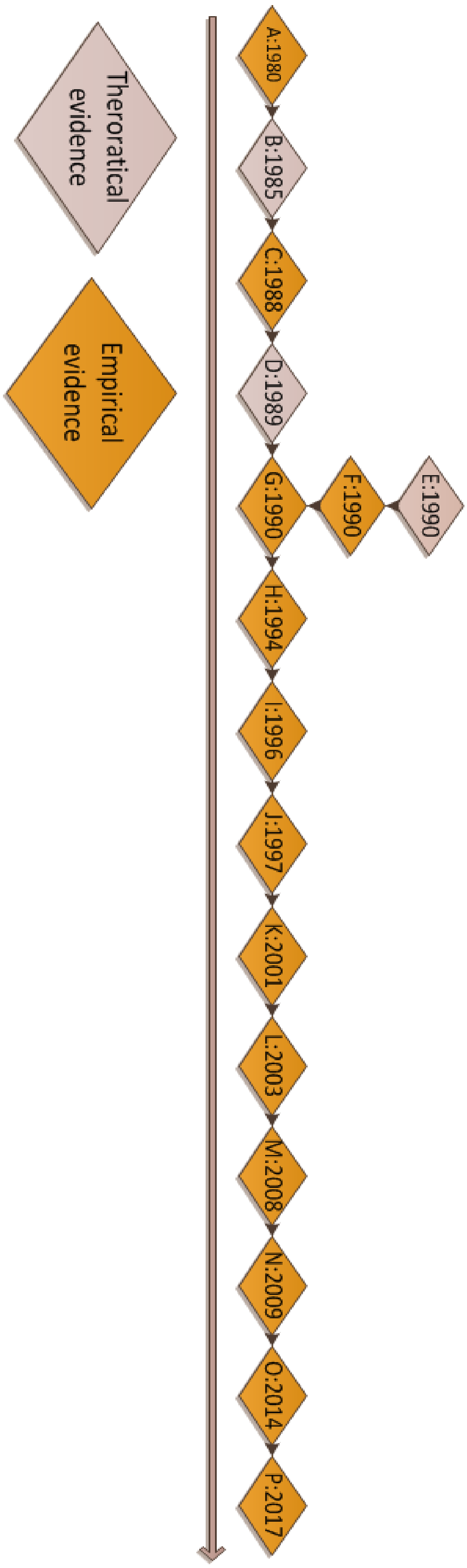


**Figure 3. Timeline of the most relevant published risk balancing models**

Table 4. Overview of all related risk balancing articles

| | Author of the article | Measurement method of risk balancing |
|---|---|---|
| *A* | Gabriel and Baker (1980) | Conceptual framework for risk balancing plus U.S. aggregate evidence |
| *B* | Collins (1985) | An alternative to the Gabriel and Baker model for the risk balancing hypothesis |
| *C* | Featherstone (1988) | Mean-variance model. Theoretical model on optimal leverages and the probability of equity losses |
| *D* | Turvey and Baker (1989) | Expected utility model to determine optimal risk |
| *E* | Turvey and Baker (1990) | Two-period discrete sequential stochastic programming model |
| *F* | Featherstone et al. (1990) | Discrete stochastic programming |
| *G* | Moss et al. (1990) | Autoregressive conditional heteroskedastic model |
| *H* | Ahrendsen (1994) | Expected utility model, extending Collins (1985) |
| *I* | Jensen and Langemeier (1996) | Tobit regression |
| *J* | Ramirez et al. (1997) | Reformulate the Collins model plus a numerical example |
| *K* | Escalante and Barry (2001) | Simulation-optimization framework |
| *L* | Escalante and Barry (2003) | Correlation analysis |
| *M* | Escalante and Rejesus (2008) | A multi-period programming framework using optimization-simulation techniques |
| *N* | Turvey and Kong (2009) | Linear regression analysis |
| *O* | De Mey et al. (2014) | Linear fixed effects regression model |
| *P* | Bampasidou et al. (2017) | Modelling debt choice |

The foundation for the risk balancing hypothesis came from Gabriel and Baker in 1980. They showed that farmers do make financial adjustment leading to a decrease in financial risk in response to a rise in business risk. It reflects a farmer's potential use of changes in his financial structure of the farm which can mitigate the effects of changes in business risk. The two external sources of business risk in the agricultural firm are the market where in the farm operates and changes or uncertainty regarding the environment. The market produces price variability and the environment can cause production variation which in time causes business risk.

Collins (1985) describes the business risk as the variance of the return on assets. It measures the risk that is exogenous, so not influenced from the inside, to the farm. While Collins and Gabriel and Baker both provided theoretical support for the risk balancing hypothesis, they both use different approaches for the financial risk as the business risk. The risk measure in the study of Gabriel and Baker uses the coefficient of variation of NOI, while Collins use variances of the ROA.

**Table 5. Overview of the used empirical measures of Gabriel and Baker, and Collins**

| | **Gabriel and Baker (1980)** | **Collins (1985)** |
|---|---|---|
| *Financial Risk (FR)* | $FR = \frac{I}{NOI - I}$ | *FR = Debts / Assets =* $\delta$ |
| *Business Risk (BR)* | $BR = \frac{\sigma_1}{\bar{c}x}$ = *STD( NOI)* | *BR = VAR(ROA)* |
| *Total risk (TR)* | $TR = \frac{\sigma_1}{\bar{c}x} + \frac{\sigma_1 \ I}{\bar{c}x(\bar{c}x - I)}$ | $\frac{\partial \delta^*}{\partial \sigma A^2} = -\frac{\rho}{(\bar{R}_A - K)}$ |

where *I, NOI* represent the interest rate and the net operating income. *STD* represent the standard deviation, *VAR* the variance, $R_A$ the return on assets, $K$ the interest rate, $\rho$ represents the level of risk aversion, $A$ represent assets. Where both theoretical models suggest that a decline in business risk will increase the financial risk.

Several assumptions must be made when working with risk balancing models. The most common assumption made in the several risk balancing models is the assumption that every farmer has a utility maximization goal. Further assumptions for the model of Collins are that the utility function of wealth is negative exponential. A normal distribution exists for the ROA and taxes are ignored.

When investigating the two financial risk equations, it can be assumed that the financial risk assessed on the Gabriel and Baker method is more volatile and more sensitive to changes in debt. When looking at a policy change that affected the whole European market, the abolishment of the milk quota comes to mind. Since March 2015 the EU milk quota system has been abolished resulting in the potential for expansion for all EU farmers for the first time since 1984. Significant expansion has occurred to date and changes in the debt structure of dairy farmers followed (Breen, 2008). The expansion resulted in a lot more loans with more interest payments. The debt rose but the assets rose as well. However, the net operating income did not rise immediately when the expansion occurred. Thus, looking at the financial risk assessed with the Gabriel method, the financial risk did rise since the net operating income only rose years later when the expansion investments began to pay back. But looking at the financial risk assessed using the Collins method, the financial risk did not rise, since with the additional debt, assets were bought, such as new stables for more cows. This is just an example that the two methods to measure financial risk are attempting to measure the same determinant, but work differently. Hence, different results are expected when comparing the two methods. The differences in the two models can have as effect that different conclusions regarding risk balancing are made. Therefore in time, policymakers can propose different new laws and regulations as they work with different data conclusions. There exists no consensus on the method of measurement regarding financial risk.

With two methods for measuring financial risk, two different methods for measuring business risk follow. While Gabriel and Baker keep focusing on the net operating income and Collins on the assets, Gabriel and Baker use the standard deviation, from now on called SD, of the net operating income while Collins uses the variance of the return on assets to assess business risk. The SD is seen as more useful to describe the variability of the data while the variance is usually much more useful mathematically. The variance of a data set measures the mathematical dispersion of the data relative to the mean. However, though this value is theoretically correct, it is difficult to apply in a real-world sense because the values used to calculate it were squared. The standard deviation, as the square root of the variance, gives a value that is in the same units as the original values. It makes it easier to work with and easier to interpret in conjunction with the concept of the normal curve. For both methods you could argue why it is better or more proper to use in certain cases. The case here is, that both methods are used throughout literature (Coefficient of variation e.g.: Gabriel and Baker, 1980; de Mey, 2014; Variance e.g.: Collins, 1985; Turvey and Kong 2009)

Looking at the different risk balancing models through time, a lot of variation exists. Featherstone (1988) uses a mean-variance equation. Here in equation (4)

$$G[EU(W)] = \overline{R}_E - \left(\frac{\rho}{2}\right)\sigma_E^2 \qquad (4)$$

where $\overline{R}_E$ is the mean of the return on equity, $\sigma_E^2$ is the variance of equity and $\rho$ is the risk-aversion coefficient. Following Collins, Featherstone did not use the interest payments compared to net operating income (I/NOI-I) as a financial risk variable, but looks at the debt to asset ratio, the leverage factor ($\delta$). Equation (5) is an objective function of the leverage factor, the debt to asset ratio

$$G[EU(\delta)] = (\overline{R}_A - K\delta)(1-\delta)^{-1} - \left(\frac{\rho}{2}\right)\sigma_A^2(1-\delta)^{-2} \qquad (5)$$

where $\delta$ represents the leverage factor and $\overline{R}_A$ the expected return on assets. And business risk is not here captured in the variance of the net operating income, but the variance of the return of assets is used. It gives a different structured formula as the focus is put upon different variables. Thus, the business risk is included with the use of the variance of the assets ($\sigma_A^2$). Turvey and Kong (1990) looked at the use of futures and options by farmers. Their optimization model is a direct discrete expected utility maximization discrete stochastic programming (DSP).

Following Gabriel and Baker, the study of de Mey et al. (2014) looks at the variation in net operating income of the past three years to assess the expected business risk of the farmer. See formula 6

$$BR = \frac{\sigma_{NOI}}{\mu_{NOI}} \qquad (6)$$

where $BR$ represents the business risk and $NOI$ the net operating income. Business risk is then defined to be the risk inherent in the firm, no matter on how it is financed (van Horne, 1974). It is mostly influenced by external influences such as policy changes, the weather and market conditions. When determining the expected business risk using the variation of the net operating income, the individual risk perception is ignored while it differs from person to person.

Escalante and Rejesus (2008) do not want to try to confirm the risk balancing hypothesis but study the difference between the use of the two Arrow prat risk aversion methods namely the constant absolute risk aversion (CARA) and the constant relative risk aversion (CRRA). The difference between the absolute risk aversion and the relative is in simple terms that absolute risk aversion in the actual amount an individual will choose to hold in risky assets for a certain amount of wealth. Multiply the Arrow Pratt absolute risk aversion by the amount of wealth to get the measure of relative risk aversion. A multi-period programming framework is used to study which variable produces more accurate results. The results suggest that the use of the constant relative risk aversion produces predictions that are better in line with the observed farm behaviour.

### *Different financial risk parameters*

Financial risk is defined by Gabriel and Baker (1980) to be the added variability of the net cash flows of the owners of equity that results from the fixed financial obligation associated with debt financing and cash leasing. Also, as mentioned by Van Arsdell (p. 304) and Van Horne (p. 252), financial risk encompasses the risk of cash insolvency. A widely used parameter to assess the financial risk of a company is the debt-to-capital ratio. It provides a picture of a company's financial structure in terms of how it is providing money for its operations and it gives an indication of its financial health. It is a simple comparison of a company's total short- and long-term debt obligations to its total capital. Debt financing brings risk with it, like uncertainties of the costs of debt and the availability of debt (Boehlje, 2002). The lower the debt-to-capital ratio is, the more equity financing structure a farmer uses. A lower ratio is preferred. The debt/equity ratio provides a more direct comparison of debt financing to equity financing. It is an indicator of a farmer's ability to meet the outstanding debt obligations. It is the leverage position chosen by the farmer and it produces a variance of the rate of return on equity. While financial risk is the dependent variable in risk balancing models and thus of high importance, no previous study specifically argues why their way of measuring the financial risk is the preferred one.

### *Different procedures*

As mentioned before, different methods and specifications are used through time when working with risk balancing models. Each method has its own advantages but also disadvantages. Stochastic programming has been used multiple times by various studies (Turvey and Baker, 1990; Featherstone, 1990) as can be found in Table 5, page 17. The goal is to provide useful information to a decision maker when those models are formulated and solved numerically. A two-stage linear program is also applied here, where the farmer has experienced or taken an action in the first stage. A recourse decision can then be made in de second stage, which has in time effect on the first stage. In this case, financial risk can be adjusted to a change in business risk. Next to discrete programming, an ARCH model is used by Moss et al. (1990) where time-varying volatility can be clustered. Also mean-variance analysis is applies to study risk balancing. It assumes investors make rational decisions and therefore expect a higher return for their increased risk level. Correlation analysis, linear regressions and linear fixed effects regressions are applied in more recent studies (See Table 5). This study chose to use multiple kinds of regression namely linear, fixed and random effects models. This is elaborated in the econometric design.

## 2.4 The role of risk aversion in risk balancing

Risk aversion is a parameter that is commonly involved when studying risk or uncertainty. It is considered subjective and hard to measure. Here is explained what risk aversion is, how it developed over time, how it is measured and used in previous research and how it is included in the revised risk balancing model.

The terms risk attitude, risk aversion and risk preference are used interchangeably in literature whilst they have different meanings. To avoid any confusion, the difference between the three terms is explained here. The risk attitude of an individual is nothing more than a descriptive label for the shape of the utility function (Kahneman and Tversky, 1979). So the risk attitude describes the shape of his or her utility function, but the curvature of the utility function is technically only described by the terms risk seeking, risk neutral and risk averse. Yet, the term risk aversion is widely used in the risk balancing literature to point out the risk attitude of the farmers. The risk preference of an individual is the willingness to take for example higher risks to achieve above-average returns. The individual should weigh all his options and asses the risk against the probabilities of different outcomes (McGew, 2011). In the rest of this study the term risk aversion will be used, following previous literature, which will implicate the degree of someone willing to take risk for a higher reward. A higher level of risk aversion implicates a lower willingness to take risks.

### 2.4.1 What is risk aversion and why is it important in decision making

Before adding risk aversion in the model, it must be understood what risk aversion is. According to Thomas (2016) it is the fundamental parameter determining how much utility we can obtain from an experience or good. When decisions imply risk, the risk attitude of an individual is an essential component in many situations (Brunette, 2015). Someone can be risk seeking, neutral or averse. In the risk balancing theories, the term risk aversion is mostly used. Risk has always been a part of decision and policy making. The changes in the food systems and policy environments are affecting the value of decision analysis under risk (Boehlje and Lins, 1998). The key components that have to be studied remain the same, namely identifying and measuring the sources of risk, evaluating risk management alternatives and the advice the EU can give the farmers that is tailored to their situation and risk aversion. The risk aversion of an individual often determines or influences important management decisions. But laboratory experiments to measure the risk aversion of an individual is simply not feasible for a large dataset, hence the risk survey is used. The risk aversion of an individual is a unique reflection of his or hers personality, as it can be influenced by life experiences or the social and economic status of the farmer (Bard and Barry, 2000). Since the policy makers at the EU are interested in the behaviour of the farmer, they are interested in the risk aversion, since the risk aversion is a major component in the decision analysis under risk (Bard and Barry, 2000). The way farmers manage their risk is dependent on the risk attitude the farmer has (Robison et al., 1984; Hardaker, Huirne and Anderson, 1997).

### 2.4.2 The measurement of risk aversion

Different elicitation techniques exist to measure risk aversion. A method to measure risk aversion using a survey is the lottery ticket example (Donkers et al., 2001; Hartog et al., 2002; Guiso and Paiella, 2008). The respondent has to state the probability of winning a given prize which makes them indifferent between receiving a given amount of money or receiving the lottery ticket. Receiving the given amount of money is the safe option with low or zero variance. The lottery ticket is of course a risky option with a high variance.

In the survey a direct scale is used as a measurement tool. The objective of eliciting individuals attitudes using a scale is to obtain the level of risk aversion However, it is problematic to measure a construct directly using only one item (Bard and Barry, 2000). The scale can better consist of multiple questions or items. In the case of the survey, it consists of several Likert scale items. The items has to correspond or be influenced by the social-psychological attribute, in this case risk aversion. The rating can be summed to yield a score for the farmer. The score, in our case the Likert score is reflecting the quantitative measurement of the attitude. Wauters et al. (2014) clearly defined that the risk survey endeavours to measure risk aversion in the agriculture of the Flemish part of Belgium.

Risk preferences are subjective and not easy to predict. The risk aversion in turn represents the psychological components of the decision maker. It establishes the shape of the utility function that quantifies the amount of satisfaction. Abundant literature is available on factors that determine risk preference and how to measure it, which makes it difficult to reach a consensus. Literature distinguishes two main categories for evaluating risk preferences. The first category is the revealed preference method where the relationship between observed behaviour (e.g. leverage factor or production decisions) and associated factors (e.g. policy or price) is estimated to assess the risk preference value. The other category is the preference method, where survey questions directly or indirectly, determine the preferences of the respondents. The risk survey provides the opportunity to use the preference method, or previously mentioned in this paper, the subjective method.

As mentioned before, a lot of different opinions exist whether to include risk aversion in the risk balancing model, and if so, how to include it. Additionally, there is the discussion concerning how to measure risk aversion. Arrow (1971) and Pratt (1964) have developed the theory of risk aversion for the univariate utility function V(x). Where the formula for Arrow-Pratt risk aversion measure is

$$R_A(w) = \frac{-u''(w)}{u\prime(w)} \qquad (7)$$

where Ra represents risk aversion, *w* represents wealth and *u* represents utility. The Arrow-prat variable has been used by different risk balancing models in the past (Ramirez et al., 1997; Bampasidou et al., 2017).

### 2.4.3 How risk is modelled in the previous risk balancing models

Using different theories, farmers risk attitude has been studied (e.g., expected utility theory, prospect theory, safety-first), but also different elicitation techniques. However, the theories are criticized due to not supporting the hypotheses (Robison, 1982; Schoemaker, 1991). The expected utility theory is one of the most known theories where rational behaviour under risk is studied (Neumann and Morgenstern, 1944), it is still used today in most of the risk balancing models.

Modelling risk aversion in the risk balancing models is not a straightforward procedure. Different theories and different elicitation techniques exist concerning risk aversion. Starting in a chronological order, Gabriel and Baker (1980) developed the foundation for the risk balancing model. In the model of Gabriel and Baker it is assumed that the farmer has both profit maximization and firm survival as ultimate goals. The farmer will try to maximize net returns without exceeding a risk constraint. The farmer acts confirming to his lexicographic utility function, which is simply comparative preferences where the farmer any amount of good X to any amount of Y. Concerning risk balancing, Gabriel and Baker only recognise that the farmer may respond in different magnitudes to exogenous shocks because of various characteristics such as risk aversion, farm size or farm type. They do not include risk aversion in their model, but recognise that risk aversion could play a role in the risk balancing behaviour of the farmers. Barry (1981) shows a farmers negative exponential utility function

$$U(\pi) = 1 - e^{-2\lambda\pi} \qquad (8)$$

where $\lambda$ is the degree of risk aversion ($\lambda > 0$), and $\pi$ is the level of income. Lower degree of risk aversion means a lower utility with respect to the level of income. They furthermore show that optimum debt is inversely related to changes in risk aversion. However, the relationship only holds as long as the expected return on assets is greater than the cost of borrowing. The absolute risk-aversion assumption for a negative exponential utility function is satisfied. Featherstone (1988) uses expected utility of wealth

$$G[EU(W)] = \bar{R}_e - (\frac{\rho}{2})\sigma_E^2 \qquad (9)$$

where $W$ is *wealth,* $R_e$ is *return on equity*, ρ is *relative risk-aversion coefficient. The risk aversion* coefficient is evaluated at the initial level of equity. The analysis in the article requires the assumption of a constant risk-aversion coefficient. Featherstone (1988) states that the objective of the farmer can be written as a function of the debt-to-asset ratio

$$G[EU(\delta)] = (\bar{R}_A - K\delta)(1-\delta)^{-1} - \left(\frac{\rho}{2}\right)\sigma_A^2(1-\delta)^{-2} \qquad (10)$$

where the expected rate of return on assets, variance of rate of return on assets and interest rate are managed. Here we see the risk aversion coefficient as the numerator with a minus sign in front of it. So as risk aversion increases the leverage factor decreases, which seems logical since a risk averse farmer does not like to take risk with a lot of equity and few assets in proportion. Featherstone follows Collins (1985) and obtained the following condition for the optimal leverage ratio ($\delta^*$):

$$\delta^* = 1 - \left[\frac{\rho\sigma_A^2}{\bar{R}_A - K}\right] \qquad (11)$$

where $\delta^*$ is the optimal leverage factor, ρ is the risk aversion parameter, $\bar{R}_A$ is the mean of the return on assets, K is the interest rate and $\sigma^2$ the variance of rate of return on assets. Where the second-order condition is only met when a farmer is risk averse. This equation tells us that farmer can choose his optimal level of financial risk, in this case the leverage factor.

The model of Ahrendsen et al. (1994) builds on the expected utility maximization model developed by Collins and by Barry. The model is however extended to include depreciation, taxes, economies of scale, wealth and partial adjustment specification. They use an Arrow Pratt measure of constant risk aversion just as Ramirez et al. (1997). A distinction is made between de absolute risk aversion (A) and the relative risk aversion (A')

$$A = -\frac{U''(x)}{U'(x)} \qquad (12) \qquad\qquad A' = -x\,\frac{U''(x)}{U'(x)} \qquad (13)$$

where x is the payoff of a given lottery and U(x) the utility derived from that pay off. Jensen and Langemeijer (1996) simply state they have no data on the risk aversion levels of the firms they were investigating, so risk aversion was not included in the empirical analysis.

Escalante and Barry (2003) formulate the equation where the debt-to-asset ratio, the leverage factor, is optimised under the assumption that borrowing costs are stochastic. The risk aversion parameter is included in that equation as a positive determinant, thus as risk aversion increases, the debt to assets ratio will in all probability rise as well.

Where Turvey and Kong (2009) come with evidence from China to support the risk balancing hypothesis they include risk aversion in their model. They build on the model of Collins thus they define profitability using the definition of equity returns as a function of expected returns on assets, financial leverage and the cost of leverage. They also solve the optimum debt level for a level of risk aversion. The equation states that more risk averse individuals will use less debt than less risk averse individuals. Turvey and Kong did not impute a measure of risk aversion, but tested risk aversion with the Chinese farmers using a couple of questions. The questions concerned risk taking and risk mitigating behaviour. The questions were also on a five-point ordinal Likert scale, just as the survey used in this study.

When measuring risk aversion and modelling it, irregularities are not uncommon. For example, people seem to be more risk averse for gains and more risk seeking for losses. Thus a constant risk aversion cannot be assumed. It is also generally accepted that risk aversion is a feeling that can develop over time also from experiences of living in a given condition. Risk aversion is not investigated as a continuous variable when examining risk balancing behaviour.

In the past there has not been reached a consensus on whether the risk aversion can be considered a constant or not. The lack of clarity has affected existing measurement methods. There are difficulties of measuring a parameter that is personal to the individual and that will vary according to the importance of the decision.

In the risk survey a scale is used as a measurement tool. Reliability testing and scale validation is essential when using this kind of scales (Bard and Barry, 2000). De Vellis (1991) argues that scale validation can be based on construct validity, convergent validity, and exploratory factor analysis which can be tested using several methods. Reliability testing tests how accurate the scale items reflect the underlying construct, in our case the risk aversion. Cronbach's coefficient is used to test the reliability as is measures the proportion of total variation due to true differences in a person's attitude towards the construct being measured. The alpha ranges from 0 to 1. The higher the alpha, the lower proportion of total variation, thus you want a high alpha. Wauters et al. (2014) used an alpha value of 0.5, items with a lower alpha were dropped. Eliminating the items that have low-item scale correlations optimizes the scale. The Cronbach alpha will rise with deleting these items, improving the statistical quality of the scale. The resulting product is a summated scale that reliably measures the defined underlying construct. As risk aversion as a variable, it can be added in the model when the regression uses a random effects model.

It is hypothesized that the attitude towards the mechanisms and management systems to cope with risk, reflects the farmers underlying construct of risk attitude. Wauters et al. (2014) uses the attitude towards those mechanisms to attain the risk aversion of the farmers. The exact method how the risk aversion variable is calculated and added into the model can be found in the econometric design (Chapter 2.5.3).

## 2.5 Econometric design

To study the different methods of measuring business risk and financial risk, and the effect of risk aversion in the risk balancing model several regression models are run with different parameters and specifications. Three kind of regressions are run, namely the simple linear regression, a fixed effects model and a random effects model. Below, you can find the econometric design, divided in the parts of business risk, financial risk, risk aversion and the full random effects model.

### 2.5.1 Business risk

The risk, the expected business risk of farmers, can be derived using several methods. In previous literature, it is defined as the coefficient of variation of *NOI* (Gabriel and Baker 1980; de Mey et al., 2014) or the variance of *ROA* (Collins 1985). Previous research uses a lagged value of business risk for the analysis since there are time effects where changes in financial risk in response to business risk will usually not take place within one year but over a longer time period (Ahrendsen et al., 1994). The Flemish FADN database complemented with the survey provides the data of the risk aversion, subjective impact of shocks and other risk perspectives of the Belgian farmers. The expected business risk measured on a subjective scale is the risk perception assessed from the survey using the subjective probability and the subjective impact. See equation 14

$$BRsub_i = \frac{subP_i + subI_i}{2} \qquad (14)$$

where *BRsub, subP, subI* represents business risk, subjective probability and subjective impact. And *i* stands for the related farm. It is expected that using the $BR_{sub}$ in the risk balancing model can show a significant negative relation with the financial risk. It can also capture expected business risk that the variability of the *NOI* cannot capture.

Next to the method of using the subjective probability and the subjective impact, the subjective influence will also be added to derive the expected business risk using a subjective scale. Since people's behaviour been shown to depend on a locus of control, the subjective influence has a possible effect on the expected business risk of a farmer (Elkind, 2008). See equation 15

$$BRinf_{i,t} = \frac{subP_{i,t} + subI_{i,t} + subIn_{i,t}}{3} \qquad (15)$$

where *BRinf* represents business risk measured including subjective influence and *subIn* represents the subjective influence the farmer has on an event happening. Using the Cronbach alpha, reliability and validity will be checked. A save Cronbach value is considered a value of alpha above 0.6 for this study. This is a higher requirement than previous studies where the value was (0.5), as certainty was needed that the items measure the same construct (Wauters et al., 2014).

Business risk using the frequentist approach, also called the objective method will be derived using three lagged values. Using historical data it uses the coefficient of variation of the *NOI* to derive the variable called $BR_{GB}$. The equation can be found at equation number 16

$$BR_{GB} = \frac{\sigma NOI}{\mu NOI} \qquad (16)$$

where $BR_{GB}$ represents the expected business risk derived on the Gabriel and Baker method, *NOI* the net operating profit and μ the mean and σ the coefficient of variation.

Since farmers risk management strategies are guided by their subjective probabilities of adverse events (Hardaker et al., 1997), using the subjective view on risk of a farmer to assess the expected business risk is tested in comparison with measuring business risk using the frequentist approach.

For the assessment of $BR_{inf}$, 27 Likert scale items used from the survey, namely nine items for the probability for an event to occur, nine for the impact that the impact could have on the farm and another nine items for the influence that a farmer has to prevent such an event. Consequently, $BR_{sub}$ consisted of 18 items before doing the Cronbach test. The variables $BR_{sub}$ and $BR_{inf}$ can be considered as a continuous variable as it belongs to interval scale category (Gaito, 1980). The following regression model was estimated to study the difference between measuring business risk on an objective manner versus a subjective manner:

$$\mathrm{FR}_{GB_{i,t}} = \beta 1(BR)_{i,t-1} + \beta 2(\tfrac{I}{D})_{i,t-1} + \beta 3(\tfrac{NOI}{A})_{i,t-1} + \beta 4(Area)_{i,t} \textstyle\sum_{K=1}^{K-1} \delta_k Type_k + \varepsilon_{i,t} \qquad (17)$$

where BR represent the three manners of Business risk as can be seen in table 6. For the definition of the remaining variables, an explanation can be found in Table 1, page 8. All the complete regression formulas can be found in Appendix D. Since the business risk is measured using the subjective probability, influence and impact can only be derived from the survey which is conducted in 2013, all three the regressions are performed using data from only 2014. This because a lagged value of expected business risk is used. Thus, the variable $FR_{GB}$ is from 2014, and the rest of the values used for the other variables are from the year 2013.

**Table 6. The three calculation methods of Business risk**

| ***Variable name*** | **Calculation method** |
|---|---|
| $BR_{GB}$ | $\frac{\sigma NOI}{\mu NOI}$ |
| $BR_{sub}$ | Subjective probability + subjective impact |
| $BR_{inf}$ | Subjective probability + subjective impact + subjective influence |

### 2.5.2 Financial risk

Taking into account the capital structure of the farm gives us the insight of how much financial risk a farmer is exposed to. Where Gabriel and Baker (1980) uses the interest coverage ratio of a farmer to assess financial risk, Collins (1985) uses the leverage factor of a farm. Collins stated that it is not appropriate to focus solely on return on assets for the analysis of capital structure choice, but debt must be taken into account as well. Financial risk is defined to be the added variability of the net cash flows of the owners of equity that results from the fixed financial obligation associated with debt financing and cash leasing (Barges, 1962).

The financial risk, following Gabriel and Baker (1980) and Collins (1985) are calculated as follows respectively

$$FR_{GB\ i,t} = \frac{I_{i,t}}{NOI_{i,t} - I_{i,t}} \qquad (18)$$

$$FRc_{i,t} = \frac{Debt_{i,t}}{Assets_{i,t}} = \delta_{i,t} \qquad (19)$$

where $FR_{GB}$ and $FR_C$ represents the financial risk as Gabriel and Baker (1980) and Collins (1985) derived it respectively, *I* is the payed interest, NOI the net operating income, *Assets* represents the assets the farmer possesses that year, *Debt* the farmer has and $\delta$ *is* the leverage factor. The risk balancing model will be run with the financial risk measured on the Collins method and financial risk measured with the Gabriel and Baker method. Focusing on the fixed debt obligations, assessing the financial risk of the farmer following Gabriel and Baker is thus also examined.

Working with the risk balancing hypothesis, the choice must be made to or focus on solvability, thus using the leverage factor as Collins does, or on liquidity. There is no combination of the two methods in one equation. It is not logical to use financial risk focusing on solvability and the business risk focusing on liquidity. For the reason that volatility or changes in both the variables do not make sense, since the variables are measured in a different way. Therefore, when financial risk is derived using the Collins method, the business risk is also derived using the Collins method, which is the variance of the Return on Assets *(VAR (ROA)).*

Table 7. Financial risk focusing on solvability or liquidity

| | Gabriel and Baker (1980) | Collins (1985) |
|---|---|---|
| *Financial Risk (FR)* | $FR_{GB} = \frac{I_{i,t}}{NOI_{i,t} - I_{i,t}}$ | $FR_{i,t} = Debt_{i,t} / Assets_{i,t} = \delta_{i,t}$ |
| *Business Risk (BR)* | $BR_{GB} = \frac{\sigma NOI}{\mu NOI}$ | $BR_{i,t} = VAR(ROA)$ |

$I$ represent here the fixed interest payments and $NOI$ the net operating income of a farm. The regression formula to compare the two methods to derive financial risk is equation 20 which is a fixed effects model

$$\text{FinancialRisk}_{i,t} = \beta 1(BR)_{i,t-1} + \beta 2(\frac{I}{D})_{i,t-1} + \beta 3(\frac{NOI}{A})_{i,t-1} + \sum_{K=1}^{K-1} \delta_k Type_k + \sum_{T=1}^{T-1} \varphi_t Year_t + \varepsilon_{i,t} \qquad (20)$$

where *FinancialRisk* is defined as the two methods for assessing financial risk explained in Table 7. The method of financial risk is accompanied by the corresponding method of measuring business risk, as can be found in Table 7.

### 2.5.3 Risk aversion

There can be a distinction made between risk and uncertainty. The two terms are used interchangeably but there is a difference. In a situation where the outcome is unknown, risk is involved. However, the probability of the occurrence is known which can be measured objectively or subjectively (Knight, 1921). So the farmers will form their expectation regarding these probabilities. Thus, risk is a known-unknown situation while uncertainty is an unknown-unknown situation. Another difference, which can be seen in all the previous risk balancing models, is that risk is analysed using the expected utility theory, while uncertainty is studied mainly in game theory. Kahneman and Tversky (1979) changed the way of thinking concerning risk as their study showed different results using empirical data compared to all the expected utility theories. They developed the Prospect Theory and it can be considered as an alternative model to the expected utility theory. They discovered that individuals are generally more adverse to losses than they are attracted to the gains of a situation. Also the initial situation an individual is in can change the preferences of the individual.

On average, farmers are expected to be risk seeking, otherwise you would not start or work in a risky and volatile market as the agricultural market (Wauters et al., 2014). The risk aversion variable is measured with a direct method and a psychometric method. The direct method delivers a single value for every farmer from 1 to 5 on a Likert scale. The variable will be treated as a categorical variable.

$$RA_{dir_i} = RA_i \qquad (21)$$

where $RA_{dir}$ represents the risk aversion measured using a direct method. The risk aversion is measured on a psychometric scale consists out of fourteen items. Using item analysis, it is identified which questions are problematic and can be dropped. Problematic in the sense that they do not measure what they should measure. The average of this scale is a measure for the latent variable risk aversion and is treated as a continuous variable. The degree of risk aversion is then calculated as follows

$$RA_{psych_i} = \frac{\mathrm{PI}_i}{N} \qquad (22)$$

where *PI* represent the fourteen, or less, depends on the reliability checks, psychometric scale items, *N* the number of psychometric scale items. Since $RA_{psych}$ is an average, it will not be treated as a categorical variable but as a latent variable. It will be included in the model as a continuous variable and the relationship between the risk attitude of a farmer and their financial risk will be investigated.

Risk aversion is assessed in two manners, the direct method and on a psychometric scale, as can be seen in Table 8.

**Table 8. Risk aversion using the direct method and a psychometric scale**

| ***Variable name*** | **Calculation method** |
|---|---|
| $RA_{dir}$ | Single direct item for measuring risk aversion. Categorical variable |
| $RA_{psych}$ | Risk aversion measured using different items on a psychometric scale. Continuous variable. |

Risk aversion is included here in the risk balancing model to study the effects of explicitly incorporating risk aversion. The linear regression formula is as follows

$$\text{FinancialRisk}_{i,t} = \beta 1(BR)_{i,t-1} + \beta 2(\tfrac{I}{D})_{i,t-1} + \beta 3(\tfrac{NOI}{A})_{i,t-1} + \beta 4(Riskaversion) + \sum_{K=1}^{K-1} \delta_k Type_k + \sum_{T=1}^{T-1} \varphi_t Year_t + \varepsilon_{i,t} \qquad (23)$$

where *Riskaversion* is the value of $RA_{dir}$ or $RA_{psych}$ which can be found in table 8. An overview of all the remaining variables can be found in Table 1, page 8.

The variable $RA_{psych}$ will also be tested as a categorical variable. Since the risk aversion was tested on a Likert scale from 1 till 5, for convenience, four different categories were produced. The first category consist of the value 1 to (but not including) 2. No assumptions are made that a certain category is risk loving or risk seeking. A lower category is assumed to include farmers who relatively are willing to take more financial risk.

### 2.5.4 Mediation effect

Risk aversion could act as a mediator in the risk balancing model, as visualized in Figure 4. A mediator is a causal chain, where one variable affects a second variable that, in turn affects a third variable. The second variable, the variable in the middle, is the mediator. To analyse to what extent risk aversion has an effect on the financial risk a farmer is exposed to with business risk as the mediator, several steps have to be conducted. When testing for mediation, no other variables should be added into the model (Kenny et al., 1988).

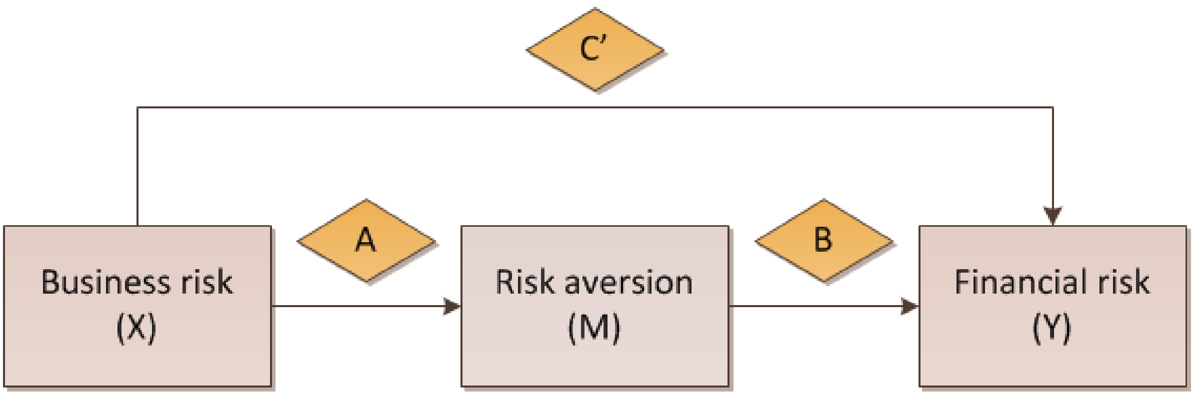


**Figure 4. Graphical representation of a possible mediation effect**

The paths A and B in Fig. 4 are here the direct effect. C' can also be considered a direct effect. However, assumed is that business risk also has an effect on financial risk through a mediation effect, the indirect effect. Thus, through M, X has an influence on Y. A four step has been developed to examine the effects of the variables on each other (Baron and Kenny, 1986).

- Step 1: A simple regression analysis with X predicting Y to test for the path of C' alone.
- Step 2: A simple regression analysis with X predicting M to test for path A
- Step 3: A simple regression analysis with M predicting Y to test for the significance of path B
- Step 4: And as a last step, a multiple regression analysis with X and M predicting Y

Zero-order relationships are checked using step 1 through 3. If one or more relationships are not significant, we can conclude that mediation is very unlikely or even impossible. When the effect if M remains significant when controlling for X, mediation can be present. To test the mediation effect in the case of a risk balancing model with risk aversion, the econometric model is as follows;

$$Step\ 1 - \mathrm{FR}_{GB_{i,t}} = \beta 1 (BR_{GB})_{i,t-1} + \varepsilon_{i,t} \qquad (23)$$

where $FR_{GB}$, $BR_{GB}$, $RA_{psych}$ represents financial risk measured using the payed interest over net operating income, business risk measured using the standard deviation over three years of net operating income and risk aversion measured on a psychometric scale. A direct simple regression analysis was conducted examining how business risk affects financial risk, as can be seen in equation 24. A constant is included as a variable for the error term.

$$Step\ 2 - \mathrm{RA}_{psych_{i,t}} = \beta 1 (BR_{GB})_{i,t-1} + \varepsilon_{i,t} \qquad (24)$$

A direct simple regression with risk aversion as dependent variable follows, followed by a regression analysis where financial risk acts as the dependent variable regressed to the risk aversion of the farmers, as can be seen in equation 25.

$$Step\ 3 - \mathrm{FR}_{GB_{i,t}} = \beta 1 \left(RA_{psych}\right)_{i,t-1} + \varepsilon_{i,t} \qquad (25)$$

In step four, mediation is supported if the effect of M, path B, remains significant when controlling for X, as can be seen in equation 26.

$$Step\ 4 - \mathrm{FR}_{GB_{i,t}} = \beta 1 (BR_{GB})_{i,t-1} + \beta 2 \left(RA_{psych}\right)_{i,t-1} + \varepsilon_{i,t} \qquad (26)$$

While there is hypothesized that risk aversion can function as a mediator in the risk balancing model, it is not expected. While risk aversion is formed by life experiences (Bard and Barry, 2000), a significant relation between the business risk and risk aversion is not expected. Step three is hypothesized to be significant since risk aversion can play a significant role when decisions are made under risk (Brunette, 2015).

### 2.5.5 Random effects model

Building on the model of de Mey et al. (2014) the following random effects regression model is performed

$$\mathrm{FR}_{GB_{i,t}} = \alpha_i + \beta 1 (BR_{GB})_{i,t-1} + \beta 2 (\tfrac{I}{D})_{i,t-1} + \beta 3 (\tfrac{NOI}{A})_{i,t-1} + \beta 4 (Area)_{i,t} + \beta 5 (RApsych)_{i,t-1} + \sum_{K=1}^{K-1} \delta_k Type_k + \varepsilon_{i,t} \qquad (27)$$

where i, and t are indexing farm and year and K represent the total amount of typologies. $\beta_{1-5}$, $\delta_k$ are parameters to be estimated. In Table 1 all the variables can be found used in the econometric design. The alpha $(\alpha_i)$ is the unobserved individual effect. The analysis will be conducted using STATA 13.1 for Windows (StataCorp, 2014). Before analysing the full model, a Chow's test is conducted to test whether the data can be analysed using one regression line since it is unbalanced panel data (Chow, 1960).

Fixed effects and random effect models work to remove omitted variable bias. They do that by measuring within a group, which is feasible here since the data used is unbalanced panel data. You control for a number of variables unique for the farmer. Since the last regression analysis its purpose is to say if there was risk balancing behaviour present in the Flemish part of Belgium, a random effect model is the preferred choice over a fixed effect model. A random effects model allows to infer something about the whole population. Using a fixed effects on a random sample, you cannot make inferences outside your data set. Using a random effects model is here also the preferred choice since only then the variable risk aversion can be added into the model. A fixed effect model works in the following way; first the OLS regressions is used on the time series sample. Then the error term observations are used to estimate error variances and correlations between the errors. Then the estimates are used to generate generalized least square. Those give the estimated for the random effects model. Heteroscedasticity will be checked, and a Durbin-Wu test will be performed. Stata can control for heteroscedasticity by adding the 'robust' option in the random effects model.

# 3. Results

Here the results of the three sub research questions are presented in order of appearance. First of all, the expected business risk measured on an objective manner versus a subjective manner was empirically tested. Exploring different methods to measure financial risk was next and the implications are of incorporating risk aversion in risk balancing models followed. Risk aversion was measured if it functions as a mediator in the risk balancing model. Last, the revised full regression model was run, and examined if there is evidence of risk balancing in the Flemish part of Belgium. For a full overview of all the regression formulas see Appendix D.

## 3.1 Measuring business risk on a subjective manner

The sole purpose of this regression is to examine if measuring the business risk on a subjective manner and on an objective manner results in the same results. Data regarding the expected business risk measured on a subjective scale is only available for 2013. That is the reason the regression where the objective manner is used, where data is available for multiple years, only the year 2014 is used. Thus the value of business risk is for 2013, and the value for financial risk and the other variables are from 2014. This is done because alternating your level of financial risk does not take place in the same year (Ahrendsen, 1994), and that is why a lagged value of business risk is used.

While keeping the independent variable the same, the variable for business risk is tested for three different methods. There was no indication of multicollinearity problems in the data, with variance inflation factors (VIF) of all regressors below the value of 5. The regression results of all three regression can be found in Table 9.

**Table 9. Regression results testing the business risk**

| Independent variable: | $FR_{GB}$ | $FR_{GB}$ | $FR_{GB}$ |
|---|---|---|---|
| Business risk: | Objective I/NOI-I | Subjective Probability and Impact | Subjective Probability, impact and influence |
| Business Risk $_{t-1}$ | 0.372$^{***}$ | 0.520$^{*}$ | 0.307 |
| | (0.10) | (0.30) | (0.35) |
| Cost of Debt $_{t-1}$ | 2.838 | 2.115 | 1.622 |
| | (3.77) | (3.93) | (4.00) |
| Assets Profitability $_{t-1}$ | -5.654$^{***}$ | -7.443$^{***}$ | -7.516$^{***}$ |
| | (1.51) | (1.51) | (1.54) |
| Area | -0.006 | -0.009$^{*}$ | -0.009$^{*}$ |
| | (0.01) | (0.01) | (0.01) |
| *Farm Type dummies* | | | |
| Horticulture | -0.278 | -0.303 | -0.248 |
| | (0.67) | (0.70) | (0.71) |
| Type Fruit | -0.394 | 0.114 | 0.102 |
| | (0.73) | (0.75) | (0.76) |
| Type Milk | -0.503 | -0.685 | -0.642 |
| | (0.57) | (0.59) | (0.60) |
| Type Granivore | -0.199 | -0.430 | -0.313 |
| | (0.64) | (0.66) | (0.68) |
| Type Mixed field crops | -1.551 | -1.755$^{*}$ | -1.720 |
| | (1.01) | (1.04) | (1.05) |
| Type Mixed crops | -0.534 | -0.618 | -0.520 |
| | (0.71) | (0.73) | (0.74) |
| Type Mixed field stock and crops | -0.802 | -0.963 | -0.938 |
| | (0.64) | (0.68) | (0.68) |
| Constant | 2.136$^{***}$ | 1.036 | 1.935 |
| | (0.69) | (1.28) | (1.35) |
| N | 479.00 | 476.00 | 465.00 |
| F-Value | 4.23 | 3.40 | 3.26 |
| p-value | 0.00 | 0.00 | 0.00 |
| R-square | 0.09 | 0.07 | 0.07 |

Standard errors in parentheses
$^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

The R-squared is relatively low at a 7 to 9 percent, however, this is not considered problematic since the purpose of this regression was not prediction. The purpose of this regression analysis is examining if changing the method of measuring business risk has effect on the risk balancing model.

Calculating the degrees of freedom for the numerator (p-1) and the denominator (n-p) bring us to 4($df_1$) and >120($df_2$) which gives a F-distribution of 2.3719. Thus, the F-value is high enough to state the model as a whole has statistically significant predictive capability.

The sample size for the three analysis vary slightly. This can be appointed to missing values since not every farmer completed the survey for a full 100%. Note that not the full sample size of >5000 was used in this regression but only for the year 2014. The first type (type field crops), is omitted since it functions as a dummy reference level for all the other types that are tested in the regression.

It is assumed that business risk can be subjectively measured, and that the individual risk perception regarding risk differ. But when deriving business risk using the subjective probability, impact and influence, it produces different regression results then when only looking at the historical data. Where the business risk measured, using an objective method, has a significant relation with financial risk, a significant relationship between the subjective business risk, excluding influence, and the financial risk exists as well. However, the significance level is smaller and the coefficient estimate differs (0.372***, 0.520*). Business risk has a positive affiliation with financial risk in all three the regressions. While the $BR_{sub}$ differs from the $BR_{GB}$, the $BR_{inf}$ has almost the same regression coefficient (0.372***, 0.307).

*Cost of debt* has a positive relationship with financial risk in all three cases (2.838, 2.115, and 1,622). *Assets profitability* and *area* has a negative affiliation with the financial risk. (-5.654***, -7.443***, -7.516*** ) (-0.006, -0.009*, -0.009*).

The purpose of the three regression analysis is to examine if measuring business risk using three methods results in different risk balancing results. Note however, that no comparison can be made between the absolute values of the regression results, for the reason that the first regression is a ratio between zero and ten. The second and third regression, where business risk is measured subjectively, are results from a Likert scale from one till five.

## 3.2 Accuracy of measuring financial risk

Here the results are presented comparing the two methods of deriving financial risk. The purpose of the regression analysis here is to examine if using different ways to derive financial risk and business risk, results in different risk balancing regression results (Table 10).

Table 10. Regression results testing the financial risk

| Fixed effects model | (1) FR Gabriel | (2) FR Collins |
|---|---|---|
| Business risk $_{t-1}$ | -0.247*** | -0.004* |
| | (0.05) | (0.04) |
| Costs of debt $_{t-1}$ | -0.654 | -0.716*** |
| | (1.30) | (0.05) |
| Assets profitability $_{t-1}$ | 1.895*** | -0.020 |
| | (0.47) | (0.02) |
| *Year dummies* | | |
| 2009 | -0.059 | -0.012* |
| | (0.17) | (0.01) |
| 2010 | 0.099 | -0.017*** |
| | (0.17) | (0.01) |
| 2011 | -0.048 | -0.026*** |
| | (0.17) | (0.01) |
| 2012 | 0.165 | -0.041*** |
| | (0.17) | (0.01) |
| 2013 | 0.100 | -0.058*** |
| | (0.17) | (0.01) |
| 2014 | 0.164 | -0.069*** |
| | (0.17) | (0.01) |
| 2015 | 0.126 | -0.086*** |
| | (0.18) | (0.01) |
| Constant | 0.949*** | 0.354*** |
| | (0.16) | (0.01) |
| N | 3347.00 | 3347.00 |
| F-value | 5.04 | 61.71 |
| p- value | 0.00 | 0.00 |
| R-Square within | 0.0180 | 0.1832 |

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Since the subjective business risk and risk aversion are only available for one year, who are not added in the model, the whole sample is used in this fixed effects regression (2005-2015). Since business risk is derived using three lagged years and 2008 is used as a dummy reference, only 2009 till 2015 dummy regression results are presented. Two fixed effects model are estimated to compare the results between the two financial risk methods.

Both fixed effect regressions show significant signs of risk balancing. The dispersion and the standard deviation of the values of the Gabriel and Baker method are larger in comparison with the Collins method, thus larger regressions estimates were expected. When $BG_{GB}$ is to increase by a value of one, $FR_{GB}$ is to decrease with the value of 0.247. When $BG_C$ is to increase by a value of one, $FR_C$ is to decrease with the value of 0.004.

Again, the R-square within is relatively low as the explained variance in the financial risk calculated in the Collins method is only 18% and 0.02% from Gabriel. This does not pose as a problem since the analysis tries not to predict financial risk, it only wants to compare the two regression results. The model of Collins does show a high F-value of 61.71 which implies statistically predictive capability.

## 3.3 The implication of incorporating risk aversion

The purpose of these regression analysis was to investigate which implications it has to incorporate risk aversion in the risk balancing model and if the risk aversion variable behaves as hypothesized. Risk aversion is not always included in the risk balancing models, or it is added as a constant. Here the risk aversion is tested as a continuous variable measured on a psychometric scale and a direct scale.

### 3.3.1 Results of including risk aversion in the risk balancing model

In Table 11 the regression results can be found of the simple linear regression with risk aversion added. In the first regression, risk aversion is added as a categorical variable derived from the direct measure from the survey. The third category is omitted as it functions as a base. Note that a risk averse scale is used, thus category one and two can be considered to be farmers which are generally risk seeking, and thus a positive relation with financial risk is expected.

Because the survey was conducted in 2013, only the sample size for 2014 is used and lagged values ( N = 396, 465).

**Table 11. Regression results testing risk aversion**

| Linear regression | (1) Financial Risk | (2) Financial Risk |
|---|---|---|
| Business risk $_{t-1}$ | 0.296*** | 0.40*** |
| | (0.11) | (0.10) |
| Cost of debt $_{t-1}$ | 4.169 | 3.40 |
| | (4.18) | (3.91) |
| Assets profitability $_{t-1}$ | -6.500*** | -5.50*** |
| | (1.58) | (1.50) |
| $RA_{dir\ t-1}$ | | |
| Category 1 | 3.832*** | |
| | (0.94) | |
| Category 2 | 0.504 | |
| | (0.42) | |
| Category 4 | 0.045 | |
| | (0.37) | |
| Category 5 | 0.108 | |
| $RA_{psych\ t-1}$ | | -0.21 |
| | | (0.24) |
| Constant | 1.370*** | 2.01*** |
| | (0.34) | (0.75) |
| N | 396.00 | 465.00 |
| F-value | 7.24 | 9.79 |
| p-value | 0.00 | 0.00 |
| R-square | 0.115 | 0.076 |

Standard errors in parentheses
$^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Looking at the regression results of the first regression, which is the regression where categorical variables are used for risk aversion since it is derived from a direct scale, we see a significant positive affiliation from category one with financial risk (3.832***). This means that farmers who indicated that they consider themselves as risk seeking, really are exposed to more financial risk than compared to the other farmers. Category two has also a positive affiliation with financial risk with category three as a reference dummy, however it is not significant. Examining the regression results from the second regression, which is the regression with risk aversion measured on a psychometric scale, we see a negative relation with the financial risk. However, the relation is not significant. It does imply that when farmers become more risk averse, the willingness to be exposed to financial risk declines.

### 3.3.2 Risk aversion as a categorical variable

To examine if farmers who are willing to take more risk also generally experience more financial risk, the following regression analysis was performed. First, using STATA, the variable $RA_{psych}$ was cut into different categories. Since the risk aversion was tested on a Likert scale from 1 till 5, for convenience four different categories were produced. The first category consist of the value one to (but not including) two. No assumptions are made that a certain category is risk loving or risk seeking. There is simply assumed that the higher the category, the more willing the farmer is to take risk. In Table 12 an overview of the frequency and percent of the four different categories is given.

**Table 12. Overview of the categories used**

| ***Category*** | **Frequency** | **Percent** | **Cumulative** |
|---|---|---|---|
| *1 – 2* | 400 | 7.69 | 7.69 |
| *2 – 3* | 2.749 | 52.87 | 60.56 |
| *3 – 4* | 1.948 | 37.46 | 98.02 |
| *4 – 5* | 103 | 1.98 | 100.00 |
| *Total* | 5.200 | 100.00 | 100.00 |

A regression analysis was performed only for the year 2014 for the reason there is only risk aversion data available for the year 2013. Below the table with the regression results can be found.

**Table 13. Regression results testing risk aversion in categories**

| Linear regression<br>Risk averse scale | (1)<br>$FR_{GB}$ |
|---|---|
| Category 1 | -0.055 |
| | (1.03) |
| Category 2 | 0.143 |
| | (0.93) |
| Category 3 | 0.077 |
| | (0.94) |
| Constant | 1.12 |
| | (0.92) |
| N | 511.00 |
| F-value | 0.06 |
| p-value | 0.98 |
| R-square | 0.00 |

Standard errors in parentheses
$^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Note that it is a risk averse scale, thus not risk seeking. Since the fourth category is used as a dummy reference and is considered to be the category with the most risk seeking farmers, it was hypothesized that the remaining categories should have a negative regression coefficient. However, only the first category has a non-significant negative regression coefficient (-0.055).

### 3.3.4 The mediation effect of risk aversion

Here the results of the four step test of Baron and Kennedy are presented. Baron and Kennedy (1986) developed a four step methodology to test if there is a mediation effect. To establish if there is a zero-order relationship among the variables, the variables in question are first regressed with a single predictor. In Table 14 the regression results of the first three steps are presented, and in Table 15, the results of step 4.

**Table 14. Regression results of the Baron and Kennedy mediation test**

| Linear Regression | (1) Financial risk | (2) Risk Aversion | (3) Financial Risk |
|---|---|---|---|
| $BR_{GB\ t-1}$ | $0.486^{***}$ | | |
| | (0.09) | | |
| $BR_{GB\ t-1}$ | | -0.014 | |
| | | (0.02) | |
| $RA_{psych\ t-1}$ | | | -0.111 |
| | | | (0.23) |
| Constant | $0.810^{***}$ | $2.776^{***}$ | $1.522^{**}$ |
| | (0.14) | (0.03) | (0.64) |
| N | 507.00 | 491.00 | 511.00 |
| F-value | 28.04 | 0.56 | 0.24 |
| p-value | 0.00 | 0.45 | 0.63 |
| R-square | 0.053 | 0.001 | 0.000 |

Standard errors in parentheses
$^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

**Table 15. Regression results of the fourth step**

| Linear Regression | (4) Financial risk |
|---|---|
| $BR_{GB\ t-1}$ | $0.486^{***}$ |
| | (0.09) |
| $RA_{psych\ t-1}$ | -0.198 |
| | (0.22) |
| Constant | $1.115^{*}$ |
| | (0.64) |
| N | 491.00 |
| F | 13.55 |
| p | 0.00 |
| r2 | 0.053 |

Standard errors in parentheses
$^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

In step one, the lagged value of expected business risk is regressed to financial risk. A positive significant relation can be observed ($0.486^{***}$). The second step where the lagged value of expected business risk is regressed to risk aversion shows a non-significant relation (-0.014). According to Baron and Kennedy, to fulfil to the requirements of a mediator, all the steps have to be significant. Thus, risk aversion cannot be considered as a mediator in the risk balancing model. The third step where risk aversion is regressed to financial risk, a negative value can be observed (-0.111). However, this relationship is also not significant.

The fourth step is to run the model with the possible mediator as controlling variable. Only one significant relationship can be observed thus the hypothesis that risk aversion works as a mediator can be rejected.

## 3.4 Random effects risk balancing model

Here the results of the random effects model are presented. The random effects model uses more degrees of freedom than a fixed effects model. It can also estimate coefficients for explanatory variables that are constant over time, in our case the variable risk aversion. Its purpose is to examine if Flemish farmers made strategic financial risk adjustments in response to perceived changes in the level of business risk based on a revised risk balancing model. The parameter estimates of equation 28 can be found in Table 16.

$$\mathrm{FR}_{GB\,i,t} = \alpha_i + \beta 1(BR_{GB})_{i,t-1} + \beta 2(\frac{I}{D})_{i,t-1} + \beta 3(\frac{NOI}{A})_{i,t-1} + \beta 4(Area)_{i,t} + \beta 5(RApsych)_{i,t-1} + \sum_{K=1}^{K-1} \delta_k Type_k + \varepsilon_{i,t} \quad (28)$$

**Table 16. Regression results full model**

| Random effects model | (1)<br>$FR_{GB}$ |
|---|---|
| $BR_{GB\ t-1}$ | -0.143*** |
| | (0.04) |
| *Cost of debt* $_{t-1}$ | 0.989 |
| | (1.31) |
| Assets profitability $_{t-1}$ | -0.773* |
| | (0.43) |
| $RA_{psych\ t-1}$ | 0.020 |
| | (0.13) |
| Area | -0.007** |
| | (0.00) |
| Type Horticulture | -0.272 |
| | (0.39) |
| Type Fruit | 0.142* |
| | (0.41) |
| Type Milk | -0.216 |
| | (0.34) |
| Type Granivore | 0.277 |
| | (0.37) |
| Type Mixed field crops | -0.740<br>(0.60) |
| Type Mixed livestock | -0.367 |
| | (0.41) |
| Type field crops and livestock | -0.408<br>(0.38) |
| Constant | 1.448*** |
| | (0.50) |
| N | 3256.00 |
| F-value | |
| P-value | 0.00 |
| R-Square within | 0.014 |

Standard errors in parentheses
$^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

We observe no form of strong- but of weak risk balancing behaviour with a significant negative coefficient estimate of 0.143*** for the business risk. The standard error is rather low (0.04) which can imply that the majority of the farmers did show risk balancing in the period of 2005 – 2015. We see that *cost of debt* has a positive influence on the financial risk decision the farmers have. As assets become more profitable, financial risk decreases. As *Area* increases, the financial risk of the farmer decreases with a coefficient estimate of -0.007**. No type dummy variables show a significant relationship with the financial risk. The interpretation of all the regression results can be found in Chapter 4.1.2.

# 4. Discussion

The purpose of the discussion is to interpret the significance of the findings and relate it to what was already known and explain new understanding or insights about risk balancing. A connection is made with the introduction and the problem statement. The research question is revisited and answered using the new insights. Also the results are explained and interpreted here. The results of the model are compared with previous research who also looked into risk balancing with a similar model. A recommendation regarding the determinants used will be made. Limitations of the study and recommendation for further research can be found in sub-chapter 4.2. Finally, after studying the results, a new hypothesis regarding risk balancing is made.

## 4.1 Findings

The first two sub-question were answered using literature study regarding business risk, financial risk and risk aversion, where the third focused on empirically comparing business risk measured with an objective method and a subjective method. Furthermore, the fourth sub-question examined if changing the manner of measuring financial risk makes a difference when examining risk balancing. The fifth question looked at the inclusion of risk aversion and additionally looks at measuring risk aversion with a direct scale versus a psychometric method.

### 4.1.1 Theoretical findings

A summary of the problem statement for this research is that there are two foremost methods to measure and examine business risk. The founders of the risk balancing hypothesis, Gabriel and Baker, whose model focuses more on liquidity. And on the opposite site, the risk balancing hypothesis of Collins which focuses more on solvency. Both methods are widely used through literature. To the best of my knowledge, there has not been made an empirical comparison between the two models and there exists no consensus which model should be used to test if there is risk balancing behaviour present. Furthermore, the business risk was tested using a frequentist approach, also known as the objective approach, in previous literature, while the subjective approach proved better in decision making and driving people's behaviour (Sjöberg, 2000). The risk aversion was omitted or considered a constant when examining risk balancing behaviour, while the risk aversion of a farmer is essential in decision making (Brunette, 2015).

*Different empirical measures*

The findings regarding the first research question show that there is a lot of interest on the subject of risk balancing and a lot of different kind of theoretical as empirical methods exist and are used. First the theoretical base was found for the risk balancing, followed by the empirical evidence.

Researchers who pursue to study risk balancing face the following issues. The first proposition is the choice between focusing on liquidity or solvency when measuring business risk and financial risk. You could assume that the financial risk assessed on the Gabriel method is more volatile and more sensitive to changes in debt, thus produces different results when used in the risk balancing model. Also, a difference in results is produced since the Gabriel method uses the standard deviation while Collins uses variances to derive business risk. Then there is the question whether business risk should be measured using historical data, thus using the frequentist method, while there is evidence that subjective probability can predict behaviour much better than historical data can. Several models are used by previous research to find evidence for risk balancing (Table 4, page 8), such as comparative statistics in theoretical models (e.g. Collins, 1985). Stochastic programming can provide useful information for decision makers (e.g. Escalante and Barry, 2001), ARCH models can cluster time-varying volatility (Moss et al. 1990) and mean-variance analysis is used to determine the optimal level of leverage factor, which then in turn can be used to find evidence for risk balancing. More recently, correlation relationship analysis, linear regression and linear fixed effects regression were performed to verify risk balancing behaviour of farmers in the EU and China.

#### *The inclusion of risk aversion*

Risk aversion is a parameter that is almost always involved when studying risk or uncertainty. It is however hard to measure and there exists no unanimity if and how to include it when studying risk balancing in the agricultural sector. It is however considered an essential element when decisions imply risk (Brunette, 2015). The risk aversion of an individual often determines or influences important management decisions, but laboratory experiments to measure the risk aversion of an individual are simply not feasible for a large dataset. It can however not be considered a constant since it changes and it is influenced by life experiences or the social and economic status of the farmer (Bard and Barry, 2000). In the theoretical models, risk aversion was not modelled, however the researchers expected that risk aversion could have an influence on risk balancing behaviour (Gabriel and Baker, 1985). Other studies assume a constant risk aversion value (e.g. Featherstone, 1988), but their models do show that if risk increases the leverage factor decreases. A farmer who is not willing to take risk, is expected to have less financial risk, thus a lower leverage factor. Turvey and Kong (2009) tried to solve the optimum debt level for a level of risk aversion. The equation states that more risk averse individuals will use less debt than less risk averse individuals, which is in line with my hypothesis. However, risk aversion was not added into the model as a categorical variable or continuous variable.

### 4.1.2 Empirical findings

The interpretations of the result of the regression analysis can be found below in chronological order. First the objective and subjective methods of measuring business risks are compared. Then the differences between measuring financial risk using the Gabriel and Baker method versus the Collins method is presented. The effect of explicitly incorporating risk aversion in the risk model is next. Finally the interpretation of the random effects model is given.

### *Business risk*

The first regressions exams if there can be any difference observed when business risk is measured using the objective method, the subjective method or the subjective method including *influence* (0.372*, 0.520*, 0.307). Note that business risk is a value varying from 0 to 10, and the subjective business risk is a value varying from 1 till 5. No significant relationship is perceptible when using the $BR_{inf}$ as independent variable. The $BR_{GB}$ and the $BR_{sub}$ do show a significant affiliation with the $FR_{GB}$. That difference could be appointed to the fact that subjective influence must be excluded when assessing the business risk on a subjective scale. The Cronbach alpha did show values above 0.6. It means that the several questions regarding subjective influence measures the same construct. However, it does not mean that the subjective influence a farmer has on a certain event should be included in the calculation of business risk. It is interesting to observe that the $BR_{sub}$ shows a significant relation with the financial risk. It could imply that farmers who expect changes in business risk react with financial alternations. Future research could focus on the subjective probability and impact, instead of the objective approach, a farmer has on a certain event to assess the expected business risk a farmer has.

### *Financial risk*

Using the full sample size and the fixed effects model we see a significant effect with the financial risk (-0.247***, 0.004*) in both models. The regression results show that making a choice by focusing on solvency or liquidity can have consequences for your risk balancing results. Regarding the risk balancing hypothesis, the same conclusion can be drawn, both models show signs of risk balancing. A difference however can be observed in the two models in *Assets profitability*. Where the model of Gabriel and Baker showed a significant positive coefficient estimate, the Collins model shows a negative coefficient estimate. This could be appointed to the fact that *Assets* is the numerator to derive the *Assets profitability.* To derive the financial risk using the Collins method, assets is used as denominator. It seems logical that when the *assets profitability* increase, the $FR_C$ decreases hence the way the variables are designed. A higher F value is observed in the model of Collins indicating a higher overall significance of the regression model (61.71). The $FR_{GB}$ can be considered more volatile than the $FR_I$. In the fixed effects model, 2008 is used as reference dummy level. Potential explanations for all the negative coefficient estimates for all the years can be a stop on the milk quota in 2008, varying levels of EU support or other environmental changes. A difference can be found when examining the R-square. Where the model of Collins shows a much higher R-square than the model of Gabriel and Baker. A reason for this could be that the model of

Gabriel and Baker uses a much more volatile independent variable namely $FR_{GB}$ which show variance that cannot be explained by the other variables.

### *Risk aversion*

Including risk aversion as a continuous variable in the risk balancing model was to the best of my knowledge the first time ever done. The results imply that the risk aversion measured on a direct scale and on psychometric scale behaves partly as hypothesized. For the linear regression model risk aversion is added as a categorical variable measured on a direct scale. Note that the scale is on a risk averse scale. The third category is used as a reference dummy level and therefore omitted. As expected, the regression coefficients are positive in the first and second category. The first category, which is 15.3% of the total sample, shows a significant positive coefficient estimate of $3.832^{***}$. The regression results imply that the more risk seeking farmers are, the more financial risk they are willing to take. Thus only the farmers who rate themselves a value of one on a risk seeking scale show significantly higher financial risk compared to the other categories.

The regression coefficients of the fourth and the fifth category are positive in contrast what was hypothesized. It was hypothesized that the fourth and fifth category was going to show negative coefficient estimations since risk averse farmers were expected to show fewer financial risk. Risk aversion was also tested using a psychometric scale derived from multiple questions regarding risk. A negative regression coefficient (-0.21), non-significance set aside, shows here that farmers that are seeking are more willingly to take financial risk, as in line with the hypothesis. Investigating the psychometric scale further, the scale was cut up in four different categories. Hypothesized was that farmers showed more financial risk when placed in a lower category, thus positive coefficient estimates were expected since the fourth category functions as a dummy reference level. The regression results for category two and three showed a positive regression coefficient (0.142, 0.077). For the first category however a negative coefficient estimate was found (-0.055). This result is not in line with the hypothesis, namely that financial risk increases when farmers become more risk seeking. All three categories did not show any significance. This result teaches us that farmers with a different risk do have different capital structures and different interest coverage ratios i.e. financial risk. In the case of Flemish farmers, a higher level of risk aversion results in a lower level of financial risk.

### *Mediation effect*

Following the Baron and Kennedy method, the mediation effect of risk aversion was tested. To accept the hypothesis that risk aversion functions as a mediator in the risk balancing model, all first three steps should be significant. Conversely, only the first step was significant, where the lagged value of expected business risk was regressed on financial risk. Since steps two and three were not considered significant, the hypothesis that risk aversion acts as a mediator for expected business risk and financial risk can be rejected. Business risk is defined as the risk a farmer faces due to changes in the market environment (e.g. production, price, institutional and policy risk). To observe a significant affiliation between the $BR_{GB}$ and the $RA_{psych}$ was not expected. While it is hypothesized that life experiences or the social and economic status of the farmer can form the risk attitude (Bard and Barry, 2000), the relation is not significant here.

### *Random effects model*
To examine is Flemish farmers made strategic financial risk adjustments in response to perceived changes in the level of business risk based on revised risk balancing models, a random effect model was regressed. The reason why there was chosen for a random effects model and not a fixed effects model, was that time invariant variables could be added into the model. In our case, the risk aversion measured on a psychometric scale could be added. The regression results suggests that if the expected business risk in the previous year increases, the financial risk in the current period decreases ($-0.143^{***}$). Which in turn, keeps the total risk in a balance, thus a weak form of risk balancing is observed. This result is in line with previous risk balancing models (de Mey, 2014). Note that absolute values cannot be compared since the study of de Mey used logarithmic transformation for his data.

*Costs of debt* is positively correlated with the financial risk a farmer is willing to take (0.989). This implies that if the costs of debt increases, the financial risk a farmer is exposed to also increase. A positive relationship was hypothesized here, subsequently when the costs of the debt increases, the interest coverage ratio also increases. However, it could also be hypothesized against a positive affiliation between cost of debt and financial risk. When the cost of debt rises, it becomes less attractive to get more loans and increase your debt level. As a result, financial risk is likely to decrease. The regression coefficient *assets profitability* shows a significant negative relation with financial risk ($-0.773^{*}$). Which implies when farmers make more profit in relation to their assets, they are exposed to less financial risk. A lower profitability leads to a higher $FR_{GB,}$ because the interest coverage ratio declines.

Risk aversion has a positive affiliation with the $FR_{GB}$, which was not the case when it was tested using a linear regression model. It is not in line with the hypothesis that farmers who consider themselves as risk averse, are less willingly to take financial risk. This difference in regression result can be explained by the fact that the random effects model uses the whole data sample, as the linear regression of Chapter 3.3.1 did not. The coefficient estimate was not significant, which was in line with the previous model.

The variable *Area* has a significant negative coefficient estimate, implying that a smaller farm is exposed to a higher level of $FR_{GB.}$ Area also had a significant relation with financial risk in previous studies where the geographical area of the sample size was considerately larger. However, the coefficient estimates were positive, implying that a smaller farm size effects lower financial risk, ceteris paribus (de Mey, 2014).

The type dummies had only one significant result, which was the fruit type (-0.142**). Fruit farmers can be sensitive to financial risk, since fruit farmers are already exposed to more risk than other farmers. They experience a lot of risk like volatility, uncertainty in commodity prices, changes in regulations and decreases in crop yield (Heifner, 1999).

## 4.2 Limitations of the study

### *Measurement of risk aversion*

Measuring risk aversion has not proven to be straightforward in the past. Where direct elicitation for risk attitudes has been used before, research has given criticism towards the method. Pennings and Garcia (2001) found that risk aversion can be considered a higher order characteristic and can therefore not be measured directly. However, they did find that it can be measured using multiple measures. This could imply that the results of the direct elicitation method used in this study are not representative for the risk aversion Flemish farmers have. Luckily, the survey of Wauters et al. (2014) also provided data which could be used to derive the risk aversion measured on a psychometric scale. It can overcome the problem which the direct scale has, namely that it cannot be measured directly. However, in my opinion comparing and combining a direct scale with a psychometric scale can give more robust results.

### *Likert scale*

An aspect of the measurement of risk aversion which can be seen as a limitation to my study is assuming a risk aversion is continuous while it is measured using a Likert scale. Note that risk aversion using the psychometric scale is mentioned here. Since a Likert scale item is in fact a set of ordered categories, to assume it is continuous is frowned upon by some researchers but possible (Allen et al., 2007). For the reason that the intervals between the scale values are not considered equal. Correlation or regression analysis with the scale is thus invalid (Jamieson, 2004). There are also studies that showed a Likert scale was a correct parameter if the assumptions regarding skewness and number of categories were met (Lubke and Muthen, 2004). The difference between a Likert item and a Likert scale must be understood though. While a Likert item is simply one item, a scale is made up of many items. In the case of the risk aversion variable that is measured directly, thus it is a Likert item, and is not considered a continuous variable. The Likert scale that is measured using the subjective probability, impact and influence has 27 items. All those items are also checked with the Cronbach Alpha if they really measure the same construct. Thus, while research disagree with using a Likert scale as continuous variables, when using enough Likert items to build a reliable Likert scale, a continuous variable is allowed in my eyes.

### *One measurement point of risk aversion*

The risk aversion of an individual is a unique reflection of his or hers personality, as it can be influenced by life experiences or the social and economic status of the farmer (Bard and Barry, 2000). The assumption of a stable, context-invariant, risk aversion and preference is challenged (Anderson and Mellor, 2009; Weber et al., 2002) Thus, it can be assumed that the risk aversion of a farmer is not constant for his whole life but can change over time. The survey conducted by

Wauters et al. (2014) is conducted for one year, namely the year 2013. Therefore the variable risk aversion could only be used for the year 2013. Since this study uses unbalanced panel data, it would be ideal if the variable risk aversion was available for every farmer for every year, since it cannot be considered a constant. However, due to the lack of data regarding risk aversion, the regression analysis that used risk aversion as a variable were only for the year 2014 or were performed as a random effects model. The same problem goes for business risk measured using the subjective probability, impact and influence. Only for the year 2013 data is available for those several variables. Since for some variables only one year of data is available, a random effects model has been used. A fixed or random effects model can control for fixed or random individual differences. With the fixed effects model, the regression line is raised or lowered for each farm. The advantage of a random effects model is that is can be used, using fewer degrees of freedom and that individual differences are considered random instead of fixed.

### *Historical data to assess expected business risk*

The variable business risk measured using the objective method, relies on historical data to assess it value. One could argue that this method does not capture all the expected business risk a famers has. Cumming and Hirtle (2001) also indicate that there is a need for discussion on how to define and capture business risk. However, when a dataset is large, it becomes troublesome to measure the expected business risk of a farmer on a subjective method. The objective method is then the preferred one because of time and money issues.

### *Outliers and data adaptation*

Every dataset and survey has outliers which can be dangerous for your results. Especially using Ordinary Least Squares (OLS), since the statistical method is sensitive to the presence of outlying units that have unusual values (Tabachnick and Fidell, 1996). An outlier is defined by Wiggins (2000) as cases, which generally lie more than three standard deviations from #Y hat. Therefore they distort statistics. In the case of this study, financial risk and business risk using the Gabriel method should be in theory a number between zero and one, as de Mey (2014) also showed with his descriptive statistics. Because $BR_{GB}$ and $FR_{C}$ make use of the net operating income, which can be considered volatile and can have a negative value, outliers were detected after plotting and examining the min and max of the variables. After identifying an outlier, the choices are to find out if there has been an error in recording the data, an error in calculating with the data or if the outlier is truly an outlier. An argument for keeping an outlier is because it represents the real world with realistic data. But when the OLS procedure is sensitive to those outliers, results cannot be generalized for the whole farmer population. In Chapter 2.1 the data adaptation before analysing can be found. One could argue that dropping or recoding negative values, or extreme high values will give a distorted image of reality. To recode negative values was an easy decision since negative values are not feasible for the $FR_{GB}$ or the $FR_{C.}$ A farmer cannot be exposed to a negative amount of risk. As farmers cannot achieve a negative value for *ROA,* negative values were here also recoded to a value of zero. However, recoding the *BR* for every value above ten to a maximum value of ten was a choice I made. This choice was made since a value above ten for business risk could only be appointed to farmers who had negative values of *NOI* for multiple years. Since these cases were only rare, less than one percent of the data was recoded by this data adaptation, a maximum value of ten was appointed to these farmers for expected business risk measured on an objective scale. For the reason of this data adaption, risk is underestimated as extreme cases of risk are adapted.

#### *Positive values of risk balancing using a linear regression model*

While the fixed effects and the random effects model provide evidence for risk balancing behaviour, the linear regression models used to test the differences in business risk resulted in positive coefficient estimates for the business risk. The $BR_{GB}$, $BR_{sub}$ and the $BR_{inf}$ all showed a positive affiliation with financial risk. This would imply that there is no evidence of weak form risk balancing but even the opposite. That is when business risk decreases, the financial risk of a farmer also decreases. The results does not weigh heavily on my results as only 10% of the data sample is used in this regression, because $BR_{sub}$ and the $BR_{inf}$ was only available for one year. Also the R-square of the 0.07 and 0.09 are relatively low, for example the R-square of the random effects model is twice as high.

#### *Mediation effect*

A limitation of testing the mediation effect is that it cannot test the significance of the indirect pathway. It is more a handy tool to test of there is a mediator present in your analysis. However, no conclusion can be drawn of the effects of the variable.

#### *The variance explained in the regression models*

The R-square is a parameter that shows how much of the variance in the dependent variable is explained by the independent variable. The R-square in most of the risk balancing models is relatively low. A low R-square can be seen as problematic when precise predictions must be made. That is not the case in this research though. Previous research regarding risk balancing experienced higher R squares. Where Escalante and Barry (2003) had an R-square of 0.27 and 0.26 for their OLS regression, Ashok, Mishra and Moss (2016) had an R-square of 16 percent for their OLS and fixed model.

## 4.3 Recommendations and advice for further research

The results of this study complement all the previous research done regarding risk balancing. Recommendations for further research are presented here below.

An innovative aspect of this research was measuring business risk using a subjective scale. Not relying on a frequentist approach, but using data from a survey to derive the expected business risk showed to be a robust method. The expected business risk derived using the subjective probability, impact and influence showed a significant relation with the financial risk that a farmer is exposed to. Future research should take into consideration that blindly relying on the frequentist approach is not the only way to derive the expected business risk. However, when the sample for the study is too large, the frequentist approach can be a solution.

### *The risk survey*

The survey conducted by Wauters et al., 2014 was a survey designed to measure risk perception, the attitudes towards risk and the perceive usefulness of the risk managements strategies (Appendix A,B,C). Working with the risk survey made me realise I missed a couple of aspects. The first one is a direct Likert scale question if farmers feel they perform risk balancing behaviour. To the best of my knowledge, there is no study done where farmer are asked directly if they perform risk balancing. Additionally, they could develop a psychometric scale focused on risk balancing. Such as questions as: *"If a new policy has as a consequence that my farm income rises, I am willing to increase my level of debt".* Now, all the questions regarding risk balancing were asked indirectly for example: "*I do not like to take decisions concerning risk".* If would be interesting to see if farmers are aware they perform financial risk alterations due to changes in the expected business risk. This for the fact that if they are aware that they perform risk balancing behaviour, they could possibly be made aware of the fact that they are exposed to the same level of total risk after a decrease in business risk. Further research could look into if there could be a possibility that farmers feel financially more safe after a decrease in business risk, but when in fact their total risk remains the same after financial alterations in their level of debt. Awareness can prevent this false feeling of safe, which in time can improve their financial reactions to changes in business risk.

### *The Gabriel and Baker method versus the Collins method*

The Collins method proved to be a more stable method to study risk balancing that the Gabriel and Baker method. This could be appointed to the fact that it uses balance sheet information which is bound to more rules and regulations than the profit and loss account of a farmer. When working with the Gabriel and Baker method, some of the variables were designed in a way that they cannot work with negative values. When adapting the data or dropping data to make the data compatible for the Gabriel method, a part of the data got lost, which is no problem when the data sample is relatively large. It does however, when you adapt extreme high cases of business risk, underestimate the level of risk. I recommend to use the Collins method when using a relatively small data sample, thus using the leverage factor and the variance of the *ROA*, because no data adaptations have to be made which can alter your regression results.

### *Risk aversion*

The variable risk aversion proved to behave as hypothesized. Farmers who were considered risk seeking, were exposed to more financial risk. On a direct scale, significance was only observed at the most risk seeking category. Setting non-significance aside there appears to be a negative relation between risk aversion on a psychometric scale and financial risk. Policymakers should take into account that their target audience exists out of different kinds of farmers with different risk aversion levels. Since there is a significant difference in farmers being risk seeking or risk averse, and their corresponding levels of financial risk, caution should be exercised when developing policies. Further research should examine if there is a relation between the level of risk aversion and the amount of risk balancing.

# 5. Summary and conclusion

The results provide a unique perspective on the use of subjectively measuring business risk, comparing two different risk balancing models when focusing on liquidity or solvency, and the effect of explicitly adding risk aversion in the risk balancing model. Using the FADN database and a survey conducted by the ILVO this study explored the interactions between financial risk and business risk on farm level using alternative specifications and determinants in the Flemish part of Belgium. The importance of these results are that it offers support for the Gabriel and Baker theoretical model as well as the Collins model. The result provides a theoretical framework for researchers who are facing issues when investigating risk balancing concerning how to measure business risk, which theoretical model to focus on and what to do with the variable risk aversion.

Gabriel and Baker (1980) and Collins (1980) were the first that developed a theoretical model for the risk balancing hypothesis. While the models can investigate the same phenomenon, namely if farmers make strategic financial risk adjustments as a response to changes in business risk, the models focus on different angles. It must be taken into account that the model of Gabriel and Baker focuses on liquidity and therefore uses parameters, such as the net operating income, that are much more volatile than the parameters Collins uses. These volatile parameters can cause problems since data adaptation is necessary before analysis, such as changing the mean value of the NOI over a three year period when it is a negative value. As a consequence risk is underestimated by these procedures. The OLS statistical method is sensitive to the presence of outlying units that have unusual values, therefore when your data sample is relatively large, data adaptations would have a smaller effect on your results compared to when your data set is small. Thus, the Gabriel and Baker method is only recommended when your dataset is large and only a small percentage of your dataset needs adaptation. The Collins method uses balance sheet information which is bound to more rules and regulations and is therefore less volatile.

It is assumed that business risk can be objectively measured, however the subjective impact is considered more important than the objective impact in decision making and driving people's behaviour (Sjöberg, 2000). Using the subjective probability and impact of an event, the expected business risk of a farmer was derived. When performing a linear regression controlling for *Cost of debt*, *Assets profitability*, *Area* and *Type* dummies, it showed a significant positive effect with the $FR_{GB}$. Thus, the business risk measured using a subjective measure can possibly replace the objective manner. The expected business risk derived using the subjective probability, impact and influence proved not to be a replacement for the $BR_{GB}$, since no significance was detected.

The level of risk aversion of a farmer does not have the significant influence on financial risk as was initially hypothesized. When adding risk aversion measured using a psychometric scale in a linear regression model, no significant relation between the risk aversion and the financial risk is observed. Setting non-significance aside, a negative relation was observed, which could imply that risk averse farmers do have less financial risk. When risk aversion is measured on a direct scale and regressed as a categorical variable only the most risk seeking farmers show significance with the financial risk. It could imply that only when farmers can consider the be at the extremity of the scale, significant affiliation exists with the financial risk.

To investigate if Flemish farmers performed strategic financial alterations as a response to changes in business risk, a random effects model was performed. While controlling for the risk aversion of a farmer the coefficient estimate of business risk regressed on financial risk was negative (-0.143***). Which would imply that using the farm observation, Flemish famers did show evidence of risk balancing in the period of 2008-2015. An increase of the ratio of the business risk ($\frac{\sigma NOI}{\mu NOI}$) would decrease the financial risk ($\frac{I}{NOI-I}$) by 0.143. The theory of a one on one relationship, where financial risk would decrease by one if business risk rises by one is rejected.

Where still unknown areas exists regarding risk balancing, new research is still done. This study can be considered as a useful tool providing a new theoretical framework and contributing to new insights and knowledge concerning risk aversion, subjectively measuring variables and comparing models. Since risk balancing can unintentionally increase the financial risk farmers are facing because of risk balancing behaviour, further research should look into the underlying causes of risk balancing using an alternative extended risk survey. Only then, risk balancing can be prevented and tailor made policies can lower the total risk a farmer is exposed to.

# 6. Literature


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# Appendix

## Appendix A Risk survey

Part of the Risk survey from Wauters et al. (2014). The Risk Aversion part. Translated Dutch to English

| Indicate whether | |
|---|---|
| The biggest risk for my farm is not caused by volatile prices but decreasing margins. | 1 – 2 – 3 – 4 – 5 |
| I do not control most risk, but the best way to deal with it, it to run my company the best I can | 1 – 2 – 3 – 4 – 5 |
| By making smart decisions I can reduce the risk for my farm | 1 – 2 – 3 – 4 – 5 |
| The law and regulations regarding agriculture and additional checks form a great threat for my farm | 1 – 2 – 3 – 4 – 5 |
| I do not like to take decisions concerning risk | 1 – 2 – 3 – 4 – 5 |
| I cannot cope with financial risk and uncertainties on my farm | 1 – 2 – 3 – 4 – 5 |
| I cannot afford to take any risks with my company | 1 – 2 – 3 – 4 – 5 |
| The profession of a farmer knows many risk, which is a challenge | 1 – 2 – 3 – 4 – 5 |
| I can afford to try new ideas even when it brings a risk | 1 – 2 – 3 – 4 – 5 |
| I am willing to take financial risks when it can lead to more profit | 1 – 2 – 3 – 4 – 5 |
| I cannot sleep at night when I did not do anything to minimalize risks | 1 – 2 – 3 – 4 – 5 |
| I postpone investments until it is really necessary | 1 – 2 – 3 – 4 – 5 |
| I am very careful with financial decisions like loans or investments | 1 – 2 – 3 – 4 – 5 |
| I am not afraid to loan a significant amount of money to increase the profitability of the farm | 1 – 2 – 3 – 4 – 5 |

## Appendix B Risk survey

Part of the Risk survey from Wauters et al. (2014). Nine questions to determine business risk. Translated Dutch to English

Focus on probability, impact or influence

| | |
|---|---|
| Verlies van productie door weersomstandigheden | 1 – 2 – 3 – 4 – 5 |
| Verlies van productie door ziektes | 1 – 2 – 3 – 4 – 5 |
| Uitzonderlijk lage verkoopsprijzen | 1 – 2 – 3 – 4 – 5 |
| Uitzonderlijk hoge kostprijzen | 1 – 2 – 3 – 4 – 5 |
| Over een lange periode te kleine opbrengsten ten opzichte van de kosten | 1 – 2 – 3 – 4 – 5 |
| Onverwachte veranderingen in de regels of het beleid met negatieve gevolgen voor mijn bedrijf | 1 – 2 – 3 – 4 – 5 |
| Te beperkte beschikbaarheid van grond of te hoge grondprijs | 1 – 2 – 3 – 4 – 5 |
| Problemen op persoonlijk vlak die een impact hebben op het bedrijf (ongeval, ziekte, onenigheid) | 1 – 2 – 3 – 4 – 5 |
| Wegvallen van (een aanzienlijk deel van) de subsidies | 1 – 2 – 3 – 4 – 5 |

## Appendix C Regression models

Information regarding of all the performed regression models

| # | Theoretical Framework | What are we going to test | Independent variable | Dependent variables | For the years | Kind of model |
|---|---|---|---|---|---|---|
| A | G&B | Business risk – 3 lagged BR | Financial risk Gabriel and Baker<br><br>I/NOI-I | Lagged Business risk<br>Cost of debt<br>Assets profitability<br>Area<br>Type | 2013 | Simple linear regression |
| B | G&B | Business risk – Subjective probability and impact | Financial risk Gabriel and Baker<br><br>I/NOI-I | Subject Business risk<br>Cost of debt<br>Assets profitability<br>Area<br>Type | 2013 | Simple linear regression |
| C | G&B | Business risk – subjective probability impact and influence | Financial risk Gabriel and Baker<br><br>I/NOI-I | Subject Business risk<br>Cost of debt<br>Assets profitability<br>Area<br>Type | 2013 | Simple linear regression |
| D | G&B | Financial risk Gabriel method | Financial risk Gabriel and Baker<br><br>I/NOI-I | Lagged Business risk<br>Cost of debt<br>Assets profitability<br>Area | 2005 - 2015 | Panel data Fixed effects model |
| E | Collins | Financial risk Collins Method | Financial risk Collins<br><br>Debt/Assets | Business SD(ROA)2<br>Cost of debt<br>Assets profitability<br>Area | 2005 - 2015 | Panel data Fixed effects model |
| F | G&B | Risk Aversion – direct scale | Financial risk Gabriel and Baker<br><br>I/NOI-I | Lagged Business risk<br>Cost of debt<br>Assets profitability<br>Area<br>Type<br>Risk Aversion direct | 2013 | Simple linear regression |
| G | G&B | Risk Aversion – Psychometric sale | Financial risk Gabriel and Baker<br><br>I/NOI-I | Lagged Business risk<br>Cost of debt<br>Assets profitability<br>Area<br>Type<br>Risk aversion psych | 2013 | Simple linear regression |
| H | G&B | Mediation effect | Financial risk | Business risk | 2013 | Simple linear regression |
| I | G&B | Mediation effect | Risk Aversion | Business risk | 2013 | Simple linear regression |
| J | G&B | Mediation effect | Financial risk | Risk Aversion | 2013 | Simple linear regression |

| | | | | | | |
|---|---|---|---|---|---|---|
| K | G&B | Mediation effect | Financial risk | Business risk + Risk aversion | 2013 | Simple linear regression |
| L | G&B | Full model to test if there is any form of financial risk alterations in response to changes in the perceived Business risk | Financial risk Gabriel and Baker or Collins<br><br>I/NOI-I | Lagged Business risk<br>Cost of debt<br>Assets profitability<br>Area | 2005 - 2015 | Panel data – Random effects model |

# Appendix D Regression models

Overview of all the regression models

A. $FR_{GB\,i,t} = \beta 1(BR_{GB})_{i,t-1} + \beta 2(\frac{I}{D})_{i,t-1} + \beta 3(\frac{NOI}{A})_{i,t-1} + \beta 4(Area)_{i,t} \sum_{K=1}^{K-1} \delta_k Type_k + \varepsilon_{i,t}$

B. $FR_{GB\,i,t} = \beta 1(BRsub)_{i,t-1} + \beta 2(\frac{I}{D})_{i,t-1} + \beta 3(\frac{NOI}{A})_{i,t-1} + \beta 4(Area)_{i,t} \sum_{K=1}^{K-1} \delta_k Type_k + \varepsilon_{i,t}$

C. $FR_{GB\,i,t} = \beta 1(BRinf)_{i,t-1} + \beta 2(\frac{I}{D})_{i,t-1} + \beta 3(\frac{NOI}{A})_{i,t-1} + \beta 4(Area)_{i,t} + \sum_{K=1}^{K-1} \delta_k Type_k + \varepsilon_{i,t}$

D. $FR_{GB\,i,t} = \alpha_i + \beta 1(BR_{GB})_{i,t-1} + \beta 2(\frac{I}{D})_{i,t-1} + \beta 3(\frac{NOI}{A})_{i,t-1} + \beta 4(Area)_{i,t} + \sum_{T=1}^{T-1} \varphi_t Year_t + \varepsilon_{i,t}$

E.

$$FR_{C\,i,t} =$$

$$\alpha_i + \beta 1(BR_C)_{i,t-1} + \beta 2(\frac{I}{D})_{i,t-1} + \beta 3(\frac{NOI}{A})_{i,t-1} + \beta 4(Area)_{i,t} + \sum_{T=1}^{T-1} \varphi_t Year_t + \varepsilon_{i,t}$$

F.

$$FR_{GB\,i,t} =$$

$$\beta 1(BR_{GB})_{i,t-1} + \beta 2(\frac{I}{D})_{i,t-1} + \beta 3(\frac{NOI}{A})_{i,t-1} + \beta 4(Area)_{i,t} + \beta 5(RAdir)_{i,t-1} + \sum_{K=1}^{K-1} \delta_k Type_k + \varepsilon_{i,t}$$

G.

$$FR_{GB\,i,t} =$$

$$\beta 1(BR_{GB})_{i,t-1} + \beta 2(\frac{I}{D})_{i,t-1} + \beta 3(\frac{NOI}{A})_{i,t-1} + \beta 4(Area)_{i,t} + \beta 5(RA)_{i,t-1} + \sum_{K=1}^{K-1} \delta_k Type_k + \varepsilon_{i,t}$$

H. $FR_{GB\,i,t} = \beta 1(BR_{GB})_{i,t-1} + \varepsilon_{i,t}$

I. $RA_{i,t} = \beta 1(BR_{GB})_{i,t-1} + \varepsilon_{i,t}$

J. $FR_{GB\,i,t} = \beta 1(RA)_{i,t-1} + \varepsilon_{i,t}$

K. $FR_{GB\,i,t} = \beta 1(BR_{GB})_{i,t-1} + \beta 2(RA)_{i,t-1} + \varepsilon_{i,t}$

L. $FR_{GB\,i,t} = \alpha_i + \beta 1(BR_{GB})_{i,t-1} + \beta 2(\frac{I}{D})_{i,t-1} + \beta 3(\frac{NOI}{A})_{i,t-1} + \beta 4(Area)_{i,t} + \beta 5(RA)_{i,t-1} + \varepsilon_{i,t}$