Wageningen University - Department of Social Sciences

MSc Thesis Business Economics Group

The viability of an onion futures contract

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This master thesis is the product of six months research in the context of the master Management, Economics and Consumers Studies at the Wageningen University. The commissioner of this thesis raised the question to investigate the viability of an onion futures contract. This report tries to provide an answer to the question of the commissioner.

During the process of this research I have got help from several people who I would like to thank. In the first place I would like to thank my supervisors Dr. Alessandro Bonanno and Prof. Joost M.E. Pennings. Thanks also to Dr. Andres Trujillo Barrera and Dr.ir. Erno Kuiper, for support with regard to the econometric part of the thesis.

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Pieter Vette
Wageningen, August 2014

Executive Summary

In terms of global production volumes, onions are an important vegetable crop. The Netherlands is a large producer and exporter of onions. The prices of onions are characterized by strong volatility. An onion futures contract is of interest for the commissioner of this research "Land en tuinbouw organisatie Nederland" (LTO). This study aimed to analyse the viability of an onion futures contract as a price risk management tool in the Dutch onion chain. After a literature study, the marketing-finance approach is chosen to serve as basis for this study. The study is divided into a technical and marketing approach.

Important aspects of the technical approach are standardization possibilities of the product, storability, market structure, cash market size and volatility of cash prices. Another part of the technical approach is the cross-hedge study, where the hedging effectiveness of already existing futures will be investigated. The marketing approach focuses on the needs of the customer. Interviews with participants in the onion chain give insight in the mindset of entrepreneurs with regard to price risk.

In the technical approach, the onion could be characterized as a storable product and after sorting a quite uniform product. The structure of the onion market characterizes itself with almost no vertical integration or the market power concentration. The market power is equally divided over the chain compared with other arable crops. The limited use of cash-forward contracts in the chain is a result of the shortage filling position in the export market of the Netherlands. The size of the cash market is small, compared with the size of the cash market of existing agricultural futures. The cross-hedge study demonstrates low hedging effectiveness of possible cross-hedges.

The marketing approach showed that participants are satisfied with high price fluctuations and the existing price risk management tools. Among the participants of the interviews there was limited interest in futures and according to them there is limited additional benefit of futures. Overall the participants did not have much experience with futures.

In conclusion there are some bottlenecks for a viable onion futures contracts. The lack of cash-forward selling contracts in the onion chain limits the need of hedging for traders. The small size of the cash market is another bottleneck, even as the small interest in futures of the interviewed participants. Further research is recommended for a quantitative marketing approach, which is not conducted in this study.

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List of abbreviations

ADF	Augmented Dickey Fuller
AHDB	Agriculture and Horticulture Development Board
Cov	Covariance
CS	Cash market size
CV	Coefficient of variation
EUR	Euro
FCZ	Futures contract size
FEPP	Futures European Processing Potatoes
FWF	Feed Wheat Futures
H*	Hedged portfolio
HE	Hedging effectiveness
HGCA	Home Grown Cereal Authority
HR	Hedge ratio
MWF	Milling Wheat Futures
MGARCH	Multivariate Generalized Autoregressive Conditional Heteroskedasticity
OHR	Optimal hedge ratio
OLS	Ordinary least squares
SOB	Seed Onions Big
SOS	Seed Onions Small
U	Unhedged portfolio
USD	United States Dollar
V	Volume of trading
Var	Variance
VAR	Vector Autoregressive
VLCT	Velocity

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1. Introduction

1.1 Background

Globally, the onion (*Allium cepa L.*) is an important vegetable crop in terms of production volumes (Opara, 2003). In 2011 nearly 85 million ton of onion were produced worldwide, with a gross production value of 28,546 million USD. Within the vegetable crops, only tomatoes exceed onion's production volume (FAOSTAT, 2013). Inherent with the increasing global production during the last decades is the increasing global export, estimated at 6.8 million ton in 2011 (FAOSTAT, 2013).

Although for years the Netherlands maintained the position of world leader in exporting dry onions, in recent years India has become the world leader (Salm van der, 2011). Regardless, in Western-Europe the Netherlands is still the largest producer and exporter of onions, with 1.4 million tons of production (gross production value of 214 million USD) and 1.3 million ton of export. Over the last decade, export and production of onions in the Netherlands are still growing (FAOSTAT, 2013).

Dry onions are a speculative product for both farmers and traders because of its strong price volatility (Baas and Pals, 2006). Price risk management is of interest of companies in the onion chain, in order to reduce their vulnerability against price volatility. Since price risk is an important topic in agriculture (Kobzar, van Asseldonk and Huirne, 2006), an onion futures contract could be a viable risk-management tool. Furthermore, hedging price risks of onions through cross-hedges could be a possibility.

Although an onion futures contract existed in the mid-twentieth century traded at the Chicago Mercantile Exchange, because of market manipulation by two traders, a law passed in August 1958 prohibited the trading of onion futures contracts in the United States (Lambert, 2010). However, among other industry actors, an onion futures contract seems to be of interest for the "Agriculture and Horticulture organization" (LTO). LTO is a Dutch farmer organization, which encourages the economic and social position of agricultural entrepreneurs (LTO, 2014). Due to its importance, this report will focus on the Dutch onion market.

1.2 Objective

LTO raised the question: Why is there no onion futures contract? They wondered whether an onion futures contract could be a viable price risk management tool, so that farmers, traders and customers could manage their risks. Hence, this work aims to :

Analyse the viability of an onion futures contract as a price risk management instrument in the Dutch onion chain.

1.3 Research questions

In order to analyse the viability of an onion futures contract as a price risk management instrument in the Dutch onion chain, some research questions have to be answered. The following research questions will be answered in different chapters:

- What determines the viability of a new futures contract?
- What characterize the onion and its market, considering aspects as storability, homogeneity, market structure, market size and cash price volatility?
- What are the possibilities of cross-hedges?
- What is the opinion of different stakeholders in the onion chain about price risk and how to manage it?

1.4 Thesis outline

This report is organized in different chapters. In chapter 2, a literature study is conducted about the viability of new futures contracts. This chapter forms a basis for chapter 3, material and methods. Chapter 3 explains the methodology of the study. A distinction is made between the technical and marketing approach. Chapter 4 and 5 are part of the technical approach, where chapter 6 represents the marketing approach. The conclusion and discussion of the study is given in chapter 7.

2. The viability of new future contracts

During the last quarter century the number of futures markets show a major increase, even as the proposals for new futures contracts (Rausser and Brayant, 2004). Many new futures contracts fail after their introduction and only few are successful (Bekkerman and Tejeda, 2013; Pennings and Leuthold, 2000). Various authors define market success as the achievement of permanently high trading volume and open interest. Many studies investigated the determinants of conditions which make a futures contract successful or not (Bekkerman and Tejeda, 2013). There are numerous explanations within different disciplines for the success or failure of a futures contract. A very comprehensive approach, which analyses the viability of new financial services, is the marketing-finance approach. The marketing-finance approach focuses on the interface between the marketing perspective and the finance perspective (Pennings, 1998). A schematic overview of this conceptual model is shown in figure 1.

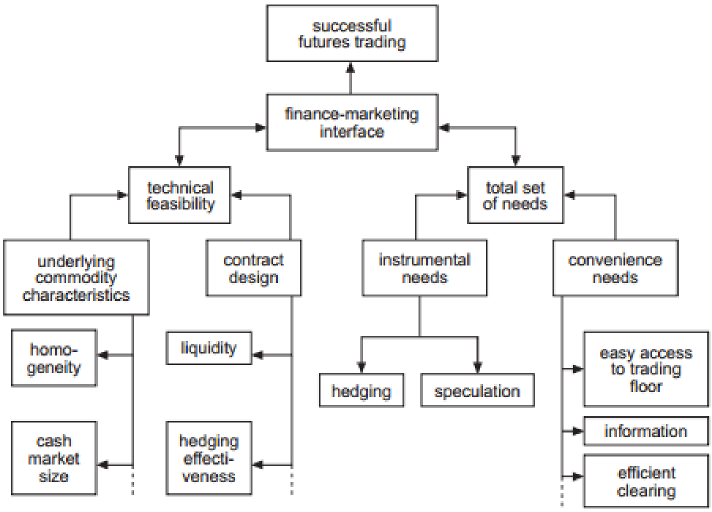

Figure 1: Conceptual model marketing-finance approach (Pennings, Wetzels, and Meulenberg, 1998)

Figure 1 is divided into two parts, technical feasibility and total set of needs. The technical feasibility called technical approach in this report, explains the conditions that have to be met in order to achieve a permanently high trading volume and open interest. The technical approach is characterized by criteria as standardization possibilities, size of the cash market, number of participants and cash price volatility (Pennings *et al*., 1998). Components as activeness of a cash market, product storability, degree of vertical integration, market power and the available cross-hedging possibilities, mentioned by Bekkerman (2013) could be qualified in the technical approach as well. This study focuses on the following determinants of technical feasibility.

1. *Characteristics of the underlying product and its cash market*
   The underlying product should be able to be exchanged, so the traded commodity unit should have a homogeneous quality level. Standardisation or a well-established grading system, which is generally accepted by all market participants, could dissolve the problem of heterogeneity. Variation in quality among the traded commodities has a negative effect on the futures trading activity, so lowering the potential success of a futures contract (Bekkerman and Tejeda, 2013). Throughout the year there should be opportunities to trade on the spot market, which enables the opportunities for arbitrage between cash and futures

markets. This requires a well-developed effective storage and transportation infrastructure that facilitates exchange opportunities over the year.

The potential trading volume of a new futures market is dependent on the underlying cash market. Participants on the spot market may hedge their price risk with the new futures contract. Therefore the size of the cash market, number of participants and activeness of the cash market determine the likelihood of success of a new futures contract. The degree of vertical integration and market power concentration influence the potential trade of futures. Finally the volatility of the cash prices is an important indicator. There is an influence of the price fluctuations towards the attractiveness for both speculators and hedgers. The incentive to insure against price risk is higher if the possible losses are big (Black, 1986). Many empirical studies documented a strong, positive correlation between volume trading and price volatility (Brorsen and Fofana, 2001).

2. *Cross-hedge possibilities.*
   In case there are already possibilities to hedge price risk with other futures contracts, a new futures contract could be abundant, so significant demand for this new financial service is unlikely (Black, 1986). The probability of success of a new futures contract is higher, when this contract provides a service which does not exists yet.

The marketing approach, illustrated on the right side of figure 1, examines the ability of a futures contract to satisfy the needs of potential customers (Pennings *et al*., 1998). The needs of potential customers could be set out in instrumental needs and convenience needs. Instrumental needs represent the needs for price risk reduction of hedgers. Hedgers may already be satisfied with the market situation without futures market. In case hedgers are interested in a new futures contract, the convenience of participating on a futures market is important. Hedgers want a flexible and easy clearing system at acceptable prices (Pennings *et al*., 1998).

3. Materials and methods

As described in chapter 2, a very comprehensive approach of analysing the viability of new financial services is the marketing-finance approach. This approach is guiding this study, where the technical approach is elaborated more than the marketing approach which is more descriptive.

Figure 2 shows a global overview of the framework of this study.

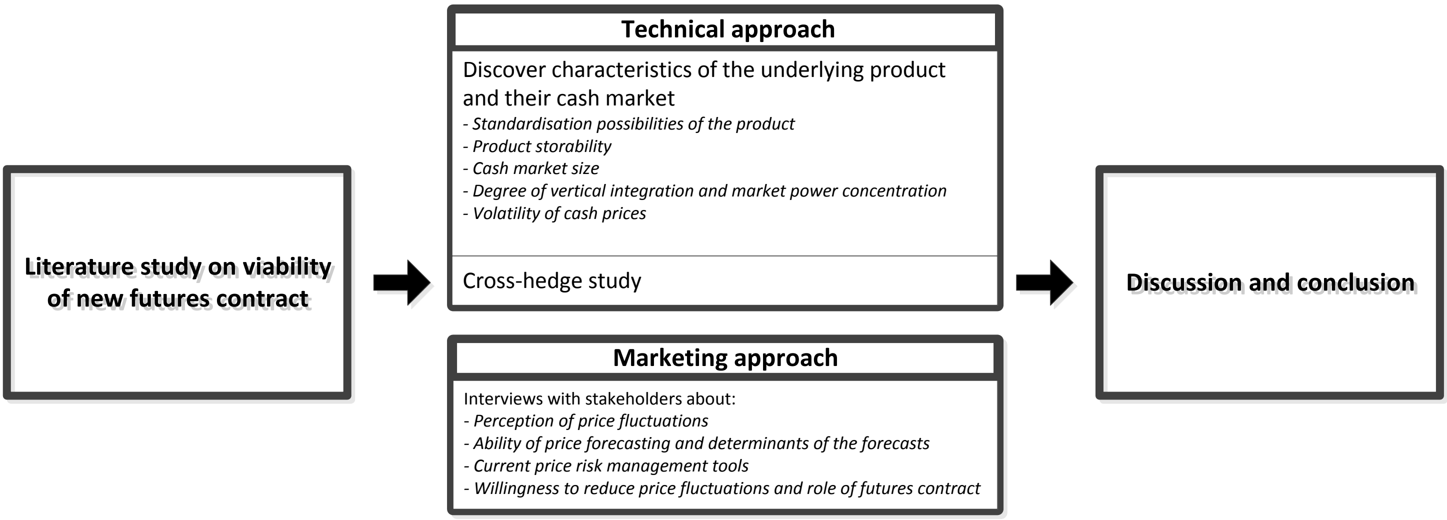

Figure 2: Framework of the study

3.1 Technical approach

The technical approach consists of two main determinants, which affect the viability of a new onion futures contract. The characteristics of the underlying product and its cash market and cross-hedging possibilities.

3.1.1 Characteristics of the underlying product and their cash market

The qualitative aspects of the characteristics of the onion and its cash market, will be investigated with the help of literature study and interviews with experts of the onion chain. Quantitative aspects such as the calculation of potential trading volume as a result of cash market size and a calculation of the volatility of the cash prices are also investigated.

The size of the cash market is an important determinant of the success or failure of a futures contract. Black (1986) determined three reasons why a large size cash market contributes to the success of a futures contract. First, a large cash market is more resistant against participants which want to control the market with large financial resources. Second, a large amount of participants in the cash market is coherent to a large group of potential hedgers. Third, a broad cash market enables the market operation in order to arbitrage hedgers positions.

A commonly used formula to calculate the potential volume of trading is shown in equation 1 (Pennings and Meulenberg, 1998). By definition the potential volume of trading is a function of contract size, cash market size, hedge ratio and velocity (Black, 1986).

$$V = \frac{CS}{FCZ} * HR * VLCT \quad (1)$$

In equation (1), V denotes the volume of contracts traded, CS is the cash market size, FCZ the futures contract size, HR the hedge ratio and VLCT the velocity. A velocity of 1 indicates that futures are traded between hedgers, which is the assumed position in this research. The activeness of speculators on the market could raise the velocity above 1.

A widely used ratio for expressing the volatility is the coefficient of variation (CV). The CV is the standard deviation divided by the mean as shown in equation (2). The CV is a stable and dimensionless expression of volatility (Pennings *et al*., 1998), which enables to make comparison between different crops. The data series which are used in the next paragraph "Cross hedge possibilities", are also used for the calculation of CV. A comprehensive description of the data can be found in paragraph 3.1.2.1.

$$CV = \frac{\sigma}{\mu} \quad (2)$$

Where σ represents the standard deviation and μ the mean of the price series.

3.1.2 Cross hedge possibilities

The existence of possible cross-hedges is an important determinant for the need or redundancy of a new futures contract. Therefore a cross hedge study will be conducted for the case of onions. The econometric software EVIEWS is used for this cross-hedge study. Dutch arable crops with tradable futures are wheat and potatoes. Since these crops are subject to the same production and weather conditions and are grown mainly on the same arable farms, they deserve further investigation on possible price relations.

3.1.2.1 Data

Price data series of seed onions (small and big), European processing potatoes and wheat (milling and feed) are used in this cross-hedge approach. The data of seed onions are spot prices and the data of potatoes and wheat are futures prices. In this study the data series is named as followed: seed onions small (SOS), seed onions big (SOB), European processing potatoes futures (FEPP), milling wheat futures (MWF) and feed wheat futures (FWF). It is weekly price data from week 18, 2008 until week 8, 2014.

Table 1 summarizes the statistics of the data series where figure 3 illustrates the movement of the prices during the sample period.

Table 1: Summary statistics data series

Abbreviation	Commodity	Units	Obs	Avg	SD	Min	Max
SOS	Seed onions small	€/100 kg	247	11.04	8.08	0.13	32.00
SOB	Seed onions big	€/100 kg	249	11.56	8.49	0.25	35.00
FEPP	European Processing potatoes futures	€/100 kg	305	15.68	6.93	3.84	32.92
MWF	Milling wheat futures	€/100 kg	305	19.22	4.52	8.94	27.62
FWF	Feed wheat futures	€/100 kg	305	15.14	3.85	11.84	22.47

This is weekly price data from of the period week 18, 2008 until week 8, 2014

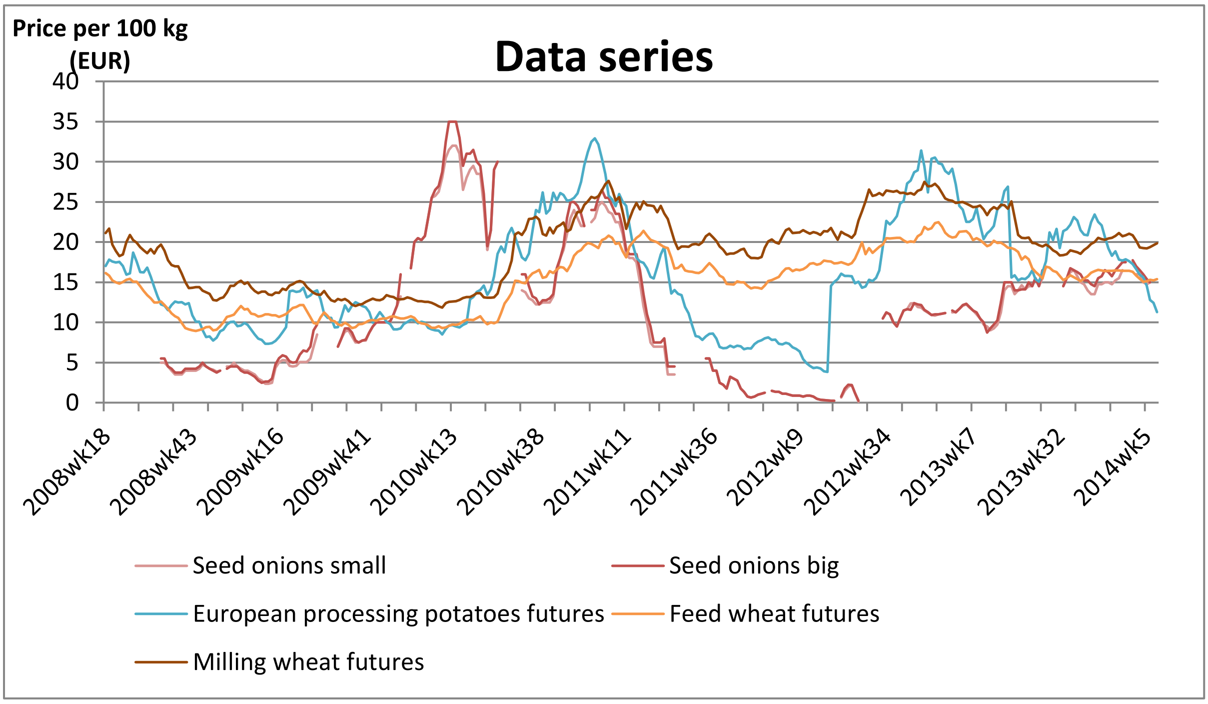

Figure 3: Price movements different data series

A visual inspection of the price series in figure 3 shows that onion prices seem to have some relation with the other commodities. In table 4 some simple correlation coefficients on price levels are calculated

Table 2: Correlation coefficients

Data series	Spearman correlation coefficients		Pearson correlation coefficients	
	SOS	**SOB**	**SOS**	**SOB**
FEPP	0.5635 *	0.5705*	0.4320 *	0.4234 *
MWF	0.0431	0.0533	-0.0026	-0.0067
FWF	0.0529	0.0600	0.0021	-0.0035

The stars indicate significance of the correlation coefficient (p<0.05)

A significant correlation on price levels can be found between the FEPP and both SOS and SOB. There is almost no correlation between wheat futures and onions.

Data resources and background

The price data of seed onions is obtained from "Productschap Akkerbouw", which is a Dutch public law governed institution involved in the marketing of arable crops. The quotations are weekly averages of the quotations of exchanges in Emmeloord, Goes and Middenmeer. Those exchanges distinguish two different quotations for big and small onions. The establishment of these price quotations on the exchanges is further described in paragraph 4.2.2.

European processing potatoes futures (FEPP) are traded at the Eurex Exchange. This contract has the size of 25 ton and the price is in EUR per 100 kg. The futures have a cash-settlement at maturity (Eurex Frankfurt AG, 2009a). The potato prices in Germany, France, Belgium and the Netherlands (all 25%) compose the final settlement price (Eurex Frankfurt AG, 2009b). The underlying product concerns processing potatoes of the varieties Bintje, Agria or comparable varieties regarding price and process purposes. The minimum tuber size is 40 mm and at least 60 percent has to be greater than 50mm (Darion Capital Management, 2011). The Dutch Potato Organisation (NAO) maintained a database of end-of-day prices of the nearby future contract and gave the opportunity to use this data set. For this research, the daily data is converted into weekly averages.

A data archive of agricultural futures prices can be found on the website of the Home Grown Cereals Authority (HGCA), which is a division of the Agriculture and Horticulture Development Board (AHDB). This data archive contains historical futures prices of LIFFE Feed Wheat and MATIF Milling Wheat, among others. Nowadays the MATIF is also part of the NYSE LIFFE, but there are still two different kind of futures contracts called "Milling wheat futures contract" and "Feed wheat futures contract" the milling wheat future contract is based on 50 ton European milling wheat with specified quality standards. The price is based on delivery in Rouen in euro and euro cents per ton. The feed wheat futures contract is based on 100 ton of feed wheat, with specified quality standards. The price is based on delivery in the mainland of Great Britain in pounds sterling and pence per ton. End-of-day data of the nearby contract for both milling and feed wheat futures are converted into weekly average prices. To enable the comparison with onions and potatoes, the prices are converted to the same order of magnitude which is EUR per 100 kg.

Data gaps

The seed onions data contain gaps, because of the lack of transactions during the period of week 26 or 27 until week 32 or 33, because of the transition to the new harvest season. The Dutch agricultural exchanges only records prices when there is a minimum amount of transactions. During this period there are almost no onions deliverable anymore from storages in the Netherlands, because of restrictions in storability of seed onions. The weeks with those gaps are deleted from the sample. There are mathematical methods to fill data gaps, but those methods are not appropriate here. Generate data is not valid, since these weeks simply do not have prices of Dutch onions.

3.1.2.2 Preliminary tests of the data

Before determining optimal hedge ratios and hedging effectiveness of different futures contracts, the date should be checked on unit root and co-integration (Bhaduri and Durai, 2008). When the series contain unit root and are co-integrated, the OLS method is not valid (Chen, Lee and Shrestha, 2003). The lag length of both unit root test and co-integration test is chosen according to Akaike information criteria.

Unit root should be tested with the Augmented Dickey-Fuller (ADF) test at the log prices and the return of the log prices (first differences). The null hypothesis of an ADF tests represents non-stationary data or data with unit root, where the alternative hypothesis is representing a stationary time series. The ADF test comes up with a test statistic, which is a negative number. "The more negative it is, the stronger the rejection of the hypothesis that there is a unit root at some level of confidence" (Greene, 1997).

A co-integration test, tests whether individual variables tie together in some long-run equilibrium relation where they represent a linear combination (Lutkepohl, 2004). A fundamental test for co-integration, which has all desirable statistical properties, is the Johansen's test (Sjö, 2008). This test will be conducted to test co-integration between onion prices and other futures prices.

3.1.2.3 Optimal hedge ratio and hedging effectiveness

In this study four different methods are used in order to estimate the optimal hedge: The regression method, the bivariate vector autoregressive (VAR) method, the error correction method and the multivariate VAR-GARCH method. The equations of these models, represented in this paragraph are derived from Bhaduri and Durai (2008). The lag length selection in these models is based on Akaike information criteria. Subsequently the hedging effectiveness of all different optimal hedge ratios is calculated.

The regression method

The regression method approaches the optimal hedge ratio in a conventional way, by using ordinary least squares (OLS) estimations. This method is only valid when all the OLS assumptions are met. Equation (3) shows the linear regression model:

$$r_{st} = \alpha + \beta\, r_{ft} + \varepsilon_t \tag{3}$$

where r_{st} and r_{ft} represents the logarithm returns of spot and futures for period *t.* The estimate of the minimum variance hedge ratio is β.

The bivariate VAR method

Equation (4) and (5) represent the models of the bivariate VAR method.

$$r_{st} = \alpha_s + \sum_{i=1}^{m} \beta_{si}\, r_{st-i} + \sum_{j=1}^{n} \gamma_{si}\ \ r_{ft-i} + \varepsilon_{st} \tag{4}$$

$$r_{ft} = \alpha_f + \sum_{i=1}^{m} \beta_{fi}\, r_{st-i} + \sum_{j=1}^{n} \gamma_{fi}\ \ r_{ft-i} + \varepsilon_{ft} \tag{5}$$

In the bivariate VAR method, the residuals series determine the optimal hedge ratio. The minimum variance hedge ratio is h^*= cov (ε_{st}, ε_{sft})/ var (ε_{ft}).

The error correction method

The error correction method is to a large extend similar to the VAR model. In this model an error correction term is added to the model, which results in the following equations:

$$r_{st} = \alpha_s + \sum_{i=1}^{m} \beta_{si}\, r_{st-i} + \sum_{j=1}^{n} \gamma_{si}\ \ r_{ft-i} + \lambda_s\, Z_{t-1} + \varepsilon_{st} \tag{6}$$

$$r_{ft} = \alpha_f + \sum_{i=1}^{m} \beta_{fi}\, r_{st-i} + \sum_{j=1}^{n} \gamma_{fi}\ \ r_{ft-i} + \lambda_f\, Z_{t-1} + \varepsilon_{ft} \tag{7}$$

Where Z_{t-1} is the error correction term with λ_s and λ_f as adjusted parameters. The procedure of calculating the minimum variance hedge ratio remains the same as for the VAR method.

The VAR(m)-MGARCH(1,1) method

There are many studies which prefer a dynamic hedge ratio estimation, because a dynamic hedge ratio should outperform the static hedge ratio (Castelino, 1990; Baillie and Myers, 1991; Kroner and Sultan, 1993; Lien, Tse and Tsui, 2002). In the case of a dynamic hedge ratio the ratio is allowed to vary over time, based on the conditional information of the covariance (ε_{st}, ε_{sft}) and variances (ε_{ft}). Equation (8) shows the estimation of the time-varying optimal hedge ratio (OHR):

$$OHR_{tv|\Omega_{t-1}} = \rho \frac{\sigma_{s|\Omega_{t-1}}}{\sigma_{f|\Omega_{t-1}}} = \frac{\sigma_{sf|\Omega_{t-1}}}{\sigma^2_{f|\Omega_{t-1}}} \qquad (8)$$

In this equation $OHR_{tv|\Omega_{t-1}}$ is the time varying hedge ratio based on the conditional information Ω_{t-1}, known at time t-1. The correlation coefficient between returns on spot position and returns on futures positions is represented by ρ and could be time-varying as well.

Equation (9) is representing the VAR-MGARCH model.

$$\begin{bmatrix} \sigma^2_{st} \\ \sigma_{sft} \\ \sigma^2_{ft} \end{bmatrix} = \begin{bmatrix} C_{ss} \\ C_{sf} \\ C_{ff} \end{bmatrix} + \begin{bmatrix} \alpha_{11} & \alpha_{12} & \alpha_{13} \\ \alpha_{21} & \alpha_{22} & \alpha_{23} \\ \alpha_{31} & \alpha_{32} & \alpha_{33} \end{bmatrix} \begin{bmatrix} \varepsilon^2_{s,t-1} \\ \varepsilon_{s,t-1}\varepsilon_{f,t-1} \\ \varepsilon^2_{f,t-1} \end{bmatrix} + \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} \\ \beta_{21} & \beta_{22} & \beta_{23} \\ \beta_{31} & \beta_{32} & \beta_{33} \end{bmatrix} \begin{bmatrix} \sigma^2_{s,t-1} \\ \sigma_{st}\,\sigma_{ft} \\ \sigma^2_{f,t-1} \end{bmatrix} \qquad (9)$$

Where σ^2_{st} and σ^2_{ft} are the conditional variance of the errors ε_{st} and ε_{ft} from the bivariate VAR model. The term σ_{sft} is the conditional covariance between the spot and futures positions. The C terms are the intercepts.

Equation (9) can be simplified as followed:

$$\begin{bmatrix} \sigma^2_{st} \\ \sigma_{sft} \\ \sigma^2_{ft} \end{bmatrix} = \begin{bmatrix} C_1 \\ 0 \\ C_3 \end{bmatrix} + \begin{bmatrix} a_{11} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & a_{33} \end{bmatrix} \begin{bmatrix} \varepsilon^2_{s,t-1} \\ \varepsilon_{s,t-1}\varepsilon_{f,t-1} \\ \varepsilon^2_{f,t-1} \end{bmatrix} + \begin{bmatrix} b_{11} & 0 & 0 \\ 0 & b_{22} & 0 \\ 0 & 0 & b_{33} \end{bmatrix} \begin{bmatrix} \sigma^2_{s,t-1} \\ \sigma_{st}\,\sigma_{ft} \\ \sigma^2_{f,t-1} \end{bmatrix} \qquad (10)$$

Where the conditional correlation b_{22} is constant over time.

Hedging effectiveness

Equation (11) represents the formula for the hedging effectiveness (Pennings and Meulenberg, 1997a,b).

$$HE = 1 - \frac{Var(H^*)}{Var\,(U)} \qquad (11)$$

where

$$Var(H^*) = \sigma^2_s + OHR^2\sigma^2_f - 2\,OHR\,\sigma_{sf} \qquad (12)$$

$$Var(U) = \sigma^2_s \qquad (13)$$

The optimal hedge ratio is represented as OHR in equation (12).

3.2 Marketing approach

In the marketing-finance approach, the marketing approach focuses on needs of potential customers. Besides hedging, there are multiple alternative risk management products or services which could meet the needs of an entrepreneur. The need for price risk reduction is dependent on the opinion of the entrepreneur.

The marketing approach focuses on the opinion of the entrepreneur about price fluctuations and their willingness to reduce these price fluctuations. Other existing price risk management tools in the onion chain will be studied. Furthermore the marketing approach examines whether an onion futures contract could contribute to the current price risk management of entrepreneurs.

Interviews with stakeholders of the onion chain, discover the current process of price risk management. Those qualitative face to face interviews should give insight in the current way of working regarding price risk.

The following topics will be discussed during the interviews:

- Perceptions of price fluctuations;
- Ability of price forecasting and determinants of the forecasts;
- Current price risk management tools;
- Willingness to reduce price fluctuations and role of futures contract.

The interviews are not a fixed paper and pencil survey, but rather more a conversation with certain topics for discussion. In annex 1 an overall questionnaire of the interviews can be found, which is adjusted specifically for every participant.

In order to get a representative view of the onion chain an accurate selection of participants should be made. Firstly onion chain specialist ir.ing.G.A. Gunter, the chairman of the onion trade committee of the Netherlands, who is well informed about the onion chain was interviewed. Together with him an accurate selection of participants of the interviews is made. Due to the limited timeframe of this study, a qualitative approach of the interviews is followed rather than a quantitative approach with many participants. Nonetheless, all links in the onion chain are interviewed. Table 3 shows the selected participants of the interviews.

Table 3: List of interviewed persons

Name	Function	Company	Description of the company	Website
Gijsbrecht Gunter	Chair holder	Committee onion trade	The trade association within the trade platform Frugi Venta.	www.frugiventa.nl
Jacob Wiskerke	Managing director	Wiskerke Onions B.V.	World's largest packager and exporter of onions.	www.wiskerke-onions.nl
Jan van der Lans	Managing director	Van der Lans International B.V.	Importer and exporter of onions.	www.vanderlans.com
Leon Mol	Agronomist	Ahold European Sourcing	Purchase department of retail organisation.	www.ahold.com
Gerard Hoekman	Director	Mulder Onions	A large exporter of onions.	www.mulder-onions.com
Marcel Goud	Manager	Goud Biervliet	Trader and commissioner of onions.	www.goudbiervliet.nl
Lindert Moerdijk	Sales director	MSP Uienhandel BV	Packager and exporter of onions.	www.msp-onions.nl
Several onion producers				

4. The onion and its cash market

The literature study on the viability of new futures contracts in chapter 2 has revealed the importance of the characteristics of the underlying product and its cash market. Aspects allocated to the characteristics of the underlying product such as standardization possibilities and product storability are mentioned in the technical approach as important determinants of successfulness of a new futures contract. Other determinants which have to do with the cash market itself are market size, market activeness, market structure and cash price volatility and will be described in this chapter.

4.1 The onion

The onion (*Allium cepa L.*) is a bulb crop and probably native to South Western Asia. Nowadays onions are cultivated all over the world, mainly in temperate zones (Attokaran, 2011). The onion is used for a wide range of food products and is both a vegetable and a spice (Opara, 2003). Many different variations in size, shape, colour and flavour are known in different parts of the world. In the Netherlands, the most important types of onions are seed onions, onion sets, silver skin onions, seed shallots and bunching onions. The seed onions and the onions sets, also known as dry onions represent the greatest proportion of the cultivated quantity. Yellow onion represents the majority of the total onion production in the Netherlands (Baas and Pals, 2006). A very small part of the onions in the Netherlands is grown organically (Bakker, 2011).

In the Netherlands onions are mainly grown at arable farms. The common trend of increasing scale in arable farming is also seen in the cultivation of onions. During the last years, the number of companies which cultivated onions decreased, while the production in the Netherlands increased (LEI and CBS, 2012).

Due to the Dutch weather, soil quality, the high technical level of the cultivation and the well-developed varieties, high yields are achieved at Dutch arable farms. Depending on the cultivar, onions mature within 100-140 days from sowing (Opara, 2003). In the Netherlands, onions are normally sown in April or planted in March and can be harvested from the middle of August. However the earliest onions, the onion sets, could already be harvested from the middle of June. To ensure the almost year round delivery of Dutch onions, onions are stored in bulk or box storages accommodated with air ventilation and/or refrigerated climate control. With those advanced storage methods is proven that the required quality by customers can be maintained in storage until June (Applied resarch plant & environment, 2003) This means that depending on the weather, there may only be a few weeks without Dutch onions deliverable.

The homogeneity of a batch of onions depends upon many factors occurring during the cultivation and post-harvest process. During the cultivation, the management of the farmer and the climate conditions are decisive aspects. However the quality of a batch of onions could be very diverse, after sorting and packaging a batch of onions is quite uniform. Companies involved in the onion chain hold on quality standards of the International Standards for Fruit and Vegetables – Onions (OECD, 2012). Aspects as consistency, shape, colour and defects decide whether a batch is class I or class II. Particular diameter size could be graded by the sorting company from 10 mm up to 70 mm, depending on the requirements of the customer. A commonly used size standard for Dutch farmers makes distinction between respectively small(<60 mm) and big (>60 mm) onions (Productschap akkerbouw, 2014).

4.2 The onion market from a Dutch perspective

For years the Netherlands maintained the position of world leader in exporting dry onions. In Western-Europe the Netherlands is still the biggest country in terms of trade and production. The average quantity of production and trade of the years 2009, 2010 and 2011 of the Netherlands and neighboring countries are represented in figure 4 (FAOSTAT, 2013). The average value of production and trade of these countries are represented in figure 5 (FAOSTAT, 2013).

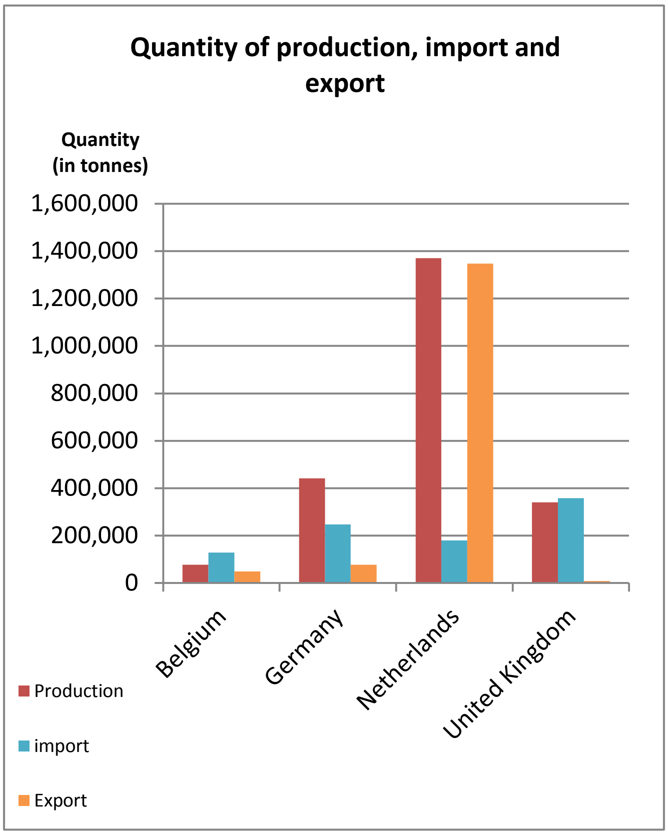

Figure 4: Average quantity of production, import and export of 2009-2011 (FAOSTAT, 2013)

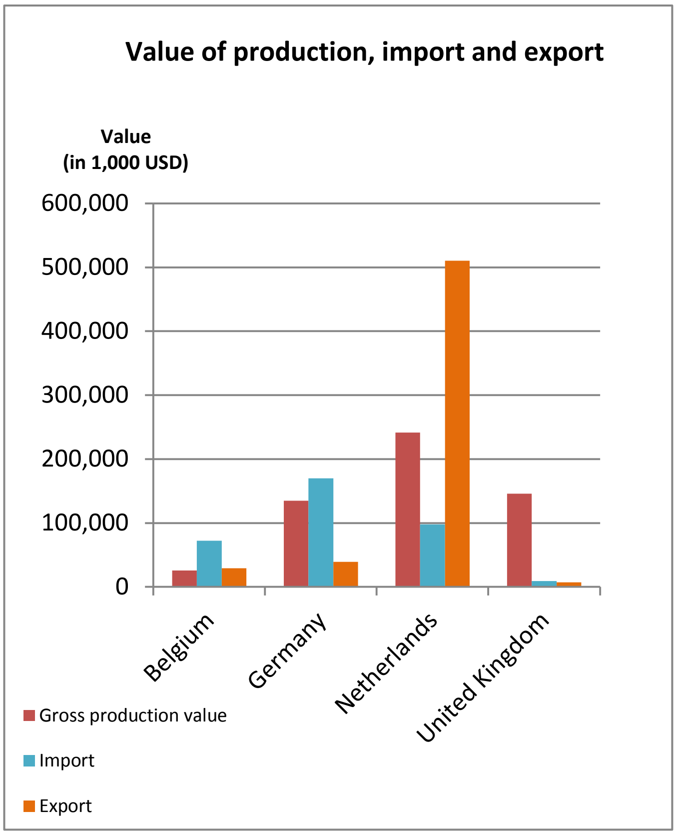

Figure 5: Average value of production, import and export of 2009-2011 (FAOSTAT, 2013)

As shown in figure 4 and 5, the neighboring countries are small players compared to the Netherlands. Several determinants are identified which make a small country like the Netherlands globally important in exporting onions by ir.ing. G.A. Gunter (onion chain specialist). The Netherlands has a well-known reputation as an enterprising, reliable and quality certificated onion trading country. The geographical position of cultivation and harbours facilitate the export possibilities. The big sorting capacity of 30,000 tonnes a week is flexible to respond on the demand in foreign markets. Due to the high realized yields, up to more than 60 tonnes per hectare, the Netherlands has a low cost price per kg. The existence of many different links in the Dutch onion chain, makes that the risk is spread more equally over the chain in comparison with many other countries where chains are more vertical integrated.

4.2.1 The chain

The market structure of dry onions in the Netherlands could be summarized as shown in the flow diagram in figure 6. The numbers are obtained from FAOSTAT, "Productschap Tuinbouw" and Frugi Venta. The amount of tonnes represented in figure 6 is an average of the years 2009, 2010 and 2011.

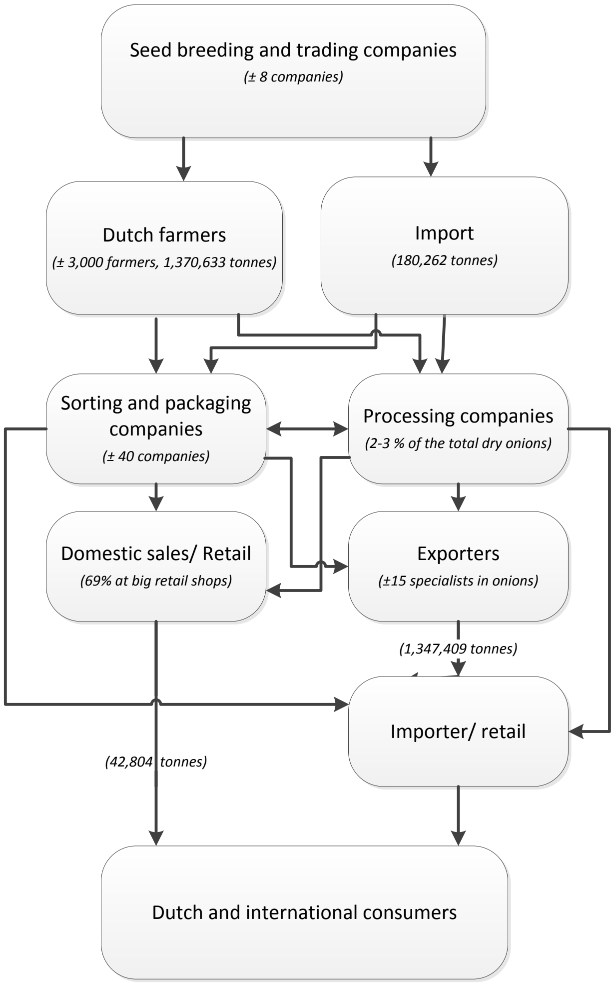

Figure 6: Dutch onion chain

The seed breeding and trading companies are at the basis of the chain. Those companies are responsible for the development and production of seed. There are about eight dominant onion-seed production companies and they deliver the onion-seed to the farmers. Those companies develop new onion varieties, taking into account the property of use. Important breeding aspects are disease resistance, yield, harvest maturity, storability, shape and taste (Baas and Pals, 2006).

About 88 percent of the traded dry onions (1,370,633 ton) in the Netherlands are also cultivated in the Netherlands while the remaining 12 percent is imported (FAOSTAT, 2013). Most of the import is to fulfill the demand for new onions, in the end of the Dutch onion season and before the new Dutch harvest. These imported onions mainly come from countries on the Southern Hemisphere, for example New-Zealand, Chili or Australia (Salm van der, 2011).

In the Netherlands there are around 3,000 individual farmers cultivating dry onions on 27,700 hectares (LEI and CBS, 2012). About 2.9 percent of the total agriculture area in the Netherlands is used for the cultivation of onions, where especially Zeeland and Flevoland are important cultivation areas (LEI and CBS, 2012). There are many different forms in which farmers could deliver their onions to a trader. It is estimated that only a small part of the onion farmers use a fixed cash-forward contract or a pool contract. The majority do not have sale commitments before sowing or planting their onions (Baas and Pals, 2006).

Farmers deliver their onions with or without the service of a commissioner or electronic auction to sorting and packaging companies or processing companies. A new initiative of a tool where farmers anonymous could sell their onions directly to a trader is uienhandel.com. This is an online transparent trading platform, where farmers could offer their onions daily. An independent inspection authority tests the lot of onions and presents the quality specifications of a certain offered batch. If both buyer and seller agree on a certain price, a contract is drawn up. The further transaction process is under the control of a committee of trust of uienhandel.com.

In total there are about 40 sorting, packaging and processing companies (Frugi Venta, 2012). In contrast with many other agricultural crops, farmers have various selling possibilities, which make them less dependent on certain marketing on channels. A small part of the onions are grown by those sorting, packaging and processing companies themselves. Approximately 5 percent of Dutch onions come from own cultivation of those companies. About 90 percent of the traded onions are sorted, topped, packaged and subsequently exported. Processing the onions is another way of commercialize the onions. There are different forms of onion processing. Peeled onions, sliced onions, pickled onions, frozen onions, dehydrated onion slices, dried fried onion slices, fried onion rings, onion powder, onion oil and onion concentrate are examples of forms in which a field crop as onions could be processed. Processed onions represent a relatively small part, since ± 2-3 percent of the Dutch traded onions are processed (Bunte, Bolhuis, de Bont, Jukema and Kuiper, 2009).

The sorting, packaging and processing companies deliver to exporters or they export themselves. A small part of the onions are delivered to domestic wholesalers or retailers. In the Netherlands there are around 250 exporters active in onions, but 15 of them, specialized in onions, are responsible for 70% of the total export (Frugi Venta, 2012). Around 30 percent of the export stays in the European Union. Africa and in particular West Africa is an important sale area.

The Dutch onion chain performs the role of shortage filling country. Other countries import Dutch onions in situations of shortages, i.e. if there are no domestic onions available. Therefore the demand is dependent on the market situations per period, which could be very time-varying. Delivery contracts do not appear for export and price agreements in advance do not exists in the Dutch export market of onions. This is the reason why there is only a limited use of cash forward contracts or other ways of price agreements more backward in the chain. Since export is not based on fixed contract volumes and prices, cash forward contracts with farmers is risky for traders. Some traders and packagers use cash forward contracts with farmers to guarantee their supply. Onion chain specialist ir.ing.G.A. Gunter indicated the different purchase transactions used over the last year, which can be found in annex 2.

4.2.2 Exchanges

Weekly a market price of onions is quoted at agricultural exchanges in Goes, Emmeloord and Middenmeer. The trading commission of these exchanges is proportional represented by farmers, traders and processing companies. Based on transactions of the last days, known by the trading commission, an upper and lower price is. Unrepresentative transactions, for instance transactions with a very small volume or with an disproportional high or low price will be disregarded in the price quotation. The trading commission have to come to a joint agreement in order to determine an official price quotation.

The trading commission quotes both a bale and farmers' price. Because of the natural range of sizes and shapes and the different types of onions as red, cultivation method, onion sets and seed onions, quality classifications there are different price quotations.

The farmers' prices are quoted as non-sorted product "dry from storage" or "ex field", depending on the period. The price is based on the percentage of a specific size in a lot. A batch will be classified in either 30% or 60% of the onions with a size greater than 60 mm.

The bale prices are classified for different diameters, <50 mm, 45/65 and 50/70, > 60 mm, > 80 mm. These prices are the prices for onions, picked at the sorting or packaging company per 100 kg excluded VAT and packaging costs

4.3 Cash market size

The size of the cash market is an important determinant for the success or failure of a new futures contract. Brorsen and Forfana (2001) used the annual production of a commodity as measurement for cash market size.

In table 4 presents the 2009-2001 average of production quantity and gross production value of onions, wheat and potatoes on a worldwide, European and Dutch scale. The production of onions is relatively small in comparison to the production of wheat and potatoes.

Table 4: Average production quantity and gross production value of 2009-2011 (FAOSTAT, 2013)

Scale	**Commodity**	**Production quantity** *(in tonnes)*	**Gross production value** *(in current million USD)*
World	Onions	79,171,560	27,985
	Wheat	678,822,421	159,984
	Potatoes	347,468,803	92,381
Europe	Onions	9,312,246	3,164
	Wheat	218,029,433	42,336
	Potatoes	120,257,066	30,278
Netherlands	Onions	1,370,633	241
	Wheat	1,315,623	274
	Potatoes	7,119,327	1,135

Different measures are used to examine the success of a futures contract. For example an annual trading volume bigger than 1,000 contracts (Sandor, 1973), an annual trading volume of more than 10,000 contracts in the third year after introducing the contract (Silber, 1981), a daily open interest of 5,000 contracts and a daily trading volume of 1,000 contracts (Black, 1986; Carlton, 1984). An example of an agricultural futures contract is the futures on European Processing Potatoes. The annual trading volume of this contract increased the last years. In 2013 a new annual record was set for this contract with 53,947 contracts (Eurex Frankfurt AG, 2014). The annual trading volumes of feed and milling wheat futures on the NYSE Euronext are much higher, with respectively 135,037 and 7,472,845 contracts, where trading volumes in ton per contract are even bigger than potatoes. On the NYSE Euronext a feed wheat contract is 100 ton and a milling wheat contract is 50 ton.

The volume of traded futures contract can be calculated with equation (1) described in paragraph 3.1.1. The average production quantity in ton of the years 2009-2011 is used as cash market size in order to determine the potential contract trade. There is no existing contract specification for onions, so the contract size is uncertain. The potential traded future contracts are calculated for different values of hedging ratios and contract sizes. A hedge ratio of 1 indicates that the total amount of produced onions is hedged by futures and a hedge ratio of 0 assumes that there is no hedging. The contract size will vary from 10 to 50 ton. The velocity of trading is fixed at 1, because this research restricts itself to the hedging service of the futures market. In reality, this velocity could be higher, due to the existence of speculators in this market and the possibility that a lot of onions could be traded multiple times a year.

In table 5 shows the potential trading volume for different contract sizes and hedge ratios calculated with equation (1). Although this research focuses on the Dutch onion market, it is unlikely that a new onion futures will only attracts Dutch participants, depending on the price dimension of the contract. Table 6 shows the results of the calculation of the potential trading volume, which is applicable on the Dutch and the neighboring countries' onion markets (Belgium, Germany and UK).

Table 5: Potential volume of contract trade in the Netherlands

		Hedge ratio				
		0.2	**0.4**	**0.6**	**0.8**	**1.0**
Contract size	**10**	27,413	54,825	82,238	109,651	123,357
	20	13,706	27,413	41,119	54,825	61,679
	30	9,138	18,275	27,413	36,550	41,119
	40	6,853	13,706	20,560	27,413	30,839
	50	5,483	10,965	16,448	21,930	24,671

Numbers are calculated with equation (1)

Table 6: Potential volume of contract trade in the Netherlands and neighbouring countries

		Hedge ratio				
		0.2	**0.4**	**0.6**	**0.8**	**1.0**
Contract size	**10**	44,607	89,214	133,821	178,428	223,035
	20	22,303	44,607	66,910	89,214	111,517
	30	14,869	29,738	44,607	59,476	74,345
	40	11,152	22,303	33,455	44,607	55,759
	50	8,921	17,843	26,764	35,686	44,607

Numbers are calculated with equation (1)

Pennings and Meulenberg (1998) used equation(1) to determine the constraints and possibilities of a milk quota futures market. They represented the potential trading volumes as function of contract size and hedge ratio in a graph. Figure 7 and 8 represent the potential trading of onion futures contracts in a similar way. These figures show that an increase of the hedging ratio will increase the volume of trading, whereas an increase in contract size will decrease the volume of trading.

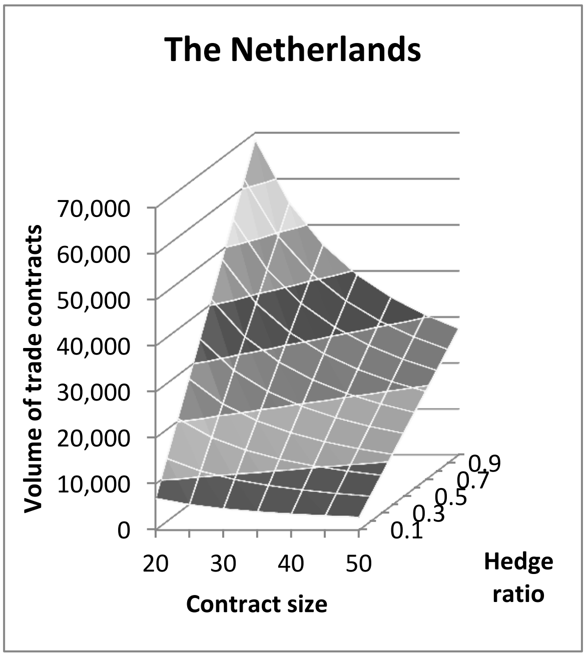

Figure 7: Potential trading volume of contracts of the Netherlands

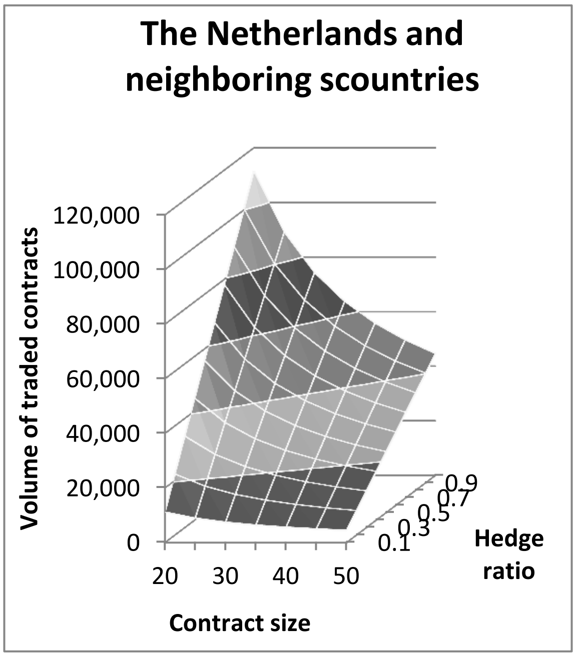

Figure 8: Potential trading volume of contracts of the Netherlands and neighbouring countries

The hedge ratio is difficult to predict, because it is uncertain how many participants an onion futures contract will attract. It is unlikely that the majority of the stakeholders will actively trade onion futures contracts, especially during the first years after introduction. Given the relatively low participation on the futures market of comparable product (e.g. potatoes) in the Netherlands a high hedge ratio is unlikely.

Taking for instance a contract size of 25 ton and a hedge ratio of 0.2, results in a potential trading volume of 20,314 contracts in the Netherlands and 14,869 contracts in the Netherlands together with neighbouring countries. Table 7 gives a representation of the example of the Netherlands together with the neighbouring countries in comparing with existing agricultural futures contracts of the EUREX.

	Traded contracts	**Notational value equivalent in (metric) ton**	**Notational value equivalent in EUR**	**Contract size**	**Closing price in EUR of 30-05-2014**
European processing potato futures	50,400	1,260,000	€ 14,490,000	25 ton	11.50
Butter futures	700	3,500	€ 12,362,000	5 metric ton	3532
Skimmed milk powder futures	200	1,000	€ 2,890,000	5 metric ton	2890
Onions	*20,314*	*507,850*	*€ 385,966*	*25 ton*	*19*

Table 7: Comparison of trading numbers of existing futures with onions

The numbers of traded contracts in 2012, contract size and the closing price of 30-05-2014 of the existing futures are obtained by EUREX. With the help of equation (1), the numbers of the onions in table 7 are calculated. The notational value equivalent both in ton and EUR is based on the assumption of a contract size of 25 tonnes and the average exchange quotation of the last week of June 2014.

With the assumptions of above, the number of traded contracts per year of onions is less than European processing potato futures, but is higher than the dairy futures. The dairy futures have a contract size of just 5 metric ton, but their financial value per unit is much more than the financial value of onions. This makes that the notational value equivalent in EUR of the dairy futures is much higher than onions.

The assumed hedge ratio in the example above is dependent on the stakeholders in the onion chain. A higher numbers could be obtained if more stakeholders in the onion will use futures. However, a notational value equivalent in EUR which is equal to the existing agricultural futures, will never be obtained because the cash market is not large enough.

In conclusion, the number of traded contracts and the notational value equivalent in ton of onions in line with other agricultural futures, but the notational value equivalent in EUR is very small compared with the other agricultural futures.

4.4 Cash price volatility

The coefficient of variation is calculated using weekly price data of various crops. Seed onions (small and big), European processing potatoes futures, wheat futures (milling and feed) and Dutch processing potatoes were subject to the volatility calculations. A more extensive description of this data can be found in paragraph 3.1.2.1.

Table 7 represents the results of the volatility calculations of the different data series. It consists weekly data from harvest year 2008 until harvest year 2013.

Table 8: Results volatility calculations various crops

Crop	Standard deviation (σ)	Average (μ)	Coefficient of variation (CV)
Seed onions small	7.93	11.25	0.70
Seed onions big	8.49	11.56	0.73
European processing potatoes	6.93	15.68	0.44
Milling wheat	45.17	192.25	0.23
Feed wheat	38.52	151.45	0.25
Dutch processing potatoes	8.28	13.84	0.60

Data: week 18, 2008 - week 8, 2014

Table 8 shows the highest CV for seed onions small and big. The futures on European processing potatoes, milling and feed wheat all have a lower CV, thus less volatility. The need for hedging given by the volatility seems to be the highest for seed onions. The Dutch processing potatoes quotation represent a CV of 0.60, which is higher than the CV of European processing potatoes futures (FEPP). The Dutch processing potatoes quotation counts 25% in the quotation of the European processing potatoes future. The international dimension of the price basis of FEPP results in smaller price fluctuations, because it is an average of the national price quotations. Considering this aspect, there is the possibility that the coefficient of variation of an onion futures contract will be lower as well, in the case of an international price basis.

In conclusion, the volatility of seed onions in the Netherlands compared to other futures traded crops high. The incentive to insure against price risk, on account of the volatility should be there.

5. Cross-hedge possibilities

Technical feasibility partially depends on the cross hedge possibilities. When there already exist futures which could eliminate price risk of onions, a new futures contract for onions is redundant and unnecessary. In this chapter the possibilities of cross-hedging seed onions with European processing potatoes futures, milling wheat futures or feed wheat futures will be investigated.

5.1 Preliminary tests on price data

Before starting the calculation of optimal hedge ratios and hedging effectiveness, some preliminary tests were conducted to explain the behavior of the data series. The data series of seed onions small (SOS), seed onions big (SOB), European processing potatoes futures (FEPP), milling wheat futures (MWF) and feed wheat futures (FWF) are tested on unit root with the ADF test. First the logged levels were tested and second the return of the logged levels were tested (first differences). Results of the ADF test are shown in table 9.

Table 9: Results ADF test

	Logged levels			Return of logged levels		
	t-statistic	**Prob.**	**Number of lags**	**t-statistic**	**Prob.**	**Number of lags**
SOS	-1.663	0.4489	3	-10.149*	0.0000	3
SOB	-1.787	0.3866	6	-6.132*	0.0000	5
FEPP	-1.947	0.3104	0	-14.445*	0.0000	0
MWF	-2.279	0.4432	1	-12.149*	0.0000	0
FWF	-1.362	0.6007	1	-12.446*	0.0000	0

Data: week 18, 2008 - week 8, 2014

All the price series contain unit roots on logged levels, but are stationary on differenced logged levels.

The next step is to test whether a long-run equilibrium exists between onions and the existing agricultural futures FEPP, MWF and FWF. The results of this Johansen co-integration test, conducted on logged levels are shown in table 10.

Table 10: Results Johansen co-integration test

Variables		Hypothesis	λ trace	λ max
SOS	FEPP	r=0	10.185	7.695
		r ≤ 1	3.765	2.490
SOS	MWF	r=0	6.472	3.891
		r ≤ 1	2.581	2.581
SOS	FWF	r=0	5.813	3.639
		r ≤ 1	2.173	2.173
SOB	FEPP	r=0	10.147	6.513
		r ≤ 1	3.634	3.634
SOB	MWF	r=0	6.279	3.764
		r ≤ 1	2.515	2.515
SOB	FWF	r=0	5.600	3.469
		r ≤ 1	2.131	2.131

The column λ trace represents the test statistics of the Johansen trace test. The column λ max represents the test statistics of the maximum eigenvalue Johansen co-integration test.

The critical values of the trace test at a significance level of 5% for hypotheses r=0 and r ≤ 1 are respectively 15.495 and 3.841. None of the combinations tested in the trace test have a trace statistic higher than the critical values, meaning that none of the hypothesizes can be rejected.

The maximum eigenvalue Johansen co-integration test, have critical values for hypothesis r=0 and r ≤ 1 of respectively 14.265 and 3.842. So this test gives the same results as the trace, where there is no co-integration among variables at a significance level of 5%. At a significance level of 10% there is co-integration between both prices series of seed onions and FEPP.

The results for the preliminary tests indicate that hedge ratio derived from the error correction method, probably will not lead to a higher hedging effectiveness, since there is no co-integration at a significance level of 5%.

5.2 The regression method

From a simple OLS regression the optimal hedge ratio is calculated. The differenced logged levels of FEPP, MWF and FWF are individually taken as independent variables for the estimation using SOS and SOB as dependent variables.

Table 11 and 12 show the results for the estimation of seed onions small and seed onions big. The constant is represented as α and the slope as β, which equals the optimal hedge ratio. The R^2 is the hedging effectiveness. The standard errors of the coefficients are represented in parenthesis.

Table 11: Results of OLS regression with seed onions small as dependent variable

Independent variable	**α (Constant)**	**β (Optimal hedge ratio)**		**R^2 (Hedging effectiveness)**
FEPP	0.004426	0.345306	*	0.013994
	(0.022941)	(0.185936)		
MWF	0.004520	0.527198		0.003460
	(0.023063)	(0.573921)		
FWF	0.004861	-0.470612		0.002389
	(0.023080)	(0.616864)		

*The stars indicate the level of significance, where * p<0.10 and ** p<0.05, respectively.*
Standard errors of the coefficients are represented in parenthesis

Table 12: Results of OLS regression with seed onions big as dependent variable

Independent variable	**α (Constant)**	**β (Optimal hedge ratio)**		**R^2 (Hedging effectiveness)**
FEPP	0.004038	0.338907	**	0.018344
	(0.019622)	(0.159043)		
MWF	0.004138	0.637010		0.006875
	(0.019737)	(0.492263)		
FWF	0.004348	-0.315587		0.001462
	0.019795	(0.529055)		

*The stars indicate the level of significance, where * p<0.10 and ** p<0.05*
Standard errors of the coefficients are represented in parenthesis

The hedge ratios derived from the OLS method result in a poor hedging effectiveness of the cross-hedges as shown in table 11 and 12.

5.3 The bivariate VAR method

In paragraph 3.1.2.3, equation (4) and (5) represent the bivariate VAR method. Bivariate VAR models are estimated for the variables FEPP, MWF and FWF in combination with the variables SOS and SOB. In these models the onions (SOS and SOB) are the spot prices and FEPP, MWF and FWF are taken as futures prices. Table 13 represents the estimates of the bivariate VAR model, with SOS as spot price and FEPP as futures price.

Table 13: Estimates of bivariate VAR model with SOS as spot and FEPP as future

	$Spot_{sos}$			$Futures_{fepp}$	
Equation (4)	**Coefficient**	**Standard error**	**Equation (5)**	**Coefficient**	**Standard error**
α_s	0.0055	0.0172	α_f	0.0001	0.0083
β_{s1}	-0.1340	0.0540	β_{f1}	-0.0105	0.0260
β_{s2}	-0.1678	0.0537	β_{f2}	-0.0404	0.0258
β_{s3}	-0.1195	0.0542	β_{f3}	-0.0140	0.0260
β_{s4}	-0.0989	0.0544	β_{f4}	-0.0190	0.0262
β_{s5}	0.0199	0.0542	β_{f5}	0.0117	0.0261
β_{s6}	0.0943	0.0537	β_{f6}	0.0197	0.0258
β_{s7}	0.0737	0.0530	β_{f7}	0.0378	0.0255
β_{s8}	-0.0085	0.0512	β_{f8}	-0.0078	0.0247
Y_{s1}	0.0240	0.1407	Y_{f1}	0.0614	0.0677
Y_{s2}	0.3651	0.1403	Y_{f2}	0.0273	0.0675
Y_{s3}	0.4001	0.1416	Y_{f3}	0.0606	0.3068
Y_{s4}	0.3446	0.1435	Y_{f4}	0.0499	0.0690
Y_{s5}	0.0244	0.1445	Y_{f5}	-0.0264	0.0695
Y_{s6}	0.0370	0.1441	Y_{f6}	-0.0231	0.0693
Y_{s7}	-0.9090	0.1481	Y_{f7}	0.0014	0.0692
Y_{s8}	1.6586	0.1510	Y_{f8}	0.0531	0.0727
R^2	**0.5140**		R^2	**0.0409**	

The optimal hedge ratio can be derived from the values of the variances/covariance matrix of the error terms, when dividing the residuals covariance Cov(ε_s ε_f) by the variance of the futures residuals Var(ε_f). Table 14 gives the variance and covariance of the residuals. Furthermore, the calculated optimal hedge ratio (*OHR*), derived from the bivariate VAR model with SOS as spot and FEPP as future is given in table 14.

Table 14: Variances/covariance of the residuals and OHR of the bivariate VAR model with SOS as spot and FEPP as future

	Values
Covariance (ε_s ε_f)	0.00202785
Variance (ε_f)	0.01625026
OHR	0.12478891

The estimates of the bivariate VAR models with the other variables will not be reported, but can be found in annex 3. Table 15 shows to the variances/covariance of the residuals and the calculated OHR of all the bivariate VAR models.

Table 15: Variances/covariance of residuals and calculated OHR of all bivariate VAR combinations

Spot	Future	Variances spot	Variances futures	Covariances	*OHR*
SOS	FEPP	0.070735737	0.016250258	0.00202785	0.12478891
SOS	MWF	0.126196358	0.001533608	0.00044948	0.29308597
SOS	FWF	0.127067139	0.001344111	-0.00060023	-0.44655976
SOB	FEPP	0.054632371	0.016097026	0.00203815	0.12661647
SOB	MWF	0.095239628	0.001534961	0.00074369	0.48450197
SOB	FWF	0.095870369	0.001343154	-0.00046776	-0.34825657

The hedging efficiency of these bivariate VAR model is calculated using equations (11), (12) and (13). Table 16 shows the variance of the unhedged and hedged portfolios. Furthermore, the calculated hedging efficiency for all bivariate VAR models is given in table 16.

Table 16: Variances of portfolios and HE of all bivariate VAR models

Spot	Future	Var_U	Var_H	*HE*
SOS	FEPP	0.129698	0.12862326	0.0082865
SOS	MWF	0.129698	0.129337895	0.0027765
SOS	FWF	0.129698	0.129388417	0.0023870
SOB	FEPP	0.095313	0.094250606	0.0111464
SOB	MWF	0.095313	0.094695004	0.0064839
SOB	FWF	0.095313	0.095174816	0.0014498

The hedge ratios derived from the bivariate VAR method result in a poor hedging effectiveness of the cross-hedges.

5.4 The error correction method

In paragraph 3.1.2.3, equation (6) and (7) represent the equations estimated using an error correction method. The error correction models are estimated for the variables FEPP, MWF and FWF in combination with the variables SOS and SOB. In these models the onions (SOS and SOB) are the spot prices and FEPP, MWF and FWF are taken as futures prices. Table 17 represents the estimates of the bivariate VAR model, with SOS as spot price and FEPP as futures price.

Table 17: Estimates of error correction model, with SOS as spot and and FEPP

	$Spot_{sos}$			$Futures_{fepp}$	
Equation (4)	**Coefficient**	**Standard error**	**Equation (5)**	**Coefficient**	**Standard error**
α_s	0.005198	0.01726	α_f	-0.000361	0.00820
β_{s1}	-0.130659	0.05427	β_{f1}	-0.004971	0.02580
β_{s2}	-0.164962	0.05392	β_{f2}	-0.035691	0.02564
β_{s3}	-0.116485	0.05438	β_{f3}	-0.009118	0.02585
β_{s4}	-0.095576	0.05471	β_{f4}	-0.013604	0.02601
β_{s5}	0.023142	0.05448	β_{f5}	0.017097	0.02590
β_{s6}	0.097744	0.05393	β_{f6}	0.025316	0.02564
β_{s7}	0.077222	0.05333	β_{f7}	0.043647	0.02536
β_{s8}	-0.005078	0.05153	β_{f8}	0.013413	0.02450
Y_{s1}	0.032550	0.14134	Y_{f1}	0.075460	0.06720
Y_{s2}	0.376013	0.14133	Y_{f2}	0.038758	0.06720
Y_{s3}	0.410701	0.14258	Y_{f3}	0.078092	0.06779
Y_{s4}	0.355261	0.14444	Y_{f4}	0.067465	0.06868
Y_{s5}	0.034648	0.14536	Y_{f5}	-0.009477	0.06911
Y_{s6}	0.046734	0.14496	Y_{f6}	-0.006995	0.06892
Y_{s7}	-0.900612	0.14449	Y_{f7}	0.015333	0.06870
Y_{s8}	1.669777	0.15199	Y_{f8}	0.071632	0.07227
λ_s	-0.001386	0.00199	λ_f	-0.002290	0.00095
R^2	**0.515028**		R^2	**0.065924**	

The optimal hedge ratio can be derived from the values of the variances/covariance matrix of the error terms, when dividing the residuals covariance Cov(ε_s ε_f) by the variance of the futures residuals Var(ε_f). Table 14 gives the variance and covariance of the residuals. Furthermore, the calculated optimal hedge ratio (*OHR*), derived from the error correction model with SOS as spot and FEPP as future is given in table 18.

Table 18: Variances/covariance of the residuals and OHR of the error correction model, with SOS as spot and FEPP as future

	Values
Covariance (ε_s ε_f)	0.001858
Variance (ε_f)	0.015876
OHR	0.117032

The estimates of the error correction models with the other variables will not be reported, but can be found in annex 3. Table 19 shows to the variances/covariance of the residuals and the calculated OHR of all the error correction models.

Table 19: Variances/covariance of residuals and calculated OHR of all error correction combinations

Spot	Future	Variances spot	Variances futures	Covariances	*OHR*
SOS	FEPP	0.070228	0.015876	0.001858	0.117032
SOS	MWF	0.124257	0.001540	0.000453	0.294156
SOS	FWF	0.125244	0.001349	-0.000563	-0.417325
SOB	FEPP	0.054916	0.015734	0.002067	0.131387
SOB	MWF	0.093953	0.001541	0.000730	0.473824
SOB	FWF	0.094690	0.001349	-0.000450	-0.333943

The hedging efficiency of these error correction models can be calculated using equations (11), (12) and (13). Table 20 shows variance of the unhedged and hedged portfolio. Furthermore, the calculated hedging efficiency for all error correction models is given in table 20.

Table 20: Variances of portfolios and HE of all error correction models

Spot	Future	Var_U	Var_H	*HE*
SOS	FEPP	0.129697916	0.128676091	0.0078785
SOS	MWF	0.129697916	0.129336800	0.0027843
SOS	FWF	0.129697916	0.129391979	0.0023588
SOB	FEPP	0.095312998	0.094220145	0.0114659
SOB	MWF	0.095312998	0.094700745	0.0064236
SOB	FWF	0.095312998	0.095174106	0.0014572

The hedge ratio obtained by the error correction model does not lead to a higher hedging effectiveness than the bivariate VAR model. This result was not surprising since the co-integration tests did not show the presence of co-integration among variables.

5.5 The VAR(m)-MGARCH(1,1) method

The residuals of both bivariate VAR models and the error correction models could contain ARCH effects, in which case a constant hedge ratio may be inappropriate. Figure 9 shows for example the residuals of the bivariate VAR model with SOS as spot and FEPP as future. The presences of the ARCH effects are clearly recognized in these graphs.

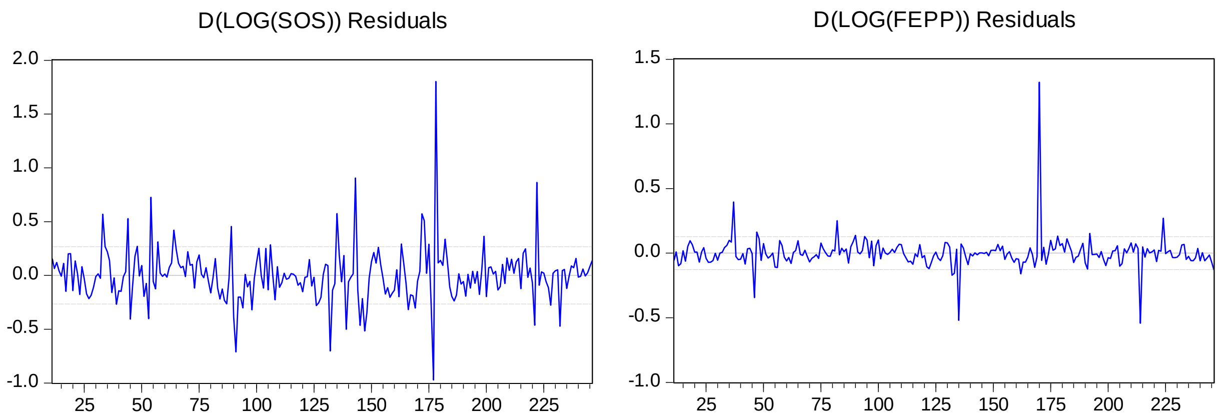

Figure 7: Residuals series from SOS and FEPP equation in bivariate VAR model

A VAR-MGARCH method allows us to obtain a time-varying hedge ratio, which is able to capture the existing volatility in the data. Possibly, it could result in a higher hedging effectiveness.

In paragraph 3.1.2.3, equation (9) and (10) represent the VAR-MGARCH model. The VAR-MGARCH models are estimated for the variables FEPP, MWF and FWF in combination with the variables SOS and SOB. In these models the onions (SOS and SOB) are the spot prices and FEPP, MWF and FWF are taken as futures prices. Table 21 represents the estimates of VAR-MGARCH model, with SOS as spot and FEPP as future. The estimates of the other VAR-MGARCH models could be found in annex 3.

Table 21: Estimates of VAR-MGARCH model, with SOS as spot and FEPP as future

Term in equation (10)	Coefficient	Standard error
C_1	0.00021	0.00002
C_3	0.00031	0.00025
a_{11}	-0.04058	0.00231
a_{33}	0.79626	0.10482
b_{11}	1.03243	0.00216
b_{22}	0.10462	0.07644
b_{33}	0.58833	0.02138

The variances/covariance matrix of the residuals of the VAR-MGARCH model varies over time. Dividing the covariance of the residuals by the variances of the future residuals, gives a dynamic hedge ratio. Figure 10 shows the dynamic hedge ratio over the entire sample period, even as the static hedge ratio derived with the bivariate VAR method, where SOS is the spot and FEPP is the future.

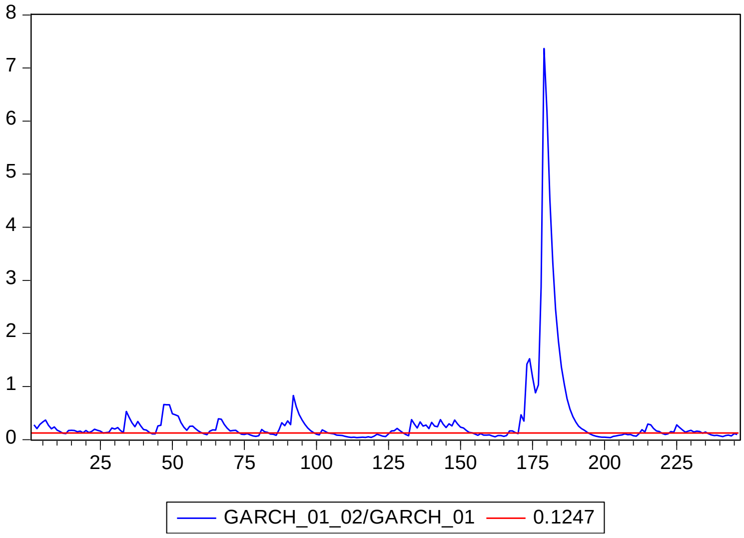

Figure 8: Dynamic and static hedge ratio (0.1247), with SOS as spot and FEPP as future

In order to examine the effectiveness of the dynamic hedge ratio, the variances of both unhedged and hedged portfolio are calculated. The return of the hedged portfolio is obtained subtracting the hedge ratio times the return of futures prices from the return of the spot prices, as shown in equation (14). The return of spot prices simply is the first differences of the spot prices.

$$R_{H,t} = \Delta S_t - (OHR * \Delta F_t) \tag{14}$$

After calculating the variance of the returns on the hedged portfolio, as well as that of the unhedged portfolio, equation 11 could be filled in. Table 22 represents the variances of the unhedged and hedged portfolios, even as the calculated hedging effectiveness as a result from the dynamic hedge ratios.

Table 22: Variances of portfolios and HE of the VAR-MGARCH model

Spot	Future	*Var_U*	*Var_H*	*HE*
SOS	FEPP	0.129697916	0.110396	0.148822098
SOS	MWF	0.129697916	0.129801	-0.000794801
SOS	FWF	0.129697916	0.138400	-0.067095018
SOB	FEPP	0.095312998	0.082959	0.129615039
SOB	MWF	0.095312998	0.093765	0.016241206
SOB	FWF	0.095312998	0.103847	-0.089536602

Using a dynamic hedge ratio clearly improves the hedging effectiveness of the cross-hedge FEPP, while MWF and FWF do not show changes in hedging effectiveness. Despite the higher hedging effectiveness of FEPP with the dynamic hedge ratio, a hedging effectiveness of 0.15 is still low.

5.6 Overview of different methods

Table 23 presents an overview of the hedging effectiveness across the different methods used.

Table 23: Summary of HE of the different methods

Spot	Future	*OLS*	*Bivariate VAR method*	*Error correction method*	VAR-MGARCH method
SOS	FEPP	0.013994	0.0082865	0.0078785	0.148822098
SOS	MWF	0.003460	0.0027765	0.0027843	-0.000794801
SOS	FWF	0.002389	0.0023870	0.0023588	-0.067095018
SOB	FEPP	0.018344	0.0111464	0.0114659	0.129615039
SOB	MWF	0.006875	0.0064839	0.0064236	0.016241206
SOB	FWF	0.001462	0.0014498	0.0014572	-0.089536602

The dynamic hedge ratio derived from the VAR-MGARCH method for the cross-hedge of FEPP, results in the highest hedging effectiveness, with respectively 0.15 and 0.13 for SOS and SOB. The other methods and futures result in very low hedging effectiveness. The HE effectiveness showed in table 23 are results from an in-sample test. Out-of-sample test are not conducted in this research.

The error correction method did not lead to a higher hedging effectiveness than the bivariate VAR method. This was predictable, since there was no co-integration found among the variables. The time-varying hedge ratio derived with the VAR-MGARCH, lead to a higher HE for the futures FEPP, but did not have a positive effect on the HE of the futures MWF and FWF. This could be due to presence of heteroscedasticity, which is lower for the futures MWF and FWF than for the future FEPP. Seemly a time-varying hedge ratio does work for the futures MWF and FWF.

Paragraph 3.1.2 suggested there possibly could be some relation between the futures of wheat and potatoes and the spot prices of onions, since these crops are subject to the same production and weather conditions and are grown mainly on the same arable farms. Although there is some correlation on price levels, this chapter pointed out that the different nature of the prices used, make that futures FEPP, MWF and FWF are no appropriate cross-hedges for SOS and SOB.

6. Marketing approach

During the interviews with stakeholders in the onion chain, multiple topics were discussed. Topics as the perception about price fluctuations, the ability of price forecasting and determinants of the forecasts, current price risk management tools and finally the willingness to reduce price fluctuations and the role of a futures market. For each participant the questionnaire is specifically adjusted. But the basis of the questionnaire can be found in annex 2. The above described topics are the basis of the marketing approach. In this chapter the opinions of the different stakeholders for each topic are explained.

6.1 Perceptions of price fluctuations

There is a broad consensus among the participants that big prices fluctuations are inherently linked to the onion market. However, these fluctuations could be experienced differently depending on the position of the participants in the chain.

From the arable crops grown on Dutch farms, there is no crop that shows a similar volatility as onions. Some questioned farmers conveyed that the high price fluctuations is one the reasons why they produce onions. They like to be concerned with the prices and speculate on the best moment of selling. Over the years the onion is one of the most profitable crops in the arable farmer’s crop portfolio. Although some years showing a loss, price is on average profitable over the years.

Traders and packagers are accustomed to the big price fluctuations and they find that volatility makes the onion market attractive. Traders think that without price fluctuations the margins will squeeze out for both farmers and traders. High volatility is fruitful for a well-functioning market structure in the opinion of the traders.

Given the fact that most Dutch onions are exported, big price fluctuations could work to the detriment of the competitive position of the export of the Netherlands. Low prices are in the advantage of the exporters, because low prices require less working capital and create export possibilities. The export possibilities of the Netherlands are mostly dependent on the price and quality, because they have the role of filling the gaps in other countries. On the other hand exporters share the opinion that stable prices, will have a declining effect on the margins.

6.2 Ability of price forecasting and determinants of the forecasts

In paragraph 6.1 it became apparent that there is a general consensus about the big volatility of the onions prices. The participants of the interviews have their own ideas about the development of prices. They all attempt to approximate the prices in advance and they try to anticipate upon that. Nevertheless, among the interview participants no one said to be confidently predicting prices.

Some farmers do not have priorities to follow the onion market very well. Some other farmers try to be well-informed, by reading professional journals and the internet. They closely monitor the weather, expected yield and stock figures. All of the interviewed farmers found it difficult to determine the right moment of selling and do not feel confident on their price forecasting.

Trading and sorting companies have to make price forecasts for the coming weeks, due to their required working stock. The accuracy of their forecasts is depending on the period of the year.

When the harvest is finished, which is often in October, traders draw their conclusions and make price forecasts for the available onions for the coming year. From that moment some traders found their selves capable to predict prices for a couple of weeks within a range of 2 cents. However, long term forecasts remain difficult. The most uncertain period, regarding price fluctuations is the period from February until the Dutch onion harvest.

An important aspect which could influence the prices is the market climate. Next to the quantitative aspects which could be approximated in some way, there is little to say about the market climate, according to the traders. A trader mentioned: *"Five boats with onions to Africa do not affect the prices, but two boats to Russia is of big impact of the onion price".* Indicating that the market climate could have a tremendous impact.

Another trader stated: "*During the last years, we saw a tremendous increase in sorting and packaging capacity. This resulted in an excess of sorting and packaging capacity in the Netherlands. Because of this excess, traders lost market power towards farmers. This appearance made the price of onions more dependent on the willingness of the farmers to sell their onions as before".*

Exporters and retail are less concerned about long term price forecasts, since this is not of interest for those companies. Most exporters and retailers take only very small positions for the working stock, which make price forecasts less important.

The following determinants were repeatedly mentioned as important for price forecasts: Own observations of the market, realized yield per hectare of the year, stock figures about amount and quality, sales information, the weather and political aspects. Those aspects create the mindset about the forecast of the entrepreneur.

6.3 Current price risk management tools

It is evident from the responses of participants that forecasting prices of onions is very difficult. It seems to be impossible to make accurate long term price forecasts, since the conditions in the market are hard to predict. A proper price risk management is needed for the different stakeholders to ensure their operational business.

The interviewed farmers cultivate several other crops like for instance potatoes, wheat, beets, alfalfa and grass seeds. Dutch farmers have a diversified crop portfolio, which makes a farmer less vulnerable to the price volatility of a particular crop. Some of the participants indicated that they only calculate the average selling prices over the last years, when making decisions about their crop portfolio. The average selling price over the years is profitable, although there are some years with very low prices. The majority of the farmers do not have many possibilities to spread the sales over the year, due to storage facilities and/or their total amount of onions is too small to split up.

Farmers have various other possibilities when they found it hard to choose the right selling moment. Possibilities as collective pools with spread selling moments, cash forwards contracts with fixed price, cash forward contracts with partly fixed price and partly spot price or participation of the trading company in the cultivation.

There is a balance between the grower prices and the bale prices of onions. The margins between those two prices declined in the last years, because of the big sorting and packaging capacity in the Netherlands. During the time gap between the purchase and sale of the onions, prices could change and influence the profit margin of the trader. Risk is involved on the stock positions and especially at high prices there is much capital involved. Depending on the risk attitude of the entrepreneur, positions are taken. There is much risk involved in long term positions, but since the margins are small, not much could be earned when minimizing the stock. As a result of the big scale of the most sorting and packaging companies cannot afford downtime, because of their depreciation on assets and costs of staff. Those companies should be certain on enough working stock, because their installations are most efficient at high utility. The big working stock makes those companies vulnerable for price risks.

With different ways of purchasing as described in annex 2, traders are spreading their price risk. For the trader there is no price risk involved in the pool system, where the farmers together share the price risk and the trader or packager receives a fixed compensation for its service. The various cash forward contracts are risk full, when the market price drops below the fixed price. Therefore it is key for a trader to agree to a low floor price of the cash forward contract. "*There are some years with prices below the floor prices, but when there are more years with prices above the floor price, you make money*" stated a trader. By participation in the cultivation, the trader partly becomes a farmer. The costs of cultivation are not linked to the market price, so the trader shares the price risk with the farmer. Spot trading is still the most used way of purchasing. As long as the bale price is in balance with the grower price, there should be no price risk for the farmers when ignoring the time gap between purchase and sales. However, this time gap exists and the price fluctuations determine the margin of the trader. The interviews with traders made clear that traders were not able to agree cash forward contracts with customers. Therefore cash forward contracts with farmers involve price risk, but meanwhile it guarantees supply.

Exporters and importers without sorting and packaging installations, do not need to maintain a big working stock. They noticed that minimizing working stock, is a way to reduce their price risk. Retail clarified, they use the same way of price risk management. The consumption pattern of onions does not vary much and the seasonal variation of consumption is predictable. Therefore they are able to predict their sales quite well and maintain a small working stock. For retail, the competitiveness of the price level towards competitors is more of importance, than the absolute price level. The retail price moves along the bale and farmers price, since retail does not want to take positions on the long term. Long term positions could be at the expense of the competiveness of the selling price in the shops.

6.4 Willingness to reduce price fluctuations and role of futures market

In the opinion of the participants, the price fluctuations are inherent to the onion market. In general no obvious dissatisfaction could be noticed about the price fluctuations among the interview participants.

Farmers who want to reduce price fluctuations already have the possibility of a pool or cash forward contract. Some other interviewed farmers appreciated the price fluctuations and do not want to reduce them. Farmers have many other crops they could cultivate. Most of the interviewed farmers indicated price fluctuations as one of the reasons why they cultivate onions. Farmers do not have very much knowledge and experience about futures. There are farmers who reacted a bit averse about futures, which could be partly due to their lack of familiarity with futures. Terms such as “peculation” and “manipulation” came up during the interviews and there exists concern about it.

Traders and packagers shared the opinion that price fluctuations are needed in the market and it is up to the entrepreneur how to manage them. The interviewed traders and packagers are not very familiar with futures markets. Farmers could have experience with futures, since potato and wheat are common products in a farmer’s portfolio. However, most traders and packagers only have onions in their portfolio. There are no existing futures contracts on these products, so they are not involved in futures markets.

The interviewed traders and packagers sell most of their onions to exporters or they export themselves, which is consistent with results described in chapter 4. Almost none of the purchasers abroad make fixed price agreements for onions in advance. Hence, exporters do not have fixed price agreements for onions in advance. Nearly all the sales of traders and packagers are based upon spot prices. After discussion with traders and packagers can be concluded that hedging a purchase price involves extra risk, since they do not have fixed price agreements for sales and they do not know in advance which price they could sell their onions for. The interviewed traders believe that this situation will not change in the future, since the Netherlands will maintain their position of shortage filling country.

Some interviewed traders and packagers had cash forward contracts with farmers to ensure their supply. If the futures price is higher than the price of the cash forward contract, it is fruitful for traders to hedge their sales price with futures. G.A. Gunter estimates that cash forward contracts constitute only a small part of the total onion purchase in the Netherlands. The interviewed traders and packagers noticed comparable types of purchasing.

An interviewed importer and exporter of onions stated that he sometimes get requests from retail to deliver a certain amount of imported onions ahead of time. This importer faced the problem that traders and packagers do not want to make price agreements in advance or they ask a price which is too high. For this reason, the importer/exporter is not able to make a deal with retailers, as it involves a high price risk. “*A futures market could be a solution for this situation*” stated the importer/exporter. However he has to admit, this requests constitute only small volumes.

In conclusion, among the interviewed participants there was limited interest in an onion futures contract. In the opinion of the interviewed farmers, a futures contract could supplement to the already existing possibilities to hedge the price risk of onions. However, they admit that price fluctuations are attractive. The interviewed traders, packagers, importers, exporters and retail organisation find a futures contract of limited added value. There are not many possibilities to fix their sales, which make hedging purchase price not of added value. In the view of the above mentioned participants, hedging does not fit in the onion market.

7. Conclusion and discussion

In this chapter a conclusion is made of the results from chapter 4, 5 and 6. Furthermore, the results are discussed.

7.1 Conclusion

This study aimed to analyse the viability of an onion futures contract as a price risk management tool in the Dutch onion chain. A technical and marketing approach formed the basis of this study.

Onions as underlying product are appropriate to standardize, since there exists well-known quality standards of onions and the uniformity of a batch of onions after sorting. The well-developed storage facilities and infrastructure of onions enable an almost year round supply of Dutch onions. With respect to the standardization possibilities and product storability, the underlying product onion is proven conducive to the introduction of a new futures contract.

The market structure of onions is characterized by almost no vertical integration. The market power is spread among the many participants in the onion chain. In contrast with many other agricultural crops, participants have various selling possibilities which make both farmers and traders less dependent on certain marketing channels. The shortage filling position of the Netherlands makes it difficult to establish cash-forward contracts with customers. Therefore the rest of the chain trades largely at spot prices and not with cash-forward contracts. The lack of fixed selling prices makes hedging purchase prices not of added value for traders. Hedging sales prices is on limited scale interesting for traders, since approximately only 10 percent of the cultivated onions are fixed by cash-forward contracts.

The size of the cash market could be a bottleneck for introducing an onion futures contract, since the notational value equivalent in EUR is quite small. Regarding the big volatility of the cash prices, there should be a need for hedging. The existing agricultural futures considered here cannot be used as proper cross-hedges, since the hedging effectiveness of those cross-hedges is low.

The marketing approach showed satisfaction among interviewed participants regarding price fluctuations and the existing price risk management tools. There was limited interest to reduce price fluctuations in the onion chain. The knowledge and experience of the participants about futures was limited; traders were not familiar with futures. As already mentioned in the technical approach the lack of fixed contracts with customers restricts the added value of hedging. Participants do not predict a change in this market structure in the future. In conclusion, in the opinion of the interviewed onion supply chain participants, an onion futures contract does not satisfy the needs of the stakeholders in the onion chain.

7.2 Discussion

In this research there are some limitations and further research is recommended at some aspects. Firstly the research focused on the Netherlands, due the importance of the Dutch onion chain. It could be interesting to include or focus on other countries as well.

Secondly, some interpretation of the cross-hedge possibilities could be discussed. The weeks without exchange quotations for onions are deleted from the sample. Even though there exists no complete data set and generating data is a worse alternative, the data gaps could slightly influence the results of the OHR and HE effectiveness calculations. Furthermore the results of the hedging effectiveness are within-sample results. Since an out of sample approach likely will result in an even lower HE, it is not worth conducting an out-of-sample approach.

Thirdly, the marketing approach is based on a limited sample of participants. Beforehand a qualitative approach is chosen, rather than a more quantitative approach. Even though the qualitative approach gave insight on the way of thinking of the chain participants, a quantitative approach could provide empirical support. Further research is recommended on the marketing approach, since this research was just introductory.

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Annex 1: Overall questionnaire of the interviews

Introduction of persons and company

1) What is your perception about price fluctuations?
    - If you could influence prices, would you decline the price fluctuations?
    - What is your opinion about stable prices and what would be the effect of stable prices?
2) How is your ability to forecast prices? (take into account time horizon and price bandwidth)
    - What determinants are important for the forecasts?
3) How are you dealing with price fluctuations?
4) What is your opinion about the current possibilities of price risk management?
    - Do you want to reduce more price risk?
5) Introduction about futures contract and calculation examples
    - What is your opinion about the advantages and disadvantages of a futures contract?
    - If there would be an onion futures contract, would you use it?

Annex 2: Overview of different purchase transactions

Indication of existing purchase transactions of onions	Percentage
1. Spot trade with delivery within 3 weeks (conform current exchange quotation)	20%
2.Spot trade conform agreed price with delivery more than 3 weeks ahead	20%
3.Spot trade conform agreed floor price + price of current exchange quotation of the delivery	10%
4.Pool	10%
5.Participation in cultivation	10%
6.Fixed cash forward contracts	7,5%
7.Fully surrender of batch to trader	7,5%
8.Cash forward contracts conform current exchange quotation of delivery, with a floor price	5%
9.Own cultivation of trader	5%
10.Fully surrender of unsorted field crop to peeling company (poor quality)	5%
	100%

Source: ir.ing.G.A. Gunter

Annex 3: Estimates of different models

Estimates of VAR models

	$Spot_{sos}$			$Futures_{mwf}$	
Equation (4)	**Coefficient**	**Standard error**	**Equation (5)**	**Coefficient**	**Standard error**
α_s	0.005446	-0.02274	α_f	0.000147	-0.00251
β_{s1}	-0.194845	-0.06313	β_{f1}	-0.00633	-0.00696
Y_{s1}	0.739619	-0.56583	Y_{f1}	0.245572	-0.06238
R^2	0.042883		R^2	0.062113	

	$Spot_{sos}$			$Futures_{fwf}$	
Equation (4)	**Coefficient**	**Standard error**	**Equation (5)**	**Coefficient**	**Standard error**
α_s	0.005245	-0.02283	α_f	0.00075	-0.00235
β_{s1}	-0.189333	-0.06331	β_{f1}	0.005569	-0.00651
Y_{s1}	0.129854	-0.6097	Y_{f1}	0.223547	-0.06271
R^2	0.036279		R^2	0.051827	

	$Spot_{sob}$			$Futures_{fepp}$	
Equation (4)	**Coefficient**	**Standard error**	**Equation (5)**	**Coefficient**	**Standard error**
α_s	0.004442	-0.01525	α_f	0.000393	-0.00828
β_{s1}	0.01269	-0.06753	β_{f1}	0.018033	-0.03665
β_{s2}	-0.157902	-0.05446	β_{f2}	-0.0541	-0.02956
β_{s3}	-0.099004	-0.05469	β_{f3}	-0.01738	-0.02969
β_{s4}	-0.079828	-0.05403	β_{f4}	-0.02069	-0.02933
β_{s5}	0.033591	-0.0541	β_{f5}	0.019882	-0.02936
β_{s6}	0.102385	-0.05356	β_{f6}	0.023476	-0.02907
β_{s7}	0.054043	-0.05345	β_{f7}	0.059489	-0.02901
β_{s8}	-0.027415	-0.05321	β_{f8}	0.00895	-0.02888
Y_{s1}	0.018401	-0.12491	Y_{f1}	0.060313	-0.0678
Y_{s2}	0.435151	-0.12519	Y_{f2}	0.016528	-0.06795
Y_{s3}	0.362372	-0.12745	Y_{f3}	0.052682	-0.06918
Y_{s4}	0.258511	-0.12914	Y_{f4}	0.046427	-0.0701
Y_{s5}	-0.048205	-0.12994	Y_{f5}	-0.01787	-0.07053
Y_{s6}	0.022182	-0.12899	Y_{f6}	-0.0136	-0.07001
Y_{s7}	-0.633375	-0.12854	Y_{f7}	-0.00632	-0.06978
Y_{s8}	1.48995	-0.13482	Y_{f8}	0.068101	-0.07318
R^2	0.490628		R^2	0.057247	

	$Spot_{sob}$			$Futures_{mwf}$	
Equation (4)	**Coefficient**	**Standard error**	**Equation (5)**	**Coefficient**	**Standard error**
α_s	0.004628	-0.01976	α_f	0.000146	-0.00251
β_{s1}	-0.105658	-0.06409	β_{f1}	-0.006374	-0.00814
Y_{s1}	0.662405	-0.4924	Y_{f1}	0.246303	-0.06251
R^2	0.017083		R^2	0.061286	

	$Spot_{sob}$			$Futures_{fwf}$	
Equation (4)	**Coefficient**	**Standard error**	**Equation (5)**	**Coefficient**	**Standard error**
α_s	0.004341	-0.01983	α_f	0.000744	-0.00235
β_{s1}	-0.097376	-0.06412	β_{f1}	0.007215	-0.00759
Y_{s1}	0.243862	-0.52935	Y_{f1}	0.223192	-0.06266
R^2	0.010573		R^2	0.052502	

Estimates of ECM models

	Spot$_{sos}$			**Futures$_{mwf}$**	
Equation (4)	**Coefficient**	**Standard error**	**Equation (5)**	**Coefficient**	**Standard error**
α_s	0.005352	-0.02257	α_f	0.000148	-0.00251
β_{s1}	-0.17252	-0.06347	β_{f1}	-0.00635	-0.00707
Y_{s1}	0.784602	-0.56184	Y_{f1}	0.245537	-0.06255
λ_s	-0.04495	-0.0206	λ_f	3.56E-05	-0.00229
R^2	**0.061505**		R^2	**0.062114**	

	Spot$_{sos}$			**Futures$_{fwf}$**	
Equation (4)	**Coefficient**	**Standard error**	**Equation (5)**	**Coefficient**	**Standard error**
α_s	0.005112	-0.02266	α_f	0.000752	-0.00235
β_{s1}	-0.16682	-0.06374	β_{f1}	0.005189	-0.00662
Y_{s1}	0.174689	-0.60568	Y_{f1}	0.22279	-0.06286
λ_s	-0.04427	-0.02085	λ_f	7.48E-04	-0.00216
R^2	**0.054046**		R^2	**0.052299**	

	Spot$_{sob}$			**Futures$_{fepp}$**	
Equation (4)	**Coefficient**	**Standard error**	**Equation (5)**	**Coefficient**	**Standard error**
α_s	0.00445	-0.01526	α_f	-0.00038	-0.00817
β_{s1}	-0.06237	-0.05458	β_{f1}	-0.00511	-0.02922
β_{s2}	-0.13923	-0.05386	β_{f2}	-0.04236	-0.02883
β_{s3}	-0.10396	-0.05381	β_{f3}	-0.01114	-0.0288
β_{s4}	-0.08443	-0.05403	β_{f4}	-0.01623	-0.02892
β_{s5}	0.022414	-0.05382	β_{f5}	0.020421	-0.02881
β_{s6}	0.096612	-0.05339	β_{f6}	0.024917	-0.02858
β_{s7}	0.048111	-0.0531	β_{f7}	0.061355	-0.02842
β_{s8}	-0.03066	-0.05267	β_{f8}	0.010463	-0.0282
Y_{s1}	0.028304	-0.12555	Y_{f1}	0.072855	-0.0672
Y_{s2}	0.439837	-0.1251	Y_{f2}	0.037991	-0.06696
Y_{s3}	0.408082	-0.12711	Y_{f3}	0.082285	-0.06804
Y_{s4}	0.297681	-0.12933	Y_{f4}	0.074052	-0.06922
Y_{s5}	-0.02662	-0.1299	Y_{f5}	-0.0039	-0.06953
Y_{s6}	0.020749	-0.12931	Y_{f6}	-0.00793	-0.06922
Y_{s7}	-0.61616	-0.12874	Y_{f7}	0.006379	-0.06891
Y_{s8}	1.449823	-0.1328	Y_{f8}	0.068958	-0.07108
λ_s	-0.00216	-0.00251	λ_f	-0.00329	-0.00135
R^2	**0.483267**		R^2	**0.074283**	

	Spot$_{sob}$			**Futures$_{mwf}$**	
Equation (4)	**Coefficient**	**Standard error**	**Equation (5)**	**Coefficient**	**Standard error**
α_s	0.004559	-0.01962	α_f	0.000146	-0.00251
β_{s1}	-0.08789	-0.06423	β_{f1}	-0.0062	-0.00823
Y_{s1}	0.710164	-0.48961	Y_{f1}	0.246772	-0.06271
λ_s	-0.03641	-0.01756	λ_f	-3.58E-04	-0.00225
R^2	**0.034383**		R^2	**0.061385**	

	Spot$_{sob}$			**Futures$_{fwf}$**	
Equation (4)	**Coefficient**	**Standard error**	**Equation (5)**	**Coefficient**	**Standard error**
α_s	0.004236	-0.01971	α_f	0.000746	-0.00235
β_{s1}	-0.07906	-0.06438	β_{f1}	0.00699	-0.00768
Y_{s1}	0.280527	-0.52639	Y_{f1}	0.222742	-0.06282
λ_s	-0.03607	-0.01802	λ_f	4.42E-04	-0.00215
R^2	**0.026815**		R^2	**0.052669**	

Estimates of VAR-MGARCH model

$Spot_{sos}$ and Fut_{mwf} Term in equation (10)	Coefficient	Standard error
C_1	0.000288	0.000245
C_3	0.000389	0.000068
a_{11}	0.817811	0.118013
a_{33}	1.727865	0.205995
b_{11}	0.584949	0.02175
b_{22}	-0.0018	0.074289
b_{33}	0.009348	0.026072

$Spot_{sos}$ and Fut_{fwf} Term in equation (10)	Coefficient	Standard error
C_1	0.001389	0.00371
C_3	0.000612	0.000286
a_{11}	-0.01086	0.00989
a_{33}	0.823308	0.107559
b_{11}	0.188705	2.174905
b_{22}	-0.13012	0.077429
b_{33}	0.540976	0.019106

$Spot_{sob}$ and Fut_{fepp} Term in equation (10)	Coefficient	Standard error
C_1	C_1	0.000214
C_3	C_3	0.000357
a_{11}	a_{11}	-0.04077
a_{33}	a_{33}	0.810956
b_{11}	b_{11}	1.032144
b_{22}	b_{22}	0.112338
b_{33}	b_{33}	0.562608

$Spot_{sob}$ and Fut_{mwf} Term in equation (10)	Coefficient	Standard error
C_1	0.000387	6.65E-05
C_3	0.0003	0.000289
a_{11}	1.736236	0.2006
a_{33}	0.842515	0.111086
b_{11}	0.009281	0.025802
b_{22}	0.057903	0.076588
b_{33}	0.558213	0.026948

$Spot_{sob}$ and Fut_{fwf} Term in equation (10)	Coefficient	Standard error
C_1	0.001425	0.002702
C_3	0.000753	0.000269
a_{11}	-0.01221	0.000754
a_{33}	0.747084	0.096764
b_{11}	0.264706	1.399762
b_{22}	-0.16069	0.088108
b_{33}	0.489451	0.026802