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A Buy-Out Scheme for the EU Milk Market

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A Buy-Out Scheme for the European Milk Market – a research into the possibilities and practicalities

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Abstract

The European dairy market is characterized by increased volatility in dairy commodity prices. This is the result of multiple CAP reforms, which reduced the protection of the European market from the world market. The increased price volatility, and in particular the sharp price decline in 2008/2009, resulted in questions about the robustness of the EU's dairy policy. In order to provide a safety net against extreme market situations, the implementation of a buy-out scheme was suggested. This paper investigates the possibilities and practicalities of a European buy-out scheme. In order to simulate the implementation of a buy-out scheme in the European milk market, an excess demand model was constructed. Based on the calculations, it was concluded that the buy-out scheme reduced the negative welfare effects of an excess demand shock of -25% simulated. Furthermore, it was concluded that efficiency of the buy-out scheme was higher than that of export subsidies. A second model, the dairy farm model, was constructed in order to assess the effects of a buy-out scheme on an individual dairy farm. It was concluded that a buy-out scheme leads to a positive profit change. Additionally, the results indicated that the inefficient producing dairy farm will profit from participation and thus will reduce their supply quantity, and that the efficient producing dairy farms will not profit from participation and thus will refrain from participation. Finally, it was concluded that a voluntary buy-out scheme that can temporary adjust the supply of raw milk to the market is preferable for the European dairy market. This scheme should be implemented country by country and at the level of the dairy processing companies.

Key words: Buy-out scheme, European milk market, Dairy farms, Remuneration, Excess demand model

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H1 – Introduction

1.1 – Background

The EU milk production comprises 14% of the value of the EU's total agricultural production in 2011. Milk is a highly perishable product and only 7% of the global dairy production is traded. The EU's dairy export accounted for over a third of total world dairy exports in 2011 (European Union, 2012). The EU dairy policy, the Common Market Organization (CMO) for milk and milk products, is quite different from the CMO's in other sectors. This is because raw milk is a highly perishable product, making it difficult to store or transport. As a result the market support has focused on first-stage processing products; principally butter, skimmed milk powder (SMP) and cheese (Meijerink and Achterbosch, 2013).

The CMO for dairy products was initially a typical CMO providing price support through variable import levies, export refunds, intervention buying and subsidies for specific domestic consumption outlets. Over-production led to the introduction of the milk quota system in 1984 (Huettel and Jongeneel, 2011). The CAP reform of 1992 reduced the level of price support and introduced coupled support in order to prevent an income decline for farmers. In the 2003 Luxembourg Agreement on reforming the Common Agricultural Policy (CAP), however, it was decided that the quota system was to be abandoned on 1 April 2015. At the same time, the intervention price was reduced stepwise in four yearly steps (butter -25%; SMP -15%) and a decoupling of the milk premiums, which were introduced with the CAP reform of 1992, was introduced. Additionally, a soft landing policy was introduced with the Health Check of the CAP in 2008, implying gradual annual quota increases and a smooth induced price decline in order to anticipate the quota abolishment in 2015 (Jongeneel et al., 2010).

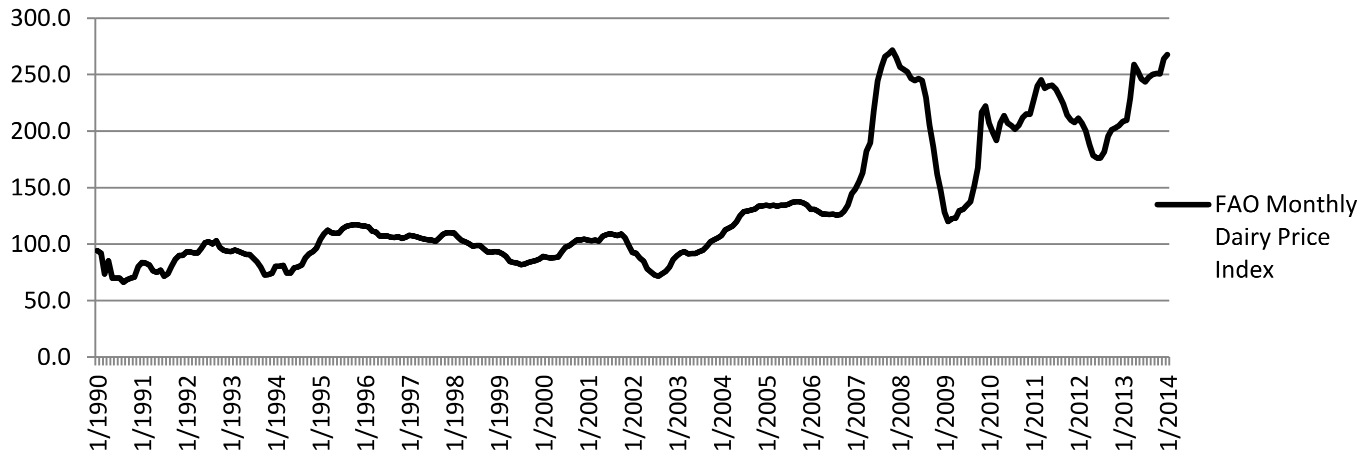

Figure 1.1 – FAO monthly dairy price index. The index consists of butter, SMP, WMP and cheese price quotations. The average is weighted by world average export trade shares for 2002-2004. Source: FAO, 2014.

The milk quotas, subsidized exports, import protections and public interventions stabilised prices and facilitated a gap between the European market price and the world market price (Pennings, 2013). The increase of the milk quotas, the reduction of price support and higher world market prices have removed this gap and the EU milk price volatility has increased accordingly. While the EU milk price volatility (coefficient of variation) over 2000-2007 was 7.16%, it rose to 11.41% during 2007-2012 (Pennings, 2013). Figure 1.1 shows a price boom in 2007, which was followed with a sharp price decline in 2008/2009 and by June 2009 the milk price in the EU-25 was down 25% compared to the previous year. This sharp decline in milk price led to a lost revenue of 11 billion euro for the dairy sector in 2009 (Fink-Kessler et al., 2013).

The strong price fluctuations, with the sharp price decline in 2008/2009 in particular, resulted in questions about the robustness of the EU's dairy policy (Jongeneel et al., 2010). This price volatility has been observed not only for milk but for all major agricultural commodities (milk, meat, cereals and oilseeds). Different causes of this phenomenon have been suggested: weather conditions & climate change, trends in food demand (mainly in rapidly-growing emerging countries), reductions in stocks, trade interventions, the explosion of the production of bio fuels, the dynamics of energy prices, the US dollar exchange rate and the *financialisation* of commodity markets with speculative behaviour (Sckokai, 2013).

The increase in milk price volatility was larger in the EU than on the world market, even though the actual level of volatility was still lower. The level of the EU milk price volatility is expected to increase to the level of the world milk price volatility if the CAP is completely liberalised (Pennings, 2013). EU milk deliveries in 2013 were well below the overall quota (reaching about 95% of the guaranteed quantity), with only a few Member States producing above their quota (Germany, the Netherlands, Ireland and Austria). Since world trade in dairy products is rather limited as compared to other commodities (7% of global dairy production is traded), small changes in supply and/or demand may lead to rather strong price fluctuations. Thus it is expected that price volatility will remain a key issue in dairy markets (Sckokai, 2013).

Price volatility is greater at the farm level than in the upstream stages of the dairy supply chain. This is because supply and demand at the farm level are inelastic, and as a result small changes in supply or demand can cause large price fluctuations (Keane and O'Connor, 2009). Milk price volatility is especially a major challenge for large/growth-oriented farms that are able to produce at low marginal costs. These farms often heavily rely on non-family labour, rented land and debt capital, resulting in high fixed payments. Although highly competitive with regard to their cost positions, these farms have turned out to be most vulnerable during times of (very) low milk prices (Theuvsen, 2013). Besides price volatility, the low correlation between input costs and the milk price is another challenge for dairy farms. Pennings (2013) concluded that changes in prices of feedstuffs (corn, wheat, soybean and oats) are not fully translated into changes in the milk price. This implies that farms are unable to transfer the change in price for feedstuffs to a change in milk price. Gross margins for dairy farms have deviated substantially over the past years and this is expected to continue in the future. The increasing input costs and the milk price volatility put the financial viability and flexibility of EU dairy farms under increasing pressure (Pennings, 2013).

A safety net against extreme market situations (mainly very low prices over a longer period of time) may contribute to dairy farms' future prospects and their willingness to stay in dairy farming. Policy measures, such as intervention prices, regulations on (private) stock-keeping and export subsidies can provide this safety net (Theuvsen, 2013). However, when the budget constraints and the quantity thresholds for intervention are taken into account, it raises the question whether these are able to control critical market imbalances (Sckokai, 2013). This is not surprising since the current policy measures, direct payments and the market regulation measures discussed, were developed to offer a basic safeguard and are not designed for volatile prices and/or crises (European Commission, 2011b). Therefore another policy measure might be considered in order to provide a safety net; a buy-out scheme. A buy-out scheme is a 'supply control' tool that either limits production or withdraws production (Sckokai, 2013).

1.2 – Research objective and research questions

The goal of this thesis research is to investigate the possibilities for implementing a buy-out scheme in the European milk market in order to provide a safety net against very low milk prices. In order to fulfil the goal of this thesis, the following questions were constructed:

1. What are the current EU policy measures in case of extreme market situations in the dairy sector?
2. Are there different set-ups for buy-out schemes? If so, what are they?
3. If implemented, what are the possible costs and welfare effects of a European buy-out scheme?
4. If implemented, what are the effects of a European buy-out scheme for an individual dairy farm and would the dairy farm participate in the scheme?
5. What are the possible practicalities or implementation issues that may arise from the implementation of a European buy-out scheme?
6. What is the most preferable set-up for a European buy-out scheme?

1.3 – Approach

A literature research was carried out in order to answer the first two research questions. This literature research was conducted with the help of the scientific search engines Scopus and Web of Science, search engine Google, the database of the Wageningen UR and the website of the European Commission. After the statement of the current EU policy measures and the possible set-ups for buy-out schemes, an excess demand model was created in order to address the third research question. Through the usage of a scenario analysis, the effects of an implementation of a buy-out scheme were calculated. These effects were quantified with the help of the Pigouvian Welfare Function.

In order to assess the fourth research question, a second model was constructed. In this model a profit maximizing problem was solved, through which the profit changes for a dairy farm as a result of the buy-out scheme were calculated. Based on these answers, it was possible to draw conclusions on whether dairy farms chose to participate in the scheme or to withhold from participation. The fifth research question was again answered by literature research. The sixth and final research question was answered through the information that was gathered through the answering of the previous five research questions.

1.4 – Overview

An overview of this thesis report will briefly be presented. Chapter 2 contains six sections, in which the buy-out scheme and its mechanisms are discussed. The chapter starts with a quick overview of different milk based dairy products that are made of raw cow milk. In section 2.2 the current EU policy measures for the dairy market are discussed. Sections 2.3 and 2.4 discuss the mechanisms behind the CAP measures and the price declining market situations. Then an introduction is given into the oligopsonistic market structure of the European dairy market. In Appendix B, a start is given about how to incorporate an oligopsonistic market structure into the empirical model. Chapter 2 ends with a description of the different buy-out schemes that are possible, and which set-up of the scheme is used in the empirical model. Chapter 3 addresses the materials and methods of this research. Section 3.1 contains the European milk market model. The analytical framework is discussed, after which the empirical model is constructed. Finally, the model is calibrated and the scenarios are constructed for the analysis. In section 3.2 the dairy farm model is constructed and this section has the same set-up as section 3.1. The results of the constructed models are presented in the fourth chapter. The implementation issues and other practicalities that arise with the implementation of a buy-out scheme are also discussed in chapter 4, namely in section 4.3. This report ends with chapter 5, which is divided in two sections. Section 5.1 contains the discussion of the performed research and its findings, and, subsequently, recommendations for further research are presented. Then section 5.2 finalises this paper with the conclusions.

H2 – A Buy-Out Scheme and its Mechanisms

This chapter provides a background in the mechanisms behind a possible buy-out scheme. First, the dairy sector and the wide variety of dairy products are shortly addressed. Section 2.2 continues with the current EU policy measures addressing the dairy market. Hereafter the theory behind the Common Agricultural Policy (CAP) measures is explained, including the effects of the CAP reforms. Section 2.4 discusses the mechanisms behind downward price shocks. In section 2.5 the oligopolistic structure of the EU dairy market and its influence is explained. The final section, section 2.6, ends this chapter by discussing the different types of buy-out schemes and the type that was used in constructing the empirical model.

2.1 – Raw milk and dairy products

The dairy sector comprises of a wide variety of milk based dairy products and thus series of interrelated product markets. Fresh cow's milk, raw milk, is the common raw material which results in similar prices trends of dairy products (De la Mano et al, 2009). Figure 2.1 shows how the fat and non-fat components of raw milk can be used for different applications. The main dairy products that are produced and traded are: cheese, butter, skim milk powder (SMP) and whole milk powder (WMP). The overview provided in figure 2.1 is a simplification since a wide variety of products per commodity exists.

As a result of the large variety of products that can be processed from raw milk, it is challenging to establish how much milk is used to produce one kilogram of end product. Richarts and Mikkelsen (1996) stated that there are several different conversion rates in order to calculate the amount of raw milk used for different dairy products, but that it is impossible to present accurate results. Since there is no more accurate solution, milk equivalents will be used in this report in order to assess the production and trade in the EU versus the world market. All milk quantities presented will be Energy Corrected Milk (ECM), meaning that all milk produced is corrected for a standard level of fat (4%) and protein (3.3%) to obtain comparable data.

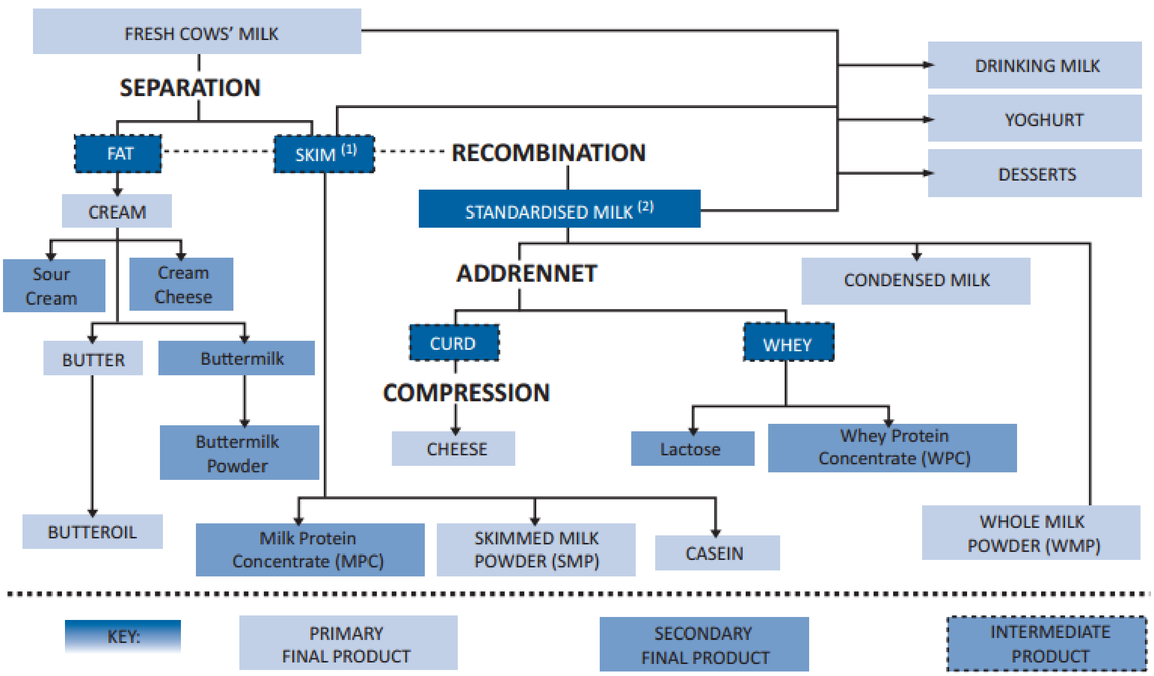

Figure 2.1 – The refinery of milk, processed into different dairy products. Source: De la Mano et al., 2009.

(1) SKIM = protein + other solids (lactose, minerals) + water
(2) STANDARDISED MILK = of a fat content adjusted by the addition of skim or cream

2.2 – Current EU policy measures in dairy market

The Common Agricultural Policy (CAP) was introduced in 1968 and has undergone multiple reforms ever since, as can be seen in figure 2.2 which shows the CAP expenditures from 1980 till 2009. The effects of two important reforms are clearly visible in the figure, namely that of the reform of 1992 and of the reform of 2003. The CAP reform of 1992 reduced the level of price support and introduced coupled support in order to prevent an income decline for farmers. These coupled payments increased the EU agricultural commodity prices and encouraged EU production. In order to reduce the impact on the different agricultural commodity markets, the 2003 reform of the CAP decoupled those payments from production and direct payments. The reform introduced a Single Payment Scheme (SPS) of decoupled income support, combining several pre-existing direct payments into a single farm payment (SFP). The decoupled SFP is intended to provide income support whilst allowing farmers more freedom to respond to market demand (Jongeneel et al., 2011). Despite the switch, price support measures largely remained but the actual price support has been reduced substantially. Furthermore, it remained possible for member states to keep some extent of direct payments coupled to production (Meijerink and Achterbosch, 2013). Furthermore, the 2003 Luxembourg Agreement resulted in the decision to abolish the quota system on 1 April 2015.

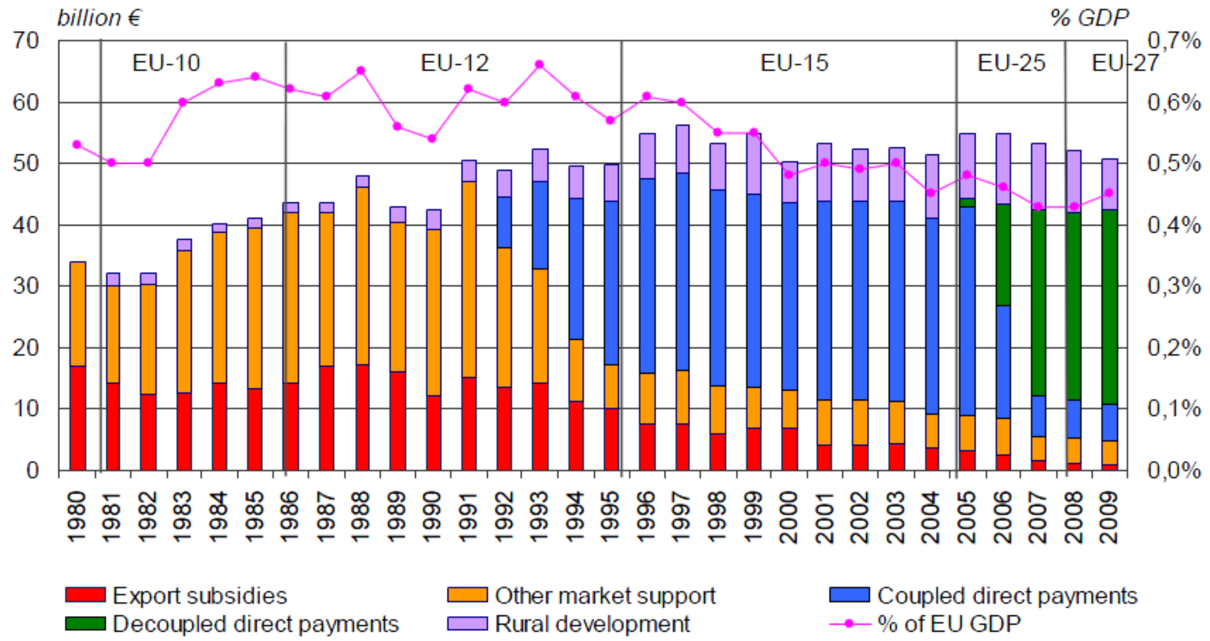

Figure 2.2 – The path of CAP expenditure 1980–2009 (in 2007 constant prices). Source: European Commission, 2011a.

The CAP currently consists of two pillars, where pillar 1 contains the direct payments and market management measures and pillar 2 the rural development policy. Within the CAP the EU dairy market is regulated by the Common Market Organisation (CMO) for milk and milk products, covering: milk and creams; buttermilk, yoghurt and kephir; whey; butter and other fats; cheese and curd; lactose and lactose syrups; preparations used as animal feed. European dairy market support currently consists of public intervention, private-storage and export refunds. These measures will now be discussed shortly.

2.2.1 – Public- and private-storage arrangements

Public intervention acts as a measure of last resort of which the prevailing rules are laid down in Chapter 1 of Regulation (EC) 1234/2007 (European Commission, 2007). Butter and SMP are the only products eligible for public intervention. Public intervention operates through intervention agencies in each member state, those agencies can buy up butter and SMP between 1 March and 31 August. The butter and SMP bought by the intervention agencies have to be disposed in such a way as to avoid disturbing the balance on the market.

The 2003 reform reduced the butter and SMP intervention prices step by step with cumulative percentage declines in the butter and SMP intervention prices of 25% and 15%. The SMP intervention price was further reduced by another 3% with the so called mini milk package (European Commission, 2008a; Jongeneel et al., 2011). This stepwise reduction of the butter and SMP intervention prices are visible in figure 2.2, which shows the developments of the EU milk price, the world milk equivalent price and the EU milk equivalent support price in the years 2000 till 2009. From the picture it becomes clear that the EU milk equivalent support price has dropped from € 282 per tonne of milk in 2003, to € 215 per tonne of milk from 2008 onwards.

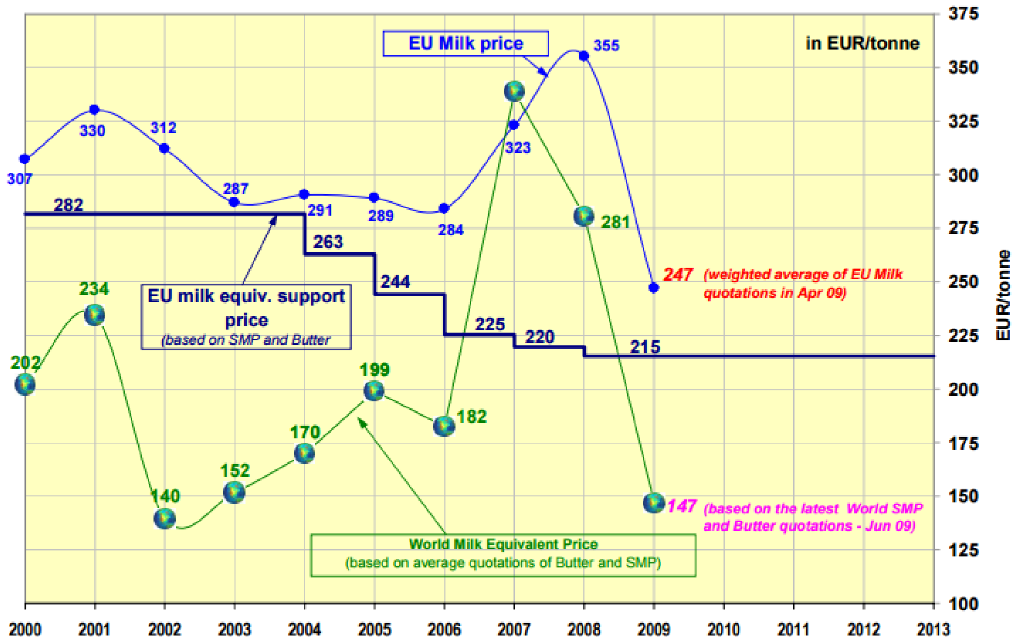

Figure 2.3 – Developments of the EU milk price, the world milk equivalent price and the EU milk equivalent support price in the years 2000 till 2009. Source: Commission of the European Communities, 2009.

Since there is no actual EU raw milk support price, the EU milk equivalent support price is based on the intervention prices and quantity thresholds for butter and SMP. In addition to EU intervention prices, there are also EU reference prices. The intervention price is equal to the reference price for SMP; this price is € 169.80 for 100 kg of SMP (European Commission, 2008b). For butter, however, the intervention price is 90% of the reference price, which is € 246.39 per 100 kg. Therefore, the intervention price for butter is € 221.75 per 100 kg (European Commission, 2008b). In addition to the predetermined intervention prices, there are also thresholds in the amount of butter and SMP that can be bought up. These thresholds are 30,000 tonnes for butter and 109,000 tonnes for SMP (European Commission, 2008b). The guaranteed quantity of butter is the most stringent threshold and corresponds to less than 0.5% of the total EU milk deliveries.

Additionally to public intervention arrangements, there are also private intervention arrangements. These private arrangements are in the form of storage aid, which may be granted for salted or unsalted butter produced from cream or milk and for certain cheeses. The aid amount is determined in the light of storage costs and the likely trend in prices for fresh butter and butter from stocks. On top of the storage aid, the Commission can also remarket the various cheeses that were stored with the help of the provided aid (European Commission, 2008b).

The CAP dairy budget for the year 2010 contained a theoretical margin of € 1000 million for market measures and direct support (the 2014 budget was not yet known), of which € 300 million had to remain under the sub-ceiling. This is in accordance to the principles of sound fiscal management. Therefore, € 700 million was potentially available for market measures and direct support (Commission of the European Communities, 2009). Research by Meulen et al. (2011) estimates the available budget for market measures and direct support in the dairy sector to be around € 500 million. When the budget and the quantity thresholds are taken into account, it raises the question about the ability to control critical market imbalances (Sckokai, 2013). This is not surprising since the current policy measures, direct payments and the market regulation measures discussed, were developed to offer a basic safeguard and are not designed for volatile prices and/or crises (European Commission, 2011b).

2.2.2 – Export subsidies

The historical purpose of export refunds was to enable EU exports to compete on the generally lower priced international market. Because the WTO called export subsidies to be trade-distorting and the fact that the funds were used more effectively through income support for EU farmers (Meester et al., 2013 : 97), the EU reduced her export subsidies dramatically from 1993 onwards. This can be seen in figure 2.2, the export refunds were over 10 billion Euros in 1993 and decreased to almost zero in 2009. Figure 2.4 shows the export subsidies provided to the EU dairy sector between September 2000 and September 2011. The price boom in 2007 resulted in zero dairy export subsidies and because of the sharp milk price decline in the years 2008/2009, the export subsidies were again activated in those two years. From 2010 onwards, dairy export subsidies were again set at zero.

The limitation on export subsidies and subsequent CAP reforms that have reduced interventionist market policies cleared the road for a near total elimination of export refunds. However, because the Doha Development Agenda has not been concluded yet, export subsidies are still on the table as a market stabilization tool (Meijerink and Achterbosch, 2013).

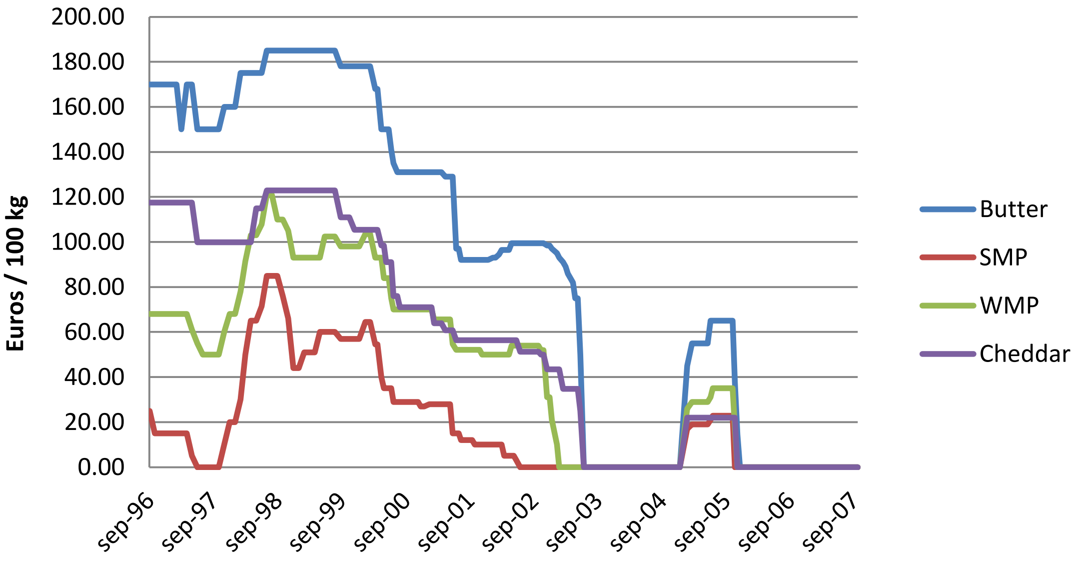

Figure 2.4 – Export subsidies for butter, SMP, WMP and cheddar from September 2000 till September 2011. Source: DairyCo, 2011.

2.3 – Theory behind the CAP measures

The milk quotas, subsidized exports, import protection and public intervention stabilised prices and facilitated a gap between the European and world milk prices (Pennings, 2013). Due to the reforms and the higher world market prices, this gap and thereby the protection of the EU dairy market has been removed. First, the effects of the supply quota for milk and the effects of the abolishment of the quota in April 2015 will be discussed. Figure 2.5 shows the effects of a supply quota in the case of autarky (no trade), so ignoring the export position of the EU. Without the supply quota in place, the market clears at market price P_0 with a milk quantity of Q_0. With the supply quota in place, the supply function is increasing till the maximum production quantity (the supply quota) is reached (Q). This results in a market price of P_d instead of P_0. The (shadow)price for the quota equals the price of milk minus the marginal cost of production, $P_d - P_s$.

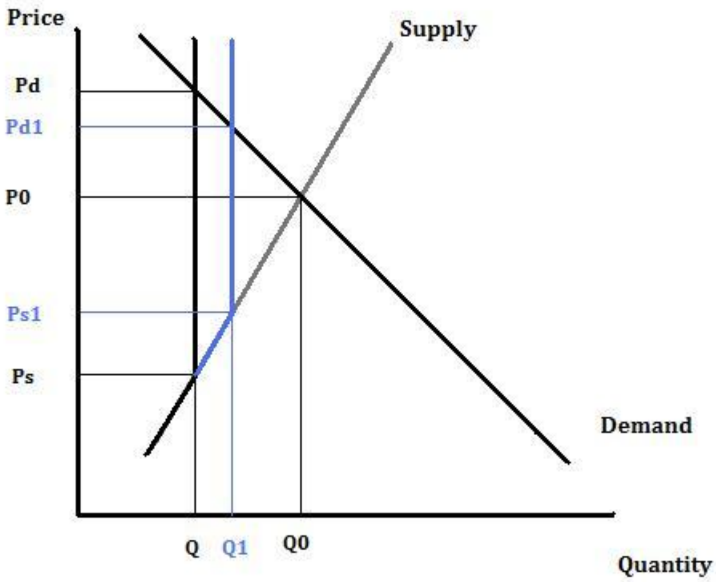

Figure 2.5 – Effects of a supply quota in the case of autarky.

The 2003 Luxembourg Agreement resulted in the decision to abolish the quota system on April, 1st, 2015. A soft landing policy was introduced with the Health Check of the CAP in 2008, implying gradual annual quota increases and a smooth induced price decline in order to anticipate the quota abandonment in 2015 (Jongeneel et al., 2010). A quota increase shifts the supply function outwards (to the right). Figure 2.5 shows the resulting new equilibrium at market price P_{d1} with a milk quantity of Q_1. The (shadow)price for the quota again equals the price of milk minus the marginal cost of production (Ps1), $P_{d1} - P_{s1}$. So, the quota has lost value. When the quota is abolished the new equilibrium is at P_0 and Q_0. It can be concluded that the step by step increase of the milk quota and the eventual abolishment of the milk quota has a downward effect on the market price and an upward effect on the milk quantity produced. Recall that autarky is assumed here.

In addition to the milk quota, the EU milk market was also protected through import tariffs, intervention and export refunds. Figure 2.6 provides an overview on the implications of these three measures. The measures create a price gap in which the domestic market price (P_d) is kept artificially higher than the world market price (P_w). The import tariff raises the price of imports, protecting the domestic market from imports. The intervention price puts a floor in the domestic market price, preventing the domestic market price to fall below this floor. Because of the difference in the world market price and the domestic market price, export refunds are needed in order to sell domestic surplus of products on the world market.

The reforms, increasing quotas and decreasing the intervention price, have reduced the domestic market price. As a result, the difference between the domestic market price and the world market price has become smaller, and thus decreasing the amount of export subsidies needed to sell domestic products on the world market.

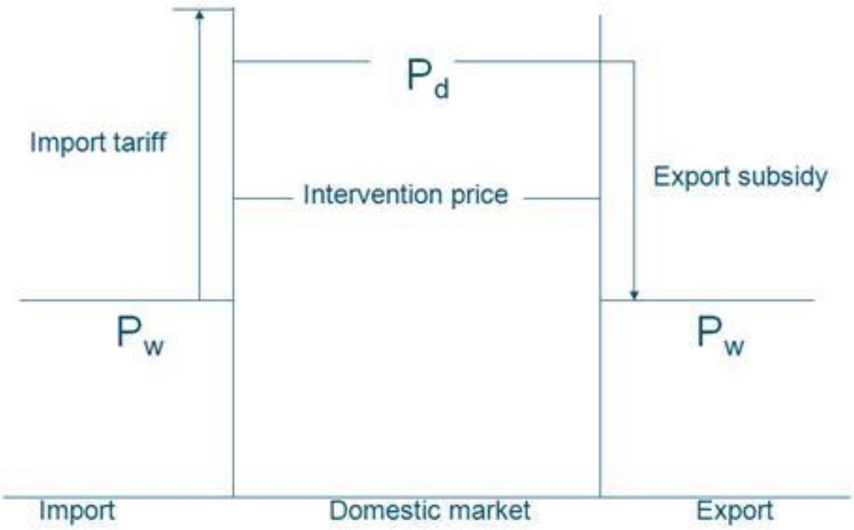

Figure 2.6 – Traditional system of price support.

When we combine the knowledge obtained through figures 2.5 and 2.6, we are able to construct figure 2.7. In this figure the European milk market situation with the previously discussed CAP measures and stepwise quota increase is presented.

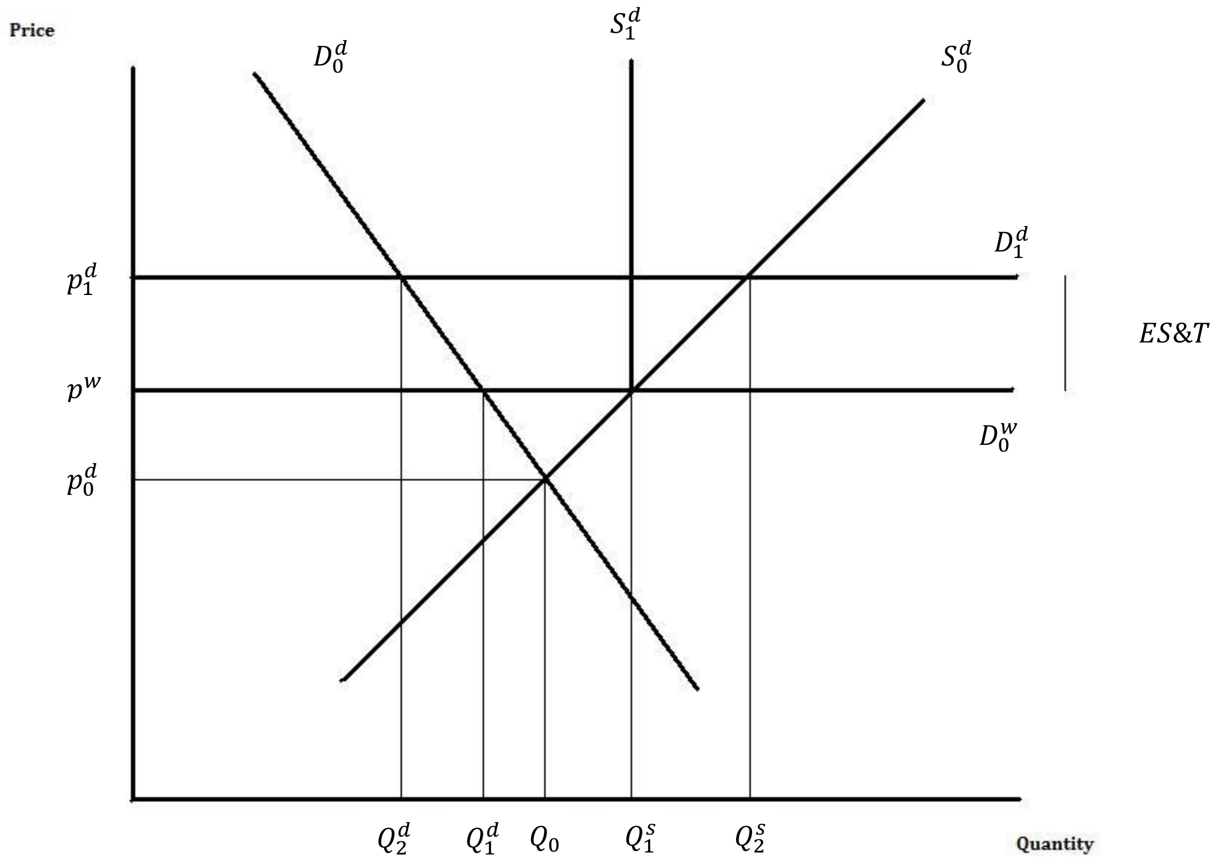

Figure 2.7 – The European milk market situation with CAP measures.

In the case of autarky, the equilibrium is found in Q_0 and p_0^d. In the case of free trade, the world market price p^w would be the domestic market price. This leads to a domestic milk demand of Q_1^d, a domestic milk supply of Q_1^s and an export of $Q_1^s - Q_1^d$. However, the European milk market is protected through import tariffs and export subsidies, $ES\&T$. As a result, the domestic market price increases from p^w to p_1^d. This results in a new domestic milk quantity demand, Q_2^d instead of Q_1^d, and a new domestic milk quantity supplied, Q_2^s instead of Q_1^s. The level of exports increase to $Q_2^s - Q_2^d$.

In this situation, the produced milk quantity is too much for the domestic milk demand and the overcapacity is provided to the world market with the help of export subsidies, ES. The costs that arise with the providing of export subsidies are considerable and a milk quota is introduced in order to lower those costs. The supply function of the EU, S_0^d, now becomes kinked, S_1^d, and the quantity supplied is restricted to Q_1^s. The market price and the marginal costs of production are now no longer equal to each other. The market price is p_1^d and the marginal costs of production are given by p^w. Therefore, the (shadow)price of the quota is equal to $p_1^d - p^w$.

The CAP reforms led to a quota increase, a decline in intervention price, and a decrease in the level of have export subsidies and import tariffs. This has narrowed the difference in the domestic milk market price and the world market price; lowered the domestic milk market price; and has increased the production in the European Union.

Jongeneel et al. (2011) plotted the world price of butter, the EU price of butter and the EU intervention price between 1997 and 2011 (see figure 2.8). In the figure, the effects of the reforms in agricultural policies can be clearly detected. Between 1997 and 2003 the CAP policies had a stabilising impact on the EU butter price. Between 2004 and 2008 the intervention price was reduced in four steps, thus allowing the EU butter price to fall. This happened and the gap between the world market price and the EU market price narrowed.

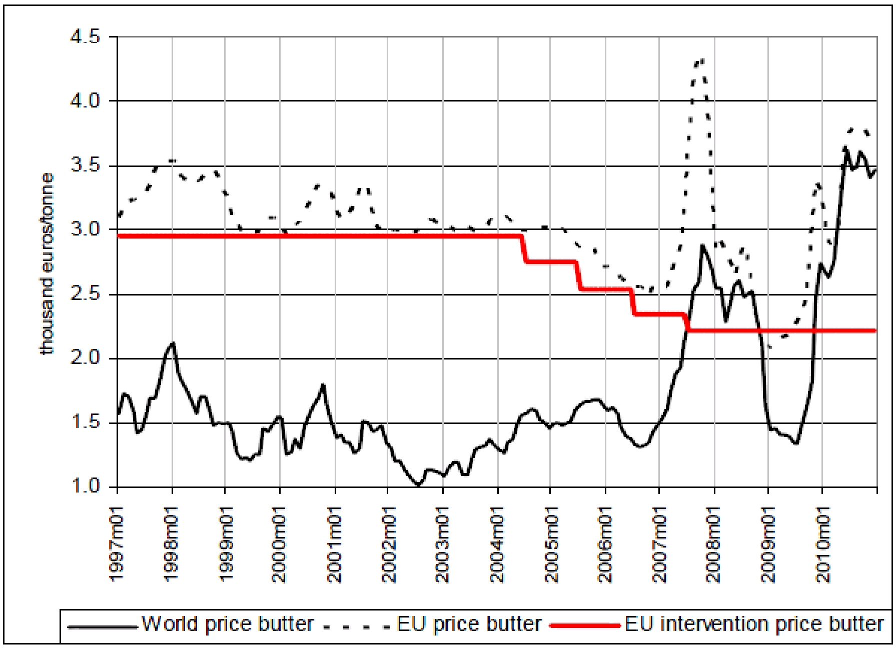

Figure 2.8 – Evolution of the EU and world butter prices from 1997 till 2010[1]. Source: Jongeneel et al., 2011.

[1] The world market price is the Oceania free on board export price for butter (82% butterfat); the EU effective intervention price is 90% of the reference price; the EU butter price is a representative price and is based on the Dutch producer prices for butter.

A special situation occurred in the months from late 2008 till early 2009, during this period the EU price for butter was significantly below the EU intervention price. This occurred during months when public intervention for butter was not open (the intervention measures are operational from 1 March till 31 August) and so the intervention system did not act as a safety net (Jongeneel et al., 2011).

The changes in volatility of the world and EU butter price can be seen more easily in figure 2.9. Mid-2007 the volatility of the EU price rose above the volatility of the world price. This situation continues until the beginning of 2009 when export refunds and intervention stocks were re-activated and volatility was reduced. At the end of 2009 the world market price again rose above the EU intervention price, correspondingly the volatility started to rise also (although it remains below the volatility of the world price).

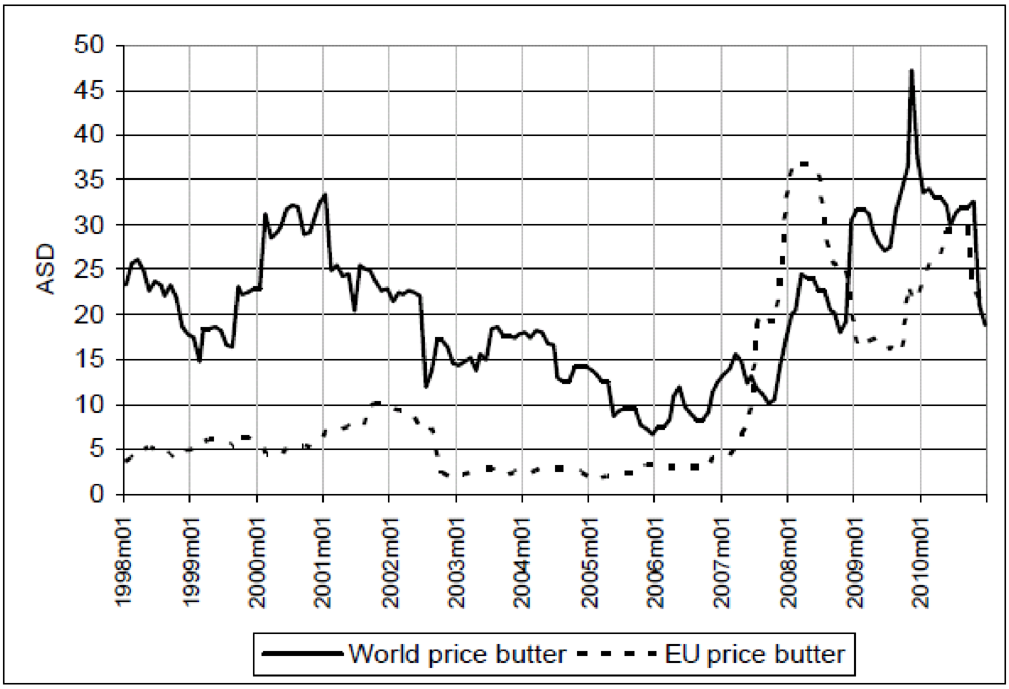

Figure 2.9 – Annualised standard deviation (ASD) for world and EU butter price from 1998 till 2011. Source: Jongeneel et al., 2011.

To summarize, as long as the world market price is below the EU intervention price for butter, EU policies have a positive impact on price stability. When the world market price lies above the intervention price, the volatility of the EU butter price increases significantly. Lowering the effective intervention price for butter made this situation more likely. The same results can be found for SMP and WMP, these results are briefly discussed in Annex A.

2.4 – Functioning of price declining market situations

The buy-out scheme functions by adjusting the supply function in cases of extreme market situations that have a downward effect on the price. This can either be a negative demand shock or a positive supply shock. In figure 2.10 a “simple” supply and demand function are drawn with an initial equilibrium in P and Q. E(P) is the expected price by milk producers at which their (lagged) production decisions are taken. In the case of a negative demand shock the demand function shifts inwards (to the left), now the red demand function instead of the black demand function. Since the farms’ production decision is somewhat static/lagged, the quantity supplied remains at Q in the short term, thus leading to a new market price of P*. In the longer term, farms will cut back their production and the market will find a new equilibrium in Q’ and P’.

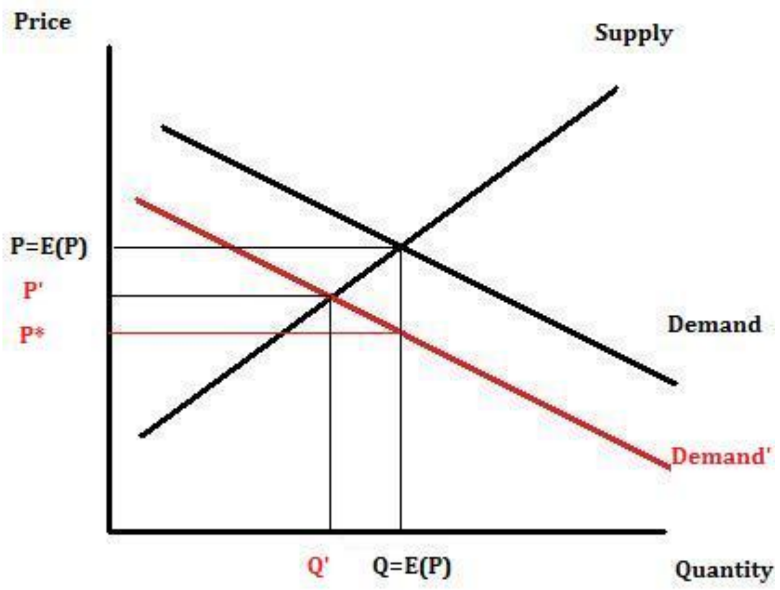

Figure 2.10 – Supply and demand function in case of negative demand shock

In the case of a positive supply shock the supply function shifts outwards (to the right), as can be seen in figure 2.11. This implies that Q’ is the new quantity supplied to the market and the market price decreases to price P’.

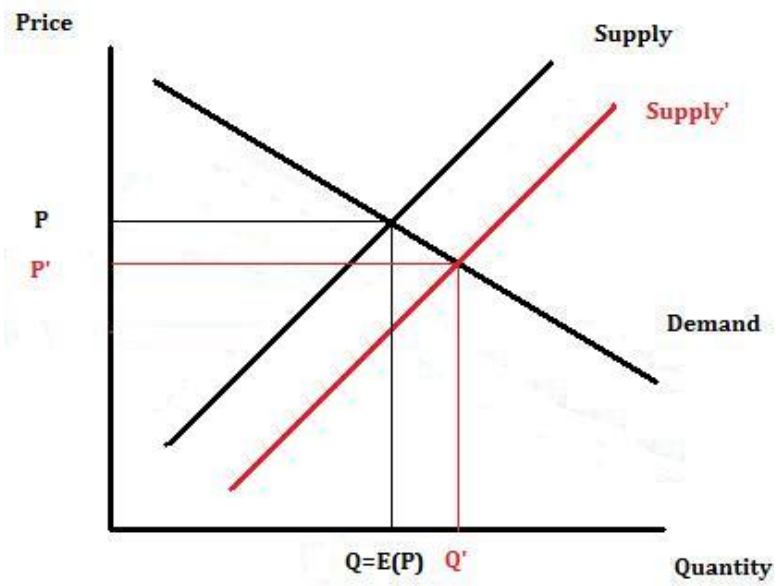

Figure 2.11 – Supply and demand function in case of positive supply shock

Based on Sckokai (2013) a simple model is created in order to illustrate the milk market in extreme market situations. First, the inverse demand function and the supply function have to be determined.

Inverse demand:

$P = \alpha - \beta Q + \varepsilon$ with $\varepsilon \sim N(\mu_\varepsilon, \sigma_\varepsilon^2)$ (2.1)

Supply:

$Q = \gamma + \delta E(P) + \eta$ with $\eta \sim N(\mu_\eta, \sigma_\eta^2)$ (2.2)

The parameters ε and η account for unpredictable shocks in demand and supply. They have the expected size of μ_ε and μ_η, and variances σ_ε^2 and σ_η^2 respectively. Solving the model gives:

$$P = (\alpha - \beta\gamma) - \beta\delta E(P) + (\varepsilon - \beta\eta) \quad (2.3)$$

If ε and η are expected to have zero mean, we get:

$$P = (\alpha - \beta\gamma) - \beta\delta E(P) \quad (2.4)$$

Assuming that the milk producers have rational expectations of the milk price gives:

$$E(P) = \frac{(\alpha - \beta\gamma)}{(1 + \beta\delta)} \quad (2.5)$$

This provides the initial equilibrium (normal circumstances) in point Q, P. However, we considered a negative demand shock (negative ε) and a positive supply shock (positive η). Remember formula (3):

$$P = (\alpha - \beta\gamma) - \beta\delta E(P) + (\varepsilon - \beta\eta)$$

Taking the first order derivate for ε gives:

$$\frac{\partial P}{\partial \varepsilon} = 1 \quad (2.6)$$

Taking the first order derivate for η gives:

$$\frac{\partial P}{\partial \eta} = -\beta \quad (2.7)$$

Formula (6) implies that a negative demand shock is fully translated, while a positive supply shock is translated by the shock times $-\beta$ (see formula (7)). Coefficient β measures the slope of the price equation, the price flexibility is this slope times Q/P.

Price flexibility

The price flexibility is an important subject with regard to the buy-out scheme since the objective is to affect the price by adjusting the quantity supplied. The price flexibility coefficient indicates the percentage change in price when the quantity supplied is changed with 1%. So if β is 2, a 1% change in the quantity supplied results in a 2% change in price (holding al other factors constant). The formula of the price flexibility coefficient is as follows:

$$\epsilon_{pf} = \beta = \frac{\%\ change\ in\ P}{\%\ change\ in\ Q} \tag{8}$$

This can be rewritten into:

$$\epsilon_{pf} = \frac{\frac{(Pnew - Pold)}{Pold}}{\frac{Qnew - Qold}{Qold}} \tag{9}$$

This in turn can be rewritten into:

$$\epsilon_{pf} = \frac{1}{\epsilon_d} \tag{10}$$

In which ϵ_d is the elasticity of demand.

The raw milk demand in the European Union is considered to be inelastic:

$$|\epsilon_d| < 1 \tag{11}$$

Implying that:

$$|\epsilon_{pf}| > 1 \tag{12}$$

So formula (12) tells us that the price flexibility coefficient will be larger than 1. In order to make an assessment about the possible costs of the different buy-out schemes, the price flexibility has to be known in order to estimate the reduction in milk supplied needed to restore the price. Formula (10) shows that the price flexibility can be calculated by means of the elasticity of demand.

2.5 – Theory of an oligopsonistic market

In a perfect market situation (perfect competition) there are many demanders and suppliers, there is free market access and exit, the product is homogeneous and the price is formed by market interaction. This results in a situation where none of the players (demanders or sellers) have enough market power to influence the price. However, an oligopsonistic market has a different market structure. The word oligopsony originates from the ancient Greek words oligoi (few) and opsonia (purchase), indicating a situation where there are only a few demanders compared too many sellers. This results in a situation in which demanders possess market power that enables them to influence the price formation. Demanders will determine the optimal input quantity by matching the marginal cost with the marginal revenue. In a perfect competition, the demander faces a flat supply curve since the quantity it demands does not influences the price of the input. However, in an oligopsonistic market structure, demanders face an upward-sloping supply curve. The quantity they demand influences the price of the input, so with every additional unit of input demanded the price of the input goes up. The demanders in an oligopsonistic market structure will thus use their market power and restrict the input quantity they demand, lowering the price below the competitive equilibrium (Varian, 2006: 471-474).

The EU dairy processing industry represents an oligopsonistic market structure where a small number of large processing companies dominate the dairy market (Tozanli, 1997; Mahon, 2005). Data from Gardebroek et al. (2010) shows that concentration ratios of processors differ between EU members. Four-firm concentration ratios in 2005 for both France and Germany are 0.43, for Poland it is 0.27 and for Italy it is 0.12. The Netherlands shows a three-firm concentration ratio for of 0.77. In general, the industry is more concentrated in Northern European countries (with Germany as an exception) than in Southern and Eastern European countries (Gardebroek et al., 2010). In addition to the oligopsonistic processing sector, the retail sector also represents an oligopsonistic market structure. An oligopsonistic retail segment imposes backward pressure on farmers and the processing industry that depend on the retail chains for their sales (ACCC, 1999). The backward pressure eventually leads to lower farm gate prices. Figure 2.12 provides an overview of the processors' and retailers' share of the consumer price for milk (4% fat and 3.3% protein) for the year 2011 in the different EU member states. In 2011 processors and retailers had the highest share of consumer price in Luxembourg (75%) and the highest share per kilogram sold in Italy (€ 107.1 per 100 kg) (Ernst & Young, 2013).

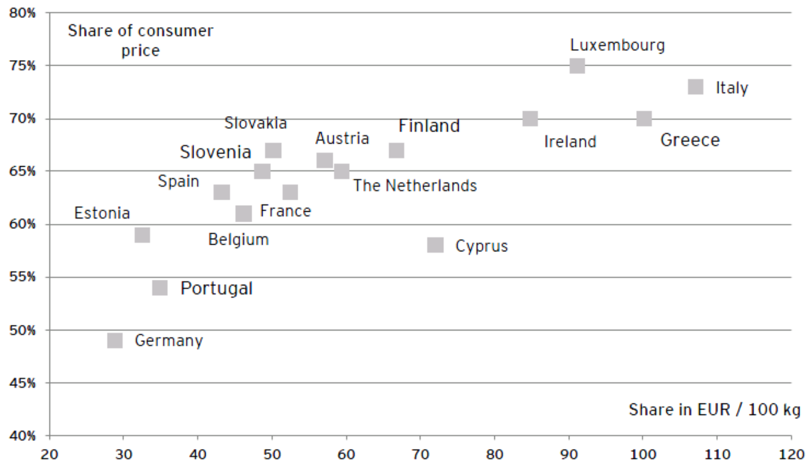

Figure 2.12 – Share of processors and retailers for milk (4% fat and 3.3% protein) for the year 2011 in consumer price (vertical axis) and in Euros per 100 kg sold. Source: Ernst & Young, 2013.

The oligopsonistic market structure of the EU dairy market is of influence on the price formation and thus can influence the working of the buy-out scheme. Appendix B shows how in a future research the oligopsonistic market structure can be incorporated and how it can influence the working of the buy-out scheme.

2.6 – The different buy-out schemes

There are different types of buy-out schemes, with the first difference in being voluntary or mandatory. Voluntary implies that a “financial” incentive must be created in order to convince dairy farms to reduce their production, where mandatory implies that dairy farms have to reduce their production if a European or national agency decides it is necessary. The second major difference is in how the production is reduced. This reduction can be achieved by reducing the number of milk cows or by reducing the milk volume produced (independent of the number of milk cows). Another type of buy-out scheme can be found in, for example, the tomato sector. In the case the tomato price drops below a certain threshold, quantities of tomatoes are removed from the market. In the Netherlands, the auctions have the responsibility to buy (at very low prices) quantities of tomatoes from producers and to remove them from the market. Tomatoes cannot be stored and as a result cannot be introduced to the market again. In this way no disturbances occur later in the market or in other markets. However, this type of buy-out scheme is politically troublesome (for example because a large fraction of the world population lacks access to good quality raw milk). Therefore the “removal” of milk is not considered an option.

2.6.1 – Reducing the number of milk cows – CWT herd retirement program

The Cooperatives Working Together (CWT) herd retirement program in the United States is a voluntary supply management approach that is privately funded. The program was initiated in July 2003 by the National Milk Producers Federation, a trade association of dairy cooperatives. Members of participating dairy cooperatives and participating independent dairy farms fund the program through an assessment of 10 dollar cents per 100 kg of milk marketed. Participation in the CWT has ranged between 67% van 74% of all milk marketed in the U.S. (Brown et al., 2010). Because CWT is privately owned, it is not subject to World Trade Organization (WTO) regulations, improving the flexibility and adaptability of the program to the changing circumstances surrounding the dairy industry (Parkinson, 2008).

Initially CWT consisted of three methods: herd retirement, reduced production marketing (RPM) programs and dairy export incentives. However, little interest has been shown in the RPM programs. It has only been used in the beginning and consequently was dropped. The RPM program attempted to reduce national milk supplies by accepting bids from producers who agreed to temporarily reduce their output by an agreed upon amount (Parkinson, 2008). Unfortunately, no information could be found about the set up of the RPM program and on the possible reasons why it failed. Therefore it was not possible to discuss this further.

Of the two methods that are still operational, the herd retirement program has been the most heavily used part of the CWT programs. Roughly 90% of the funds have been used for herd-retirement (Brown et al., 2010). Since this research focuses on buy-out schemes, the herd retirement method is the only method of the CWT program that is discussed.

The CWT program periodically solicits bids from eligible dairy farms (those paying an assessment fee) representing the amount of compensation they are willing to accept in order to slaughter their dairy herds. In order to determine when to hold a herd retirement, the CWT has set guidelines including: all-milk price, cost of milk production, milk-feed price ratio, dairy cow numbers, milk production and dairy cow culling. In order to accept a herd, an audit process is held that includes examining current milk production relative to the previous year to ensure that the herd has not seen significant changes in production prior to be accepted. If the audit is successful the dry and milking cows are CWT tagged and the producer is responsible to send the animals to slaughter in the next 15 days. Once the tags are returned to CWT, the producer receives his/her check (Brown et al., 2010).

Producers have to sell all of their milking cows and if they have interest in multiple operations, they must offer cows from all of the operations if they wish to participate. Furthermore, a producer has to stay out of production for a year if they want to receive their full payment, producers are paid 90 % of their bid when accepted but the last 10 % plus interest is paid twelve months later if the producer is still out of milking (Brown et al., 2010).

In the original herd retirement rules, regional safeguards were included to ensure a balanced approach to removing cows. This tended to cause average bids across regions to vary when the safeguard level was triggered. The level of average bids has varied with economic conditions. In tough economic times, average bids tended to be lower than in strong financial times (Brown et al., 2010). The herd retirement program was ramped up significantly in late 2008 as a result of the serious decline of milk prices in the industry (Brown et al., 2010).

2.6.2 – Reducing the production volume of milk – a European Milk Board proposal

The European Milk Board (EMB) has elaborated on an EU supply management system in which a monitoring body is established on a European level. This body will monitor the European dairy market and collect data such as production costs, farm-gate prices, retail prices, milk production and milk demand. Based on the data collected, an upper and lower limit of the target farm-gate price for 1 kg milk is created. This in turn creates a price range of what is seen as an acceptable farm-gate price. If the market farm-gate price goes through the minimum limit or threshold, a buy-out scheme is activated to adjust the ratio of supply to demand (through an adjustment in the supply of raw milk) (EMB, 2012).

The desired reduction in milk production can be achieved through a mandatory process or a voluntary process. A mandatory process requires the continuation of an individual farm volume limit which is universally binding, thus ensuring that every milk producer adheres to the stipulated volumes. This process is very similar to the milk quota system with the difference that the volume is adjusted depending on the market situation (EMB, 2012). Since the milk quota system was officially abolished on the 1st of April, 2015, it is very unlikely that this variant of a buy-out scheme is realistic. A voluntary process will require financial incentives for dairy farms to cut back their production volume. An important issue hereby is the level of the remuneration. If the remuneration is too low, participation might be too low to bring the price back in the target range. If the remuneration is higher than strictly necessary, the costs will be higher than necessary and dairy farms will be overcompensated. In general, two options exist in order to establish the level of remuneration, the monitoring body can set the remuneration based on the data collected or milk producers place biddings at which remuneration they are willing to cut back their production.

2.6.3 – Buy-out scheme implemented in empirical model

Since the aim of the buy-out scheme is to temporary adjust the supply of raw milk to the market, and there is no structural oversupply of milk to the market, it is preferred to temporary withdraw milk production from the market, thus leaving the animal stock unchanged (Sckokai, 2013). This makes a herd reduction program like the CWT not preferable. Fink-Kessler et al. (2013) stated five actions that milk producers can take in order to adjust their production volume, (1) reducing the use of concentrated feed, (2) feeding calves with full milk, (3) extending dry period for cows, (4) insemination of heifers later, or (5) selling old dairy cows earlier than planned. The main question hereby is the percentage amount of production reduction that is needed and which amount can be achieved. A proposal in the European Parliament talks about a production cut by at least 5% (Dantin, 2011). However, experiences of the 2008/2009 milk crisis have shown that a reduction in the annual milk volume by 1% up to 2% may be enough to stabilise the price (Fink-Kessler et al., 2013).

In the event of a severe imbalance in the market for milk and milk products, the European Commission could consider a system based on Article 186 of the single CMO ("disturbance clause"). The scheme would allow milk producers, on a voluntary basis, to reduce their deliveries against compensation. This supplementary measure is designed to be applied only in the context of exceptional disturbances, in order to limit the market price fall (European Commission, 2010; Ernst & Young, 2013). So, although a compulsory system may allow somewhat quicker adaptations to changes in demand (Theuvsen, 2013), a voluntary scheme is considered by the European Commission. In this research, both systems, a mandatory and a voluntary scheme, are applied. In the European milk market model, discussed in section 3.1, a mandatory scheme is assumed. In the dairy farm model, discussed in section 3.2, a voluntary scheme is assumed. In this way more insight is provided into the differences of the two systems.

It is possible that the buy-out scheme is financed through the current CAP budget for intervention in the EU dairy sector, so fully by the European Union. This was advocated by the EMB in their proposal (EMB, 2012). However, it might also be the case that in order to finance the buy-out scheme, dairy farms will face some sort of payment. One way of financing the scheme is by imposing a levy on all dairy farms in the EU. This will prevent any free-rider problems, these problems can arise since every EU dairy farm will benefit from the higher market price. In section 3.2.2, more options of funding the scheme are discussed. However, due to the many uncertainties around the funding of the scheme and due to a time-constraint, it was assumed in the empirical models that the EU would fund the scheme.

H3 – Materials and Methods

In this chapter the effects of a buy-out scheme are discussed from different points of view, namely that of the EU and of an individual dairy farm. Therefore, two models are needed; the first one models the European milk market and the second one models a profit function of a dairy farm. In section 3.1 the European milk market model is constructed and discussed, here a mandatory scheme is assumed. This section starts with the analytical framework in section 3.1.1, followed by the construction of the empirical model in section 3.1.2, and finishes with section 3.1.3 in which the model is calibrated and the scenarios for analyses are constructed. Section 3.2 addresses the dairy farm model, here a voluntary scheme is assumed, and has the same set-up as section 3.1. So, first the analytical framework is presented in section 3.2.1. This is followed by the construction of the empirical model in section 3.2.2. After which, the calibration of the model in section 3.2.3 finishes this chapter.

3.1 – European milk market model

3.1.1 – Analytical framework

This section starts with the simplest framework, namely a buy-out scheme in a market without trade (autarky). The autarky framework is followed with a framework including trade but with a difference in the country's size, small and large. The small country hypothesis assumes that the share of the country's supply and demand on the world market is too small to influence the world market price. Whereas the quantities supplied and demanded by a large country influence the world market price.

Autarky

Figure 3.1 shows the working of a mandatory buy-out scheme after a demand contraction in a framework of autarky (no trade). In the case of a mandatory scheme, the new supply function (S') is comparable to a supply function under a production quota. If a voluntary scheme was to be implemented the new supply function would not be kinked, but the supply function would shift to the left. This is because some farmers will cooperate in the scheme and others would increase their production. The demand contraction is represented by a shift from the demand function, D, to the demand function, D'. This results in an equilibrium in which the market price and the quantity supplied are both lower, the market price decreases from P to P' and quantity from Y to Y' . If this new market price is equal or beneath the 'intervention' price, the buy-out scheme is activated. Dairy farms are offered a remuneration in order to decrease their production volume, this in turn will change the overall supply function of the country. A certain reduction of the total supply is pursued ($\bar{Y}$), which is represented by the new supply function (S'). As a result of the decline in milk quantity supplied to the market, the market price becomes $\bar{P}$ instead of P'. Since the production is below the equilibrium, the marginal costs are not equal to the market price. As a result of the buy-out scheme the marginal cost of production are now equal to MC.

Figure 3.1 also illustrates the general welfare effects associated with the introduction of the buy-out scheme to the milk market. Compared to the situation that arose after the negative demand shock, the consumer welfare decreases with $A + C$. In this model it is not possible to illustrate the change in welfare for the individual dairy farm. The producer surplus in this model is increased with $A - D$. In order to compensate the producers for the production restriction, a remuneration will be paid. This remuneration must at least be equal to the lost profit over the lost production. The lost production is equal to $(Y' - \bar{Y})$. The lost profit is equal to the market price under the buy-out scheme, $\bar{P}$, minus the marginal cost under the buy-out scheme, MC. So, the remuneration and the cost of the scheme, is equal to $(\bar{P} - MC) * (Y' - \bar{Y})$. This is equal to the rectangle $C + D + E + F$.

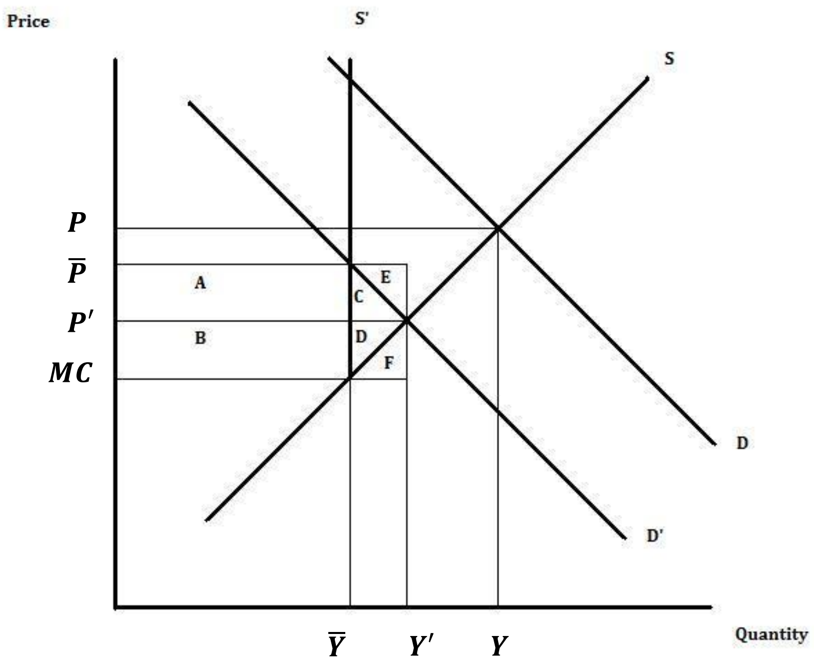

Figure 3.1 – Working of a buy-out scheme after a negative demand shock in autarky.

Small country hypothesis

As concluded before, the price volatility on the European milk market mainly arises from fluctuations on the world market. Therefore, it is of interest to include the world market and the possibility of trade. The small country hypothesis implies that the country has no effect on the world market through its supply and demand quantities; these quantities are too small to influence the world market. This implies that the activation of a buy-out scheme in a small country without effective border measures, cannot influence the market price. The market price within the country can only be stabilized by protecting the internal market from the world market e.g. through an adjustment of the import tariffs.

Large country hypothesis

We will now investigate the working of a buy-out scheme when the large country hypothesis applies, assuming that a mandatory scheme is applied and no effective border measures are present (free trade), so the world market price is equal to the domestic price ($P_2^d = P_1^d$). Figure 3.2 provides an overview of the effects of a demand contraction on the world market and the introduction of a buy-out scheme. The demand contraction on the world market shifts the demand function of the ROW inwards, it becomes MD' instead of MD. The new equilibrium on the world market is found in $\widetilde{P_2^d}$ and $\tilde{X}$. This results in a new domestic price of $\widetilde{P_1^d}$, at which $\widetilde{Y_1^d}$ is demanded and $\widetilde{Y_1^s}$ is supplied in the home country. In order to increase the new market price ($\widetilde{P_1^d}$), a buy-out scheme is activated in the home country. The new supply function in the home country becomes S', the quantity supplied by the home country becomes $\overline{Y_1^s}$. This changes the supply function on the world market from XS to XS', which results in a new world market price ($\overline{P_2^d}$). Since free trade is assumed, $\overline{P_1^d} = \overline{P_2^d}$, and at $\overline{P_1^d}$ the demand in home country is $\overline{Y_1^d}$.

In figure 3.2, the consumer welfare decreases with the parallelogram $A + B + C$, as compared to the situation that arose after the negative demand shock. The overall producer surplus increases with $A + B + C + D - H$. The cost of the scheme is given by the rectangular $E + F + H + I + J$, which is equal to $(\overline{P_1^d} - MC) * (\ddot{Y}_1^s - \overline{Y_1^s})$. $\ddot{Y}_1^s$ is the quantity supplied in the home country at price $\overline{P_1^d}$ if no restriction was present.

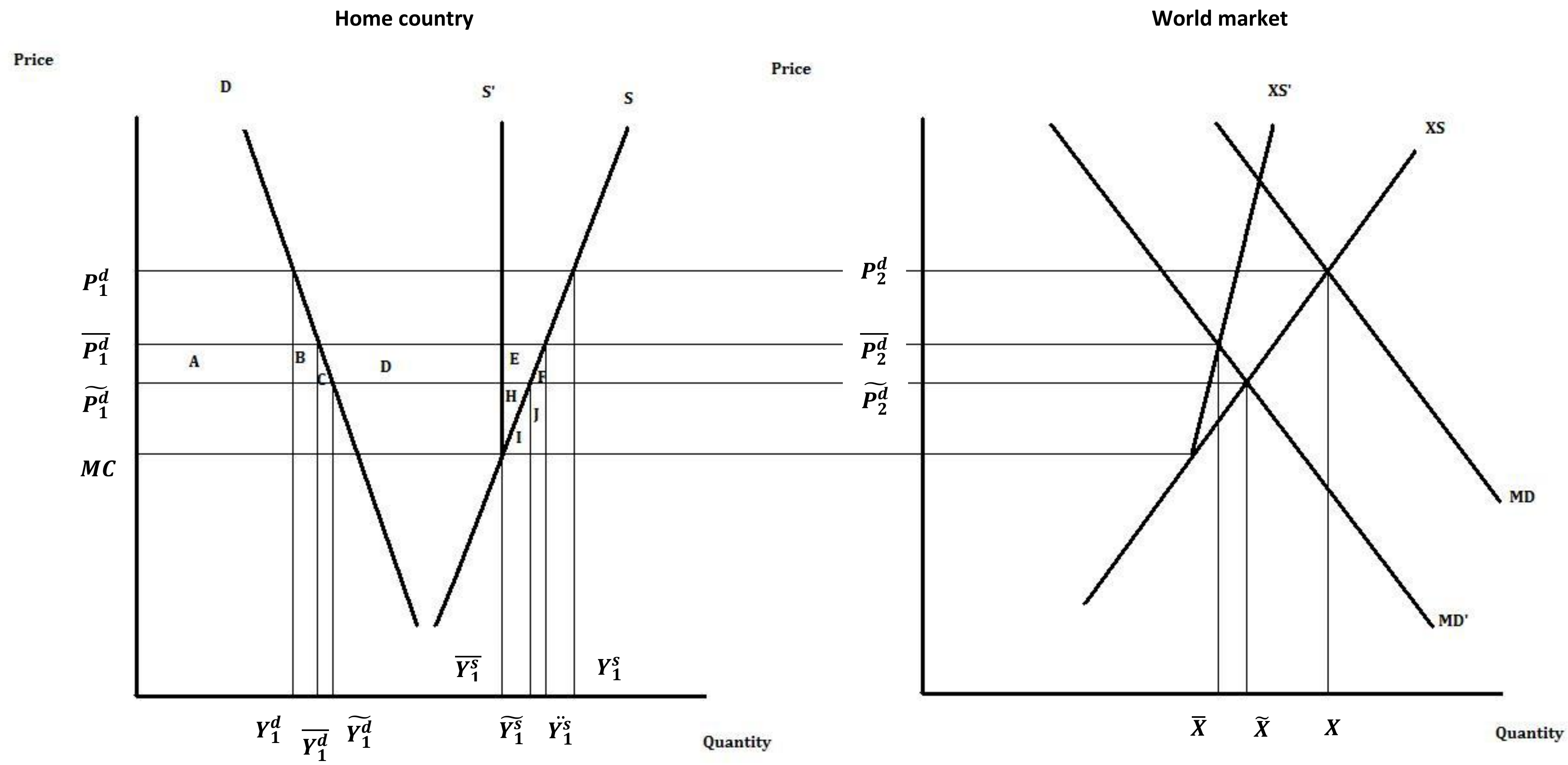

Figure 3.2 – Working of a buy-out scheme after a demand contraction on the world market (large country hypothesis).

3.1.2 – Empirical Model

In order to simulate the implementation of a buy-out scheme in the European milk market, an excess demand model is constructed. This model is a stylized representation of the EU-world milk market, in which the supply and (derived) demand are defined in terms of milk equivalents. The world market is represented by the excess demand of the rest of the world (ROW). This excess demand is met by the excess supply of the EU through exports. It is assumed that the world market is in equilibrium, formula (3.4) indicates this equilibrium constraint for the world market. Both demand functions for the EU and the ROW are presented by formula (3.1). For now we assume that the prices in the EU and on the world market are in equilibrium, see formula (3.5).

$$Y_i^d = \alpha_i * p_i^d + \beta_i + \sigma_i \tag{3.1}$$
$$Y_1^s = \gamma_1 * p_1^d + \delta_1 \tag{3.2}$$
$$Y_2^s = Y_1^s - Y_1^d \tag{3.3}$$
$$Y_2^d = Y_2^s \tag{3.4}$$
$$p_1^d = p_2^d \tag{3.5}$$

Where:

Y_i^d	milk demand in country i (1=EU, 2=ROW)
Y_i^s	milk supply in country i (1=EU, 2=ROW)
p_i^d	domestic milk price in country i (1=EU, 2=ROW)
α_i	slope demand function in country i (1=EU, 2=ROW)
β_i	intercept supply function in country i (1=EU, 2=ROW)
σ_i	demand shock in country i (1=EU, 2=ROW)
γ_1	slope supply function in EU
δ_1	intercept supply function in EU

Buy-out scheme

Now the buy-out scheme of the EU is added to the model. The mandatory scheme will restrict the production to a certain share of the old production volume, see formula (3.6). If the buy-out scheme targets to remove 2% of the old production volume, $buyout$ is equal to 0.98. As a result, the marginal costs of production and the price are no longer identical and formula (3.2) needs to be rewritten into formula (3.7).

$$Y_1^s = Yo_1^s * buyout \tag{3.6}$$
$$Y_1^s = \gamma_1 * MC_1 + \delta_1 \tag{3.7}$$

Where:

$buyout$	targeted production volume compared to old production volume
MC_1	marginal cost of production in EU under the buy-out scheme

Export subsidies

Although the EU currently does not grant export subsidies for dairy products, the measure still exists and might be reintroduced if necessary in extreme market situations. Therefore, it was decided to include export subsidies into the model, thus enabling us to compare the effects and the efficiency of the buy-out scheme to the effects and the efficiency of export subsidies. There are different approaches to the introduction of export subsidies to the model, these are:

$p_1^d = p_2^d + sub$	specific subsidy	(3.8)
$p_1^d = (1 + sub) * p_2^d$	ad valorem subsidy	(3.9)
$p_1^d = (1 + sub) * p_2^d$	variable export subsidy, p_1^d is fixed	(3.10)

Where:
sub EU export subsidy

If the current mechanism is applied, the EU aims at stabilizing the price at a certain level. So it aims at fixing p_1^d at a certain level, with the export subsidy covering the difference between the world and EU price. Therefore formula (3.10) is the most obvious one to apply in the model.

Import tariff

Almost all countries in the world have import tariffs on dairy products in place and the sizes of these tariffs differ substantially. An import tariff works identical as export subsidies, resulting in three comparable approaches to introduce import tariffs to the model as with the case of export subsidies.

$p_2^d = p_1^d + T$ specific tariff (3.11)
$p_2^d = (1 + t) * p_1^d$ ad valorem tariff (3.12)
$p_2^d = (1 + t) * p_1^d$ variable import tariff, p_1^d is fixed (3.13)

Where:
T, t import tariff

With respect to using one of the formulas to implement import tariffs in the model, we have to recall that the model uses excess demand. In the excess demand function the current ROW import tariffs and the transport costs are already included. Furthermore, it is assumed that the ROW will not change their tariffs in response to the EU actions (either the implementation of a buy-out scheme or the reactivation of export subsidies). Therefore, none of the formulas (23, 24, 25) are applied in the model.

3.1.3 – Data, calibration & scenarios

Two datasets were constructed for calibrating the empirical model. It was decided to use the first dataset (table 3.1) to calibrate the empirical model, and the second dataset (table C1) to perform a sensitivity analysis (see Annex C). In both datasets a milk price of €341.6 per tonne of milk is used, this is the average milk price paid in 2012 by the 17 largest dairy enterprises in Europe plus three large dairy enterprises outside the EU (EMI, Fonterra and USA class III) (LTO, 2013). Additionally, the EU export to the ROW is 14 million tonnes in both datasets.

Besides the similarities of the two datasets, they differ in two ways, the milk supply quantities and the used supply and demand elasticities. In the first dataset, the supply quantities are based on data from the IFCN. According to the IFCN about 620 million tonne of cow milk was produced globally in 2012, of which 141 million tonnes of cow milk was produced in the EU (IFCN, 2013). The second dataset is based on data provided by Scheepstra (2013). Here buffalo milk was included in the world milk market, leading to an increase of the total world supply from 620 million to 737 million tonnes of milk (Scheepstra, 2013). Furthermore, the EU supply of raw milk is increased from 141 million to 152.5 million tonnes of milk. With respect to the supply and demand elasticities, the first dataset uses the supply elasticity (0.4) and demand elasticity (-0.4) stated in two different papers (Soregaroli and Trevisiol, 2005; Jongeneel and Tonini, 2009). The supply elasticity of 0.4 is the average EU-27 supply elasticity from the European Dairy Industry Model (EDIM), where the demand elasticity of -0.4 is the average elasticity for France and Italy from EDIM. The second dataset uses the elasticity values provided in the FAPRI – Elasticity Database, a supply elasticity of 0.13 and a demand elasticity of -0.06.

Table 3.1 – First dataset. Quantities in million tonnes of milk equivalents and price in euro per tonne of milk.

	EU
Supply	141.00
Demand	141.0-14.0 = 127.00
Export	14.00
Supply elasticity	0.40
Demand elasticity	-0.40
Price	€ 341.60

Sources: Supply quantities – IFCN, 2013, Export – PZ, 2013, Elasticities – FAPRI, 2014, Price – LTO, 2013.

With the data provided in table 3.1, a calibration of the model was performed in order to find the values for the different slopes and intercepts. Recall that the formula of the elasticity of demand is represented by formula (3.14). Since the slope α_i is equal to $\frac{\partial Y}{\partial p}$, we can substitute formula (3.14) into formula (3.1) and rearranging we find formula (3.15). When α_i is known, formula (3.1) can be rewritten into formula (3.16) in order to calculate the intercept of the demand function β_i.

$$\varepsilon_i^d = \frac{\partial Y}{\partial p} * \frac{P}{Y} \quad (3.14)$$
$$\alpha_i = \varepsilon_i^d * (Yo_i^d / po_i^d) \quad (3.15)$$
$$\beta_i = Yo_i^d - \alpha_i * po_i^d \quad (3.16)$$

Where:

ε_i^d	initial elasticity of demand in country i (1=EU, 2=ROW)
Yo_i^d	initial demand in country i (1=EU, 2=ROW)
po_i^d	initial domestic milk price in country i (1=EU, 2=ROW)

Since the excess supply of the EU is the supply function of the ROW, we first need to find the slope and intercept values of the supply function of the EU. Recall that the formula of the supply elasticity is represented by formula (3.17) and that the slope γ_1 is equal to $\frac{\partial Y}{\partial p}$. Substituting formula (3.17) into formula (3.1) and rearranging we find formula (3.18). Now that the slope of the EU supply function is known, formula (3.1) can be rewritten into formula (3.19) in order to find the intercept of the EU supply function, δ_1. The slope and intercept of the ROW supply function can then be found by subtracting the slope α_1 and intercept β_1 of the EU supply function from the slope γ_1 and intercept δ_1 of the EU demand function, see formulas (3.20) and (3.21).

$$\varepsilon_1^s = \frac{\partial Y}{\partial p} * \frac{P}{Y} \quad (3.17)$$
$$\gamma_1 = \varepsilon_1^s * (Yo_1^s / po_1^d) \quad (3.18)$$
$$\delta_1 = Yo_1^s - \gamma_1 * po_1^d \quad (3.19)$$
$$\gamma_2 = \gamma_1 - \alpha_1 \quad (3.20)$$
$$\delta_2 = \delta_1 - \beta_1 \quad (3.21)$$

Where:

ε_1^s	initial elasticity of supply in country i (1=EU, 2=ROW)
Yo_1^s	initial supply in country i (1=EU, 2=ROW)

Now that the model is constructed and calibrated, the scenarios can be created in order to perform a scenario analysis. The aim of the analysis is to analyze the effects of a buy-out scheme. In order for a buy-out scheme to be activated, the market price of milk must have reached the predetermined intervention price of milk. Since milk is a highly perishable product, a sudden positive supply shock is unlikely. A sudden negative demand shock driving the raw milk price down, is more likely. Therefore, a negative excess demand shock of the rest of the world is assumed. The size of the negative excess demand shock is 25%, which corresponds to -3.5 million tonnes of milk. In order to reveal the effects of this negative excess demand shock, the first scenario will be the base scenario only covering this shock. In order to assess the welfare effects of the buy-out scheme, it is assumed that EU decides to intervene in the milk market. The EU can currently do this by reactivating the usage of export subsidies. It is interesting to compare the effect of intervening trough the usage of export subsidies with the effect of intervening through implementation of a buy-out scheme. Therefore, the second scenario assumes an intervention the implementation of a buy-out scheme, while the third scenario assumes the usage of export subsidies.

In order to compare the different scenarios with each other, the welfare costs of the involved stakeholders have to be quantified. This quantification is done with the use of the Pigouvian welfare function. This function combines the changes in producer surplus, consumer surplus and the costs of the intervention, either the buy-out scheme or the export subsidies, in order to come to the overall change in social welfare. The consumers, demanders, can also be companies; for example: processing companies. If that is the case, the consumer surplus equals the change of surplus (i.e. profit) of the processing companies. Formula (3.22) gives the Pigouvian welfare function, hereby assuming that the changes in producer surplus, consumer surplus and government budget are valued equally (Gardebroek and Peerlings, 2010; p. 159-160).

$$\Delta W = \Delta PS + \Delta CS + \Delta C \qquad (3.22)$$

Where:

ΔW change in total welfare
ΔPS change in producer surplus
ΔCS change in consumer surplus
ΔC intervention costs made by either the buy-out scheme or the export subsidies.

In order to compare the 'direct' effects of the implementation of a buy-out scheme or of export subsidies, the percentage change of supply (ΔY_i^s), demand (ΔY_i^d), and price (Δp_i^d) are calculated for both countries, see formulas (3.23), (3.24) and (3.25). Additionally, the changes in producer surplus, consumer surplus and intervention costs for the EU are calculated in formula (3.26) till formula (3.30). In the excess demand model, the excess demand function is found by subtracting the demand function of the ROW from the supply function of the ROW. Furthermore, no policy measure is taken in the ROW, thus no intervention costs ΔC are made in the ROW. This implies that we can directly calculate the total welfare change in the ROW by using formula (3.32), the consumer and producer surplus changes are already included.

If the buy-out scheme is implemented, p_1^d is no longer equal to the MC_1. Therefore, in scenario II the MC_1 is stated and the ΔPS_1 is calculated differently by using formula (3.28) instead of (3.27). Furthermore, ΔC_1 is represented by two different formulas calculating the costs of the buy-out scheme and the costs of the export subsidies (formula 3.29 and formula 3.30). Formula (3.29) is equal to the formula $(\overline{P_1^d} - MC_1) * \left(\ddot{Y}_1^s - \overline{Y_1^s}\right)$, which was obtained based on figure 3.2.

$$\Delta Y_i^s = \left(\frac{(Yn_i^s - Yo_i^s)}{Yo_i^s}\right) * 100 \quad (3.23)$$

$$\Delta Y_i^d = \left(\frac{(Yn_i^d - Yo_i^d)}{Yo_i^d}\right) * 100 \quad (3.24)$$

$$\Delta p_i^d = \left(\frac{(pn_i^d - po_i^d)}{po_i^d}\right) * 100 \quad (3.25)$$

$$\Delta CS_1 = -(\left(0.5 * \alpha_1 * {pn_1^d}^2 + \beta_1 * pn_1^d\right) - \left(0.5 * \alpha_1 * {po_1^d}^2 + \beta_1 * po_1^d\right)) \quad (3.26)$$

$$\Delta PS_1 = (\left(0.5 * \gamma_1 * {pn_1^d}^2 + \delta_1 * pn_1^d\right) - \left(0.5 * \gamma_1 * {po_1^d}^2 + \delta_1 * po_1^d\right)) \quad (3.27)$$

$$\Delta PS_1 = \left(0.5 * \gamma_1 * {MC_1}^2 + \delta_1 * MC_1\right) + \left(Yn_1^s * (pn_1^d - MC_1)\right) + ((Yo_1^s - Yn_1^s) * (pn_1^d - MC_1)) - (0.5 * \gamma_1 * {po_1^d}^2 + \delta_1 * po_1^d) \quad (3.28)$$

$$\Delta C_1\ buy-out\ scheme = (Yo_1^s - Yn_1^s) * \left(pn_1^d - MC_1\right) \quad (3.29)$$

$$\Delta C_1\ export\ subsidies = (Yn_1^s - Yn_1^d) * (pn_2^d - pn_1^d) \quad (3.30)$$

$$\Delta W_1 = \Delta PS_1 + \Delta CS_1 + \Delta C_1 \quad (3.31)$$

$$\Delta W_2 = -(\left(0.5 * \alpha_2 * {pn_2^d}^2 + \beta_2 * pn_2^d\right) - \left(0.5 * \alpha_2 * {po_2^d}^2 + \beta_2 * po_2^d\right)) \quad (3.32)$$

Where:

ΔY_i^s	supply change in percentage in country i (1=EU, 2=ROW)
ΔY_i^d	demand change in percentage in country i (1=EU, 2=ROW)
Δp_i^d	price change in percentage in country i (1=EU, 2=ROW)
ΔCS_1	change in consumer surplus in EU
ΔPS_1	change in producer surplus in EU
$\Delta C_1\ buy-out\ scheme$	change in intervention costs due to the buy-out scheme in EU
$\Delta C_1\ export\ subsidies$	change in intervention costs due to the export subsidies in EU
ΔW_i	total welfare change in country i (1=EU, 2=ROW)
Yn_i^s	milk supply in new situation in country i (1=EU, 2=ROW)
Yo_i^s	milk supply in initial situation in country i (1=EU, 2=ROW)
Yn_i^d	milk demand in new situation in country i (1=EU, 2=ROW)
Yo_i^d	milk demand in initial situation in country i (1=EU, 2=ROW)
pn_i^d	milk market price in new situation in country i (1=EU, 2=ROW)
po_i^d	milk market price in initial situation in country i (1=EU, 2=ROW)
MC_1	marginal cost of production in EU under the buy-out scheme

3.2 – Dairy farm model

3.2.1 – Analytical framework

The primary objective of the introduction of a buy-out scheme is to protect dairy farms in the EU from very low prices. So far we have created a European market model in which the overall welfare effects could be illustrated, with the assumption of a mandatory buy-out scheme. Now the analytical framework is discussed in which the effects of a voluntary buy-out scheme on the individual dairy farm can be assessed. In figure 3.4 these effects are illustrated. The individual dairy farm is a price taker, implying that actions of the farm do not have an influence on the demand curve. As a result, the dairy farm faces a flat demand curve and supplies at the interception with the supply curve (i.e. his inverse marginal cost curve). In the normal situation, without a buy-out scheme, the farmer will supply quantity Y and receive price P. The dairy farm thus has a revenue of $D + E + G + F + H + I$ and costs of $F + H + I$. Therefore, profit equals $D + E + G$.

If a voluntary buy-out scheme is implemented, the dairy farm can choose to participate or not. The new market price under the scheme becomes $\overline{P}$. If the dairy farm participates in the scheme, the supply is restricted with a certain amount. Its supply function becomes kinked, see S', and the new quantity supplied to the market will be $\overline{Y}$. Since the dairy farm is participating, a remuneration is received. This remuneration is in place to compensate the dairy farm for its restriction in production. It is assumed that the remuneration is equal to $(\overline{P} - \overline{MC}) * (Y - \overline{Y})$, which is the area $B + E + F$. So, if the dairy farm participates it has a profit of $A + D + G + B + E + F$. Compared to the situation without the buy-out scheme, this is a positive profit change of $A + B + F$.

However, a dairy farm might also choose not to participate in the scheme. In this case, the farm does not face a supply restriction. Since the implementation of the scheme results in a higher market price, $\overline{P}$, the dairy farm will increase its quantity supplied to $\tilde{Y}$. This results in a profit for the dairy farm of $A + B + C + D + E + G$. Compared to the situation without the buy-out scheme, this is a positive profit change of $A + B + C$.

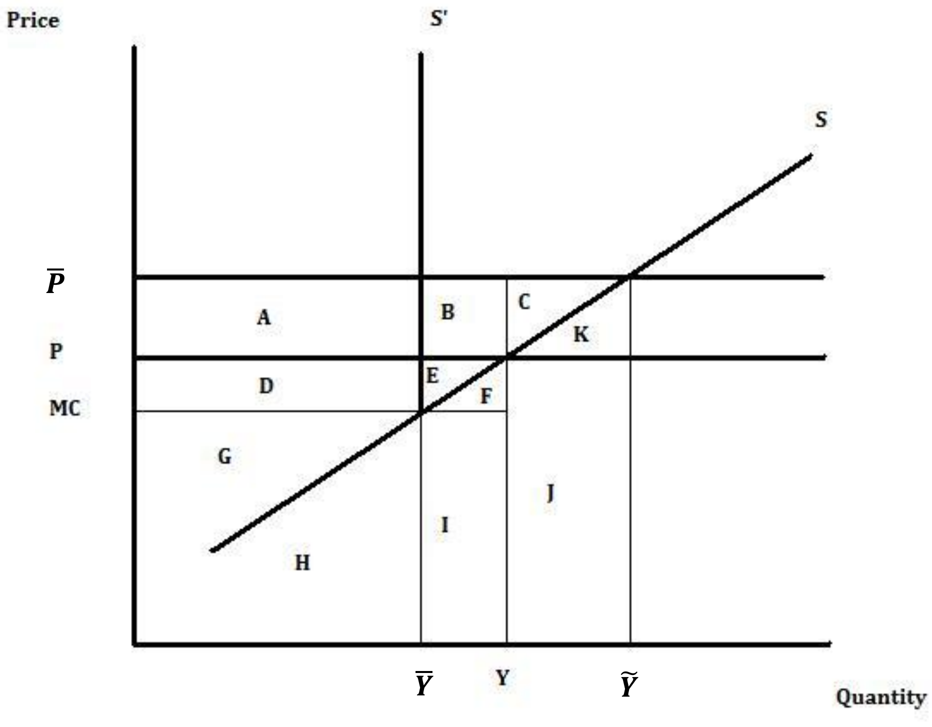

Figure 3.4 – welfare effects of the buy-out scheme for the individual dairy farmer.

So far we have compared the new situation for dairy farms, participation or non-participation, with the pre-buy-out scheme situation. However, since farms cannot influence the implementation of the buy-out scheme, they can only decide to participate or not, it is more interesting to comparing the difference in profit obtained through participation and through non-participation. Profit of the dairy farm in case of participation is given by: $A + D + G + B + E + F$ and in case of no-participation it is: $A + B + C + D + E + G$. The difference in participating or not can thus be given by $-C + F$.

The dairy farmer is indifferent towards participation if $F = C$. If $F < C$, the dairy farmer will not participate in the scheme. If $F > C$, the dairy farmer will participate in the scheme. Setting the remuneration too high leads to unnecessary over-compensation of participating dairy farms. Note that the cost structure of producing milk is very different among European countries, so setting an EU wide remuneration is likely to have distributional impacts.

3.2.2 – Empirical Model

In order to calculate the effects illustrated in figure 3.4 more precisely, a profit maximizing problem of an individual dairy farm is constructed. It is assumed that a dairy farm is rational and that it strives to maximize his profits. Dairy farm i faces the following profit maximizing problem:

$$\pi_i(p, w, z_i) = argmax_{y_i}(p * y_i - C_i(y_i, w, z_i)) \qquad (3.33)$$

Where:

π_i	profit of farm i
p	price of milk
y_i	production of farm i
w	vector of variable input prices
z_i	vector of fixed inputs of farm i
C_i	cost function of farm i

Taking the first the first order condition of equation (3.33) and rearranging gives that the price of milk equals marginal costs:

$$p = \frac{\partial C_i(y_i, w, z_i)}{\partial y_i} \qquad (3.34)$$

Solving (3.34) gives the optimal quantity of output supplied.

Participation constraint

Now we assume that a buy-out scheme is implemented and that a dairy farm has to participate or not. The level of remuneration determines the choice of the dairy farm. This is assuming that the dairy farm does forego any profits by reducing their production volume. Theuvsen (2013) points out that there are dairy farms who do not forego any profits by reducing their production volume since their marginal costs already exceed milk prices. If that is the case, dairy farms will already profit if the decrease their production, so remuneration results in overcompensation of those farms.

The profits obtained through participation need to be at least equal, or higher, than the profits obtained through non-participation. If a dairy farm participates it has to reduce the production of milk to $\bar{y}_i$ instead of y_i. We thus have two profit maximization functions, namely formula (3.35) for the farm that does not participate, and formula (3.36) for the farm that does participate.

$$\tilde{\pi}_i = \bar{p} * \tilde{y}_i - \tilde{C}_i(\tilde{y}_i, w, z_i) \qquad (3.35)$$

$$\bar{\pi}_i = \bar{p} * \bar{y}_i - \bar{C}_i(\bar{y}_i, w, z_i) + \omega(y_i - \bar{y}_i) \qquad (3.36)$$

Where:

$\bar{p}$	milk price under the buy-out scheme
$\tilde{\pi}_i$	profit of farm i at $\bar{p}$ without participation in the buy-out scheme
$\tilde{y}_i$	production of farm i at $\bar{p}$ without participation in the buy-out scheme
$\tilde{C}_i$	cost function of farm i at $\bar{p}$ without participation in the buy-out scheme
$\bar{\pi}_i$	profit of farm i at $\bar{p}$ with participation in the buy-out scheme
$\bar{y}_i$	production of farm i at $\bar{p}$ with participation in the buy-out scheme
$\bar{C}_i$	cost function of farm i at $\bar{p}$ with participation in the buy-out scheme
y_i	production of farm i at p, the price before the buy-out scheme
ω	remuneration per unit of milk.

When:

$\bar{\pi}_i \geq \tilde{\pi}_i$ participation
$\bar{\pi}_i < \tilde{\pi}_i$ no participation

For the farms participating in the scheme it holds that $\bar{\pi}_i \geq \tilde{\pi}_i$, for the farms not participating in the scheme it holds that $\bar{\pi}_i < \tilde{\pi}_i$. However, we are interested in the farmer at the margin who will be indifferent about participating or not participating, for him it holds that $\bar{\pi}_i = \tilde{\pi}_i$. Through him we can find the marginal level of remuneration that needs to be paid in order to make the buy-out scheme work. To refer back to figure 3.4, this is the situation when $-C + F = 0$. Assuming $\bar{\pi}_i = \tilde{\pi}_i$, we find the following formula:

$$\bar{p} * \bar{y}_i - \bar{C}_i(\bar{y}_i, w, z_i) + \omega(y_i - \bar{y}_i) - \left(\bar{p} * \tilde{y}_i - \tilde{C}_i(\tilde{y}_i, w, z_i)\right) = 0 \qquad (3.37)$$

$$\bar{p} * \bar{y}_i - \bar{p} * \tilde{y}_i - \bar{C}_i(\bar{y}_i, w, z_i) + \tilde{C}_i(\tilde{y}_i, w, z_i) + \omega(y_i - \bar{y}_i) = 0 \qquad (3.38)$$

$$-\bar{p} * (\tilde{y}_i - \bar{y}_i) + (\tilde{C}_i(\tilde{y}_i) - \bar{C}_i(\bar{y}_i)) + \omega(y_i - \bar{y}_i) = 0 \qquad (3.39)$$

Based on formula (3.39) we can conclude that participation or not depends on the differences in revenues, costs and the remuneration. Figure 3.4 shows that this equals $-C + F$, which in turn equals:

$$-\tfrac{1}{2}(\bar{p} - p) * (\tilde{y}_i - y_i) + \tfrac{1}{2}(p - \overline{MC_i}) * (y_i - \bar{y}_i) = 0 \qquad (3.40)$$

Where:

$\overline{MC}_i$	marginal cost of dairy farm i with participation in the buy-out scheme

Financing the scheme

It is possible that the buy-out scheme is financed through the current CAP budget for intervention in the EU dairy sector, so fully by the European Union. However, it might also be the case that in order to finance the buy-out scheme, dairy farms will face some sort of payment. One way of financing the scheme is by imposing a levy on all dairy farms in the EU. This will prevent any free-rider problems, these problems can arise since every EU dairy farm will benefit from the higher market price. Since all farms have to pay a levy, the payment of the levy does not have an influence on the decision of the farm to participate or not. So, this option of financing the scheme does not change the empirical model used.

Another option of financing the scheme is by imposing membership fees on dairy farms who want to have the option of participating in the scheme in extreme market situations. Thus the fee represents the value of participation choice. This membership fee can either be independent or dependent on the level of production. If this membership is independent on the level of the production, the fee is likely to be an annually fixed contribution. If this is the case, the first order conditions of profit maximization will not be affected and in turn the production levels will not be affected. Furthermore, the participation fee has to be paid whether or not the farm participates, so it also does not affect the choice of participation. Therefore, this option of financing the scheme does not change the empirical model used.

Another possibility is that farms that participate in the scheme have to pay a fixed amount of contribution. Formula (3.41) shows that this option lowers the profit farms obtained by participating in the scheme, instead of non-participation. If $\bar{\pi}_i$ remains positive after the payment of the fee a farm still will participate, if not it no longer participates.

$$\bar{\pi}_i = \bar{p} * \bar{y}_i - \bar{C}_i(\bar{y}_i, w, z_i) + \omega(y_i - \bar{y}_i) - M \qquad (3.41)$$

Where:

M participation fee of the buy-out scheme.

Although, the funding of the scheme can be done in various ways, the most likely way of financing the scheme is try a levy paid by all the dairy farms. In this way, no free rider problem exists. This way does not influence the choice of participation and therefore this aspect will not be taken into account in the empirical model.

3.2.3 – Data and calibration

In order to provide a first insight into the effects of a buy-out scheme on dairy farms in the EU, formula (3.40) is applied to the constructed dataset of table 3.2. The aim hereby is to find the difference in profit of participation compared to the profit of non-participation. Since we do not know the exact supply function of specific dairy farms in the EU, we will consider two values for the following three variables: yearly production, supply elasticity and the production restriction under the buy-out scheme. In this way, eight different outcomes of formula (3.40) are generated. This enables us to assess the influence of the three variables and in turn provides us insights into which dairy farms will participate and what their willingness to pay is for participating in the scheme. The maximum amount a farm is willing to pay for participation is equal to the extra profit he will receive from participation compared to non-participation.

The yearly productions of an average dairy farm in the Netherlands and in Italy are used in order to represent a large and small size dairy farm. The production numbers, 603 tonnes of milk for the average Dutch dairy farm and 286 tonnes of milk for the average Italian dairy farm, are from the year 2009 and from the FADN database. The supply elasticities of FAPRI and EDIM are used, representing a more inelastic supply and a more elastic supply. The current milk equivalent milk price of € 215 per tonne of milk is used as the intervention price for the buy-out scheme. It is assumed that the buy-out scheme results in a market price increase of 10%, leading to a market price of € 236.50 per tonne of milk. Furthermore, two percentages of production restrictions for farms who participate in the scheme are considered, namely 1% and 2%. These numbers correspond to the numbers stated by Fink-Kessler et al. (2013).

Table 3.2 – dataset for the calculations of the dairy farm model, quantities in tonnes of milk and prices in euro per tonne.

Yearly production NL (2009)	603.00
Yearly production IT (2009)	286.00
Supply elasticity (FAPRI)	0.13
Supply elasticity (EDIM)	0.44
Current intervention	€ 215.00
Market price under buy-out scheme	€ 236.50
Production restriction	1.00%
Production restriction	2.00%

Sources: Supply quantities – IFCN, 2013, Export – PZ, 2013, Supply Elasticity – Jongeneel and Tonini, 2009, Demand Elasticity – Soregaroli and Trevisiol, 2005 Price – LTO, 2013.

Based on the formulas (3.1, 3.14, 3.15) a calibration is performed, which is comparable to the one performed in section 3.1.3. However, the dairy farmer is a price taker, so we do not have a demand equation, but just the price level. Formula (3.42) presents a supply function for dairy farm i, with formula (3.43) as the function of his supply elasticity.

$$y_i = a_i + b_i * p \tag{3.42}$$

$$\varepsilon_i^s = \frac{\partial y}{\partial p} * \frac{p}{y} \tag{3.43}$$

Where b_i is $\frac{\partial y}{\partial p}$, since the supply elasticity is known, b_i can be calculated and subsequently a_i through formulas (3.44) and (3.45).

$$b_i = \varepsilon_i^s * \left(\frac{y_i}{p}\right) \tag{3.44}$$

$$a_i = y_i - b_i * p \tag{3.45}$$

The supply function equals the inverse marginal cost function, so marginal cost of production in case of the buy-out scheme can be derived.

H4 – Results

This chapter consists of three parts in which the results of the European milk market model, the results of the dairy farm model, and possible practicalities that arise with the implementation of a buy-out scheme are discussed. The parts are discussed in the previously mentioned order.

4.1 – Results European milk market model

The results of the European milk market model, in which a mandatory buy-out scheme was assumed, will now be discussed per different scenario. These results are based on the dataset presented in table 3.1, in Annex C a sensitivity analysis is presented based on a second dataset presented in table A1. The outcome of the sensitivity analysis is shortly discussed at the end of this section.

Scenario I: base scenario

Table 4.1 presents the outcomes of the base scenario, indicating that a negative excess demand shock of 25% results in a price decrease of 3.03%. This lower price induces an increase in demand in the EU (1.21%) and a reduction in supply (-1.21%). Excess demand of the rest of the world falls less than 25% (-23.18%), as the decrease in the price leads to an increase in demand offsetting the exogenous demand shock partially. Total EU supply decreases to 150.789 million instead of 152.5 million tonnes of milk and the EU export falls from 14 million to 10.736 million tonnes of milk. Consumers in the EU gain (€ 1321.46 million), while producers in the EU loose (€ 1449.47 million). The negative excess demand shock results in a total welfare change for the EU of: 1321.46 - 1449.47 = € -128.01 million. The total welfare change in the ROW is € 146.11 million, which is mainly caused by the decreased milk price.

Table 4.1 – Results of scenario I: base scenario. Quantities in million tonnes of milk, price in euro per tonne of milk, and welfare changes in millions of Euros.

	EU	ROW
Demand (127.00)	128.54	
Supply (141.00)	139.29	
Export (14.00)	10.75	
Price (€ 341.60)	€ 331.26	
% change demand	1.21	-23.18
% change supply, including export	-1.21	
% change price	-3.03	
Change Consumer Surplus	€ 1321.46	
Change Producer Surplus	€ -1449.47	
Change total welfare	€ -128.01	€ 146.11

Scenario II: buy-out scheme

In table 4.2 the results of scenario 2, the implementation of a buy-out scheme, are presented. The results indicate that the scheme has to remove 1.67% of the original supply level (141 million tonnes of milk) in order to stabilize the price at € 335 per tonne of milk. This percentage lies between the 1% and 2% removal that was stated earlier as realistic reductions to stabilise the prices (based on the 2008/2009 milk crisis). The implementation of the buy-out scheme reduces the price decrease from 3.03% to 1.93%. This higher price level leads to a smaller increase in EU demand (0.77% instead of 1.21%). The export level is reduced somewhat more, 10.662 million tonnes of milk compared to 10.754 million tonnes of milk.

The buy-out scheme leads to a smaller reduction in producer surplus and a smaller increase in consumer surplus than in the base scenario. The total welfare change in the ROW is € 92.93 million. The total welfare change in the EU is now: 841.41 – 913.75 – 18.08 = € -90.42 million, which is 29.36% less negative than in the base scenario. The outcome thus favours the implementation of a buy-out scheme. Important hereby to note is that a 1% decrease of production in the EU has a larger positive effect on price than the effect of a 1% reduction of demand by the rest of the world. This is due to the fact that this model is based on the excess demand of the rest of the world and not the actual total demand. Therefore the (excess) demand of the rest of the world is small compared to EU supply.

Table 4.2 – Results of scenario II: buy-out scheme. Quantities in million tonnes of milk, price in euro per tonne of milk, and welfare changes in millions of Euros.

	EU	ROW
Demand (127.00)	127.98	
Supply (141.00)	138.64	
Export (14.00)	10.66	
Price (€ 341.60)	€ 335.00	
% change demand	0.77	-23.70
% change supply, including export	-1.67	
% change price	-1.93	
Marginal cost of production	€ 327.33	
Change Consumer Surplus	€ 841.41	
Change Producer Surplus	€ -913.75	
Costs of buy-out scheme	€ 18.08	
Change total welfare	€ -90.42	€ 92.93

Scenario III: export subsidies

If the EU decides to reactivate export subsidies in order to stabilize the price at € 335 per ton, an export subsidy of around 18.17% is needed (see table 4.3). The export subsidies create a difference of € 51.51 between the EU price (€ 335) and the ROW price (€ 283.49). This has severe implications for the producers and consumers in the ROW, however, they are included in this research. The lower ROW price leads to a smaller excess demand contraction compared to the other scenarios (-17.01%), this corresponds to a new export level of 11.93 million tonnes of milk. Total EU supply becomes 139.91 million tonnes of milk, which is a decline of 0.77%. Since the EU price is € 335, EU demand will be at the same level as in scenario II (127.98 million tonnes of milk).

The change in consumer surplus, 841.39, is almost identical than the consumer surplus change that was found with the implementation of a buy-out scheme, 841.41. This was to be expected since the quantity demanded and the market price are identical. The change in producer surplus is, however, somewhat more negative with the usage of export subsidies. This is remarkable since the quantity supplied in the case with export subsidies is somewhat higher at the same market price. However, this can be explained through the remuneration of 18.08 million that is paid by the government to the producers, in the case of a buy-out scheme. This overcompensates the producers. The costs of implementing export subsidies, however, are much higher than the costs of implementing a buy-out scheme. As a result, the total welfare change in the EU is now: 841.39 – 926.95 – 614.46 = € -700.02 million. This is considerably more negative than the total welfare effect in the base scenario (€ -128.01 million) and the total welfare effect in scenario II (€ -90.42 million).

The change total welfare in the ROW is considerable higher than in scenario I and scenario II, € 855.05 million. This is because the export subsidies result in a larger decline of the world market price. The world market price is € 283.49, while it was € 331.26 in scenario I and € 335.00 in scenario II. By definition an export subsidy raises the price in the exporting country and lowers the price in the importing country (on the world market). However, the rise in price is less than the subsidy. From a total welfare point of view; consumers lose, producers gain and the government has costs. Additionally, the terms of trade worsen, since the price of the export in the foreign market is reduced. An export subsidy unambiguously leads to costs that exceed the benefits (Krugman and Obstfeld, 2009: 192-193).

The outcome thus strongly rejects the implementation of export subsidies. Again it is important to recall that the model is based on the excess demand of the rest of the world and not the actual total demand. Therefore the excess demand of the rest of the world is small compared to EU supply. So influencing the price through affecting the world market is very costly compared to influencing the price through actions within the EU market.

Table 4.3 – Scenario III: export subsidies. Quantities in million tonnes of milk, price in euro per tonne of milk, and welfare changes in millions of Euros.

	EU	**ROW**
Demand (127.00)	127.98	
Supply (141.00)	139.91	
Export (14.00)	11.93	
Price (€ 341.60)	€ 335.00	€ 283.49
% change demand	0.77	-17.99
% change supply, including export	-0.77	
% change price	-1.93	-17.01
Change Consumer Surplus	€ 841.39	
Change Producer Surplus	€ -926.95	
Costs of export subsidies	€ 614.46	
Change total welfare	€ -700.02	€ 855.05

Sensitivity analysis: Appendix C

A couple of conclusions can be derived from the results of the sensitivity analysis (see appendix C) done with the second dataset presented in table C1 in appendix C. First of all, if both outcomes for the base scenario are compared, it can be concluded that effects of a negative excess demand shock of the ROW are greater with the second dataset. This can be explained by the considerable difference between the supply elasticity and the demand elasticity that are being used. In the second dataset both demand and supply are more inelastic. Therefore the downward price effect is much larger, which in turn results in bigger changes in consumer and producer surplus. Secondly, it can be concluded that the outcomes of both datasets show that export subsidies are not a favourable option. The costs are too high compared to their effects on consumer and producer surplus. The third and final conclusion is that the outcomes of both datasets are favourable for the implementation of a buy-out scheme. It reduces the total welfare effects of the negative excess demand shock of the rest of world. However, it should be noted that the costs of implementing a buy-out scheme are considerably larger when the second dataset is used (€ 143.642 million compared to € 18.076 million).

4.2 – Results dairy farm model

Table 4.4 contains the results for the dairy farm model, in which a voluntary buy-out scheme was assumed. The table contains the marginal costs under the four different combinations of supply elasticity and production restriction. Then the difference in profit from participation compared to profit obtained through non-participation is presented for the average Dutch dairy farm in 2009. This followed by the results for the average Italian dairy farm in 2009. When comparing the four different outcomes for the marginal costs, it can be concluded that the more inelastic supply elasticity of FAPRI results in larger changes in marginal costs. As a result, the dairy farm with FAPRI supply elasticity profit from participation and thus will reduce its supply quantity. When we look at the outcomes obtained through the higher EDIM supply elasticity we conclude that the EDIM outcomes are all negative. This implies that the dairy farms with EDIM supply elasticity do not profit from participation and thus will refrain from doing so.

When we look at the profit outcomes using the FAPRI elasticity at a 1% restriction, € 30.42 and € 14.43 respectively, we place questions about the willingness of dairy farms to participate for such small profit changes. Considering that milk cows are very sensitive with regard to (drastic) changes in their feed supply (Salamon et al. 2012) and that dairy farms need to change their normal business plan, the profit from participation over non-participation seems to be too low to convince dairy farms to cooperate. It is simply too much to trouble for such a small reward. However, the profit from participation compared to non-participation increases considerably if a higher production restriction is introduced. If a 2% production restriction is required, the profit from participation compared to non-participation increases in the Dutch case from € 30.42 to for € 244.83. For the Italian farm the profit from participation compared to non-participation is increased from € 14.43 to € 116.12 respectively. So, we can conclude that from a dairy farm's perspective, a higher percentage removal is preferred.

Table 4.4 – Results dairy farm model. Marginal cost is given in eurocents per kg of milk and the profit is given in Euros.

	Elasticity FAPRI – restriction 1%	Elasticity FAPRI – restriction 2%	Elasticity EDIM – restriction 1%	Elasticity EDIM – restriction 2%
Marginal costs	19.85	18.19	21.01	20.52
Profit from participation compared to non-participation (NL)	**€ 30.42**	**€ 244.83**	**€ -205.66**	**€ -96.64**
Profit from participation compared to non-participation (IT)	**€ 14.43**	**€ 116.12**	**€ -97.55**	**€ -45.84**

4.3 – Implementation issues

This section discusses the most important practicalities that arise with a possible implementation of a buy-out scheme.

Effectiveness of a buy-out scheme

The effectiveness of a buy-out scheme has been questioned in multiple papers; Pennings (2013), Theuvsen (2013), Weber (2013) and in a paper by the Dairy Policy Analysis Alliance (2010). We will discuss the practicalities that can affect the effectiveness in the short and long run. First let us consider the shorter run effects. For the effectiveness of the buy-out scheme in the short run it is important how dairy farms react to the implementation. If farms anticipate the implementation, they are likely to increase their production, extending the downward pressure on the milk price. As we have discussed in section 3.1.2, dairy farms will expect a higher milk price due to the buy-out scheme and the farms who do not participate will increase their production. Both actions, increasing the production before and during the scheme, result in higher costs in order to stabilize the price at a certain point. If other things are held constant, the less anticipated a buy-out scheme is, the less likely non-participants are to increase their production (Dairy Policy Analysis Alliance, 2010). Furthermore, Pennings (2013) stresses that trade outside of the EU dairy market needs to be tempered, because otherwise the buy-out scheme will not be effective as milk and milk products from outside the EU may fill the production gap caused by the scheme.

Pennings (2013), Theuvsen (2013) and Weber (2013) all argue that the effectiveness of a buy-out scheme is even lower in the long run. After the buy-out scheme has been applied repeatedly, producers will take possible EU compensation payments or the new higher established market price into account. Price signals will be ignored and dairy farms will be hindered in their adjustments of their production based on supply and demand. Therefore, the total volume of milk production in the EU, as well as the probability that supply exceeds actual demand will increase (Theuvsen, 2013). Thus hindering structural changes and resulting in a negative impact on competiveness (Pennings, 2013).

Defining the market conditions of the scheme

Defining the market conditions of the scheme is not a trivial task. Thereby it is vital to consider that within the EU countries, a large variability in raw milk prices as well as in milk production costs is registered. These differences are lower for bulk processed products (SMP; butter) (Sckokai, 2013). Because of the large differences in marginal costs between the EU countries, it is difficult to determine the right price level. Furthermore, the intervention price and targeted market price under the buy-out scheme should be kept as low as possible in order to prevent structural imbalances as discussed above.

Besides the prices, the duration of the scheme is also of importance. If the scheme has a predetermined budget, the market will know how long it can continue to compensate dairy farms for producing less milk. In other words, market participants will know when the funds run dry and they will capitalise on this knowledge and will be able to squeeze the market (Pennings, 2013). Additionally, the administrator will not know a priori how long the milk markets will be in crisis (Pennings, 2013).

The budget for the scheme is thus of great importance. So far we assumed that the EU funds the scheme through their current budget. However, it is also likely that farms will pay a certain fee in order to be able to participate in the scheme, this way the budget can be increased. This membership fee and the different set-ups are discussed in section 3.2.2.

Distributional impacts

The conditions of the market scheme imply that a buy-out scheme has distributional impacts. The very diverse variable and fixed costs of milk production in Europe will lead to distributional impacts of the scheme. If the EU milk market price is very low, it will be most attractive for farms with high marginal costs of milk production to participate in the buy-out scheme (Weber, 2013). This is because these farms are the first to come into a situation in which prices do not cover variable marginal costs anymore. In other words, the more milk they produce and sell, the more money they lose (Theuvsen, 2013). Since the marginal costs of production are likely to be the highest in the least efficient regions, it is expected that production will go down in those regions (Fink-Kessler et al., 2013). Large reductions in certain regions could negatively affect the production of processing and input delivering industries, which could lead to political tension. Furthermore, if all countries have to pay to fund the scheme, some countries will pay more than they gain. A scheme that is implemented country by country seems to be more desirable from a political point of view. However, such a scheme is likely to be less efficient, since not only the producers with the highest marginal cost are participating.

Remuneration level

Since the production costs and the cost structures of European dairy farms are very diverse, setting the remuneration level is a severe information problem. The dairy farms know which payments they will find attractive enough to reduce their production, from an agency theory perspective this is a typical hidden information problem (Arrow 1985). A solution could be to introduce a tender system (Dairy Policy Analysis Alliance, 2010). A tender system uses the hidden information of the farms, which is crucial for an effective and transaction-cost efficient reduction of quantities delivered to dairy companies (Theuvsen, 2013).

Transaction costs

A reduction of the milk supply has to be compared to a point of reference, in order to check if the farms are committed to the scheme. The transaction costs that arise with a buy-out scheme are considerable; data finding costs, monitoring costs, enforcing costs, etc. In addition to the transaction costs for the government there are also transaction costs at the level of dairy farms. All these transaction costs are not taken into account by simulations performed in this research.

In order to keep the transaction costs as low as possible, the buy-out scheme can be implemented at the level of the dairy processing companies. This is because the infrastructure is already present and the raw milk centralizes here, making it easy to control and monitor the raw milk supply. However, dairy processing companies might not be willing to cooperate since underproduction involves costs. Additionally, reducing milk production may interfere with contractual arrangements that dairy farms have with processors. Thus farms may not be allowed to significantly reduce milk production due to their contract (Pennings, 2013).

Spill-over effects

Then there are also possible undesirable effects for other sectors. A decrease in milk production could lead to extra slaughtering of dairy cattle or a shift towards another production, creating market distortions in other markets.

Chapter 5 – Discussion and Conclusions

Chapter 5 is the last chapter and is divided into two parts. First the discussion and subsequently the recommendations are stated. This chapter ends with the conclusions of the research.

5.1 – Discussion and recommendations

In this research, multiple assumptions were made and different subjects were left outside the analysis. Therefore, a discussion is presented on the limitations of this research and recommendations are made with respect to future research.

Wide variety of dairy products

The dairy market comprises of a wide variety of milk based dairy products and thus series of interrelated product markets. However, in this research we address the European milk market, so the fresh cow milk. But raw milk is not traded, the main dairy products that are traded are: cheese, butter, SMP and WMP. Multiple price linkages and conversion rates exist between those four dairy products and the raw milk price. This feature was only partly taken into account by using milk equivalents. Further research should be carried out on these price linkages in order to understand the influence on the results found in this research.

Excess demand model

An excess demand model was constructed and used in this research. In this model the world market is represented by the excess demand of the rest of the world and this excess demand is met by the excess supply of the EU through exports. This is a great simplification of the world market. First of all, three main dairy exporting regions can be found in the world. Besides the European Union, these are Oceania and the United States. In this research, only the European Union was considered. Additionally, there was only one importing region considered, the Rest of the World. This is again a great simplification. The main importing regions in the world can be separated into China, Russia and South-East Asia. The prices and elasticities in these regions are likely to differ, while they were now taken as a whole.

Furthermore, it was assumed that the current ROW import tariffs and the transport costs were already included in the excess demand function. If the ROW would be broken down into different regions, it becomes necessary to include trade measures and transportation costs. This is because per country, the trade measures and transportation costs differ.

The excess demand model has strong implications on the outcomes of the scenario. Since the model is based on the excess demand of the ROW and not on the actual total demand, the (excess) demand of the rest of the world is small compared to EU supply. This makes that a 1% decrease of production in the EU has a larger positive effect on price than the effect of a 1% reduction of demand by the rest of the world.

Calculations European milk market model

A few remarks are needed with respect to the calculations of the European milk market model. First of all, the used intervention price and target price under the buy-out scheme were unrealistically high. These prices were chosen based on the year 2012 in which the milk price was considered to be high. In any further research, lower prices should be used in order to get more precise results. Although, it has to be noted that it would not change the conclusions found through this model. Secondly, the transaction costs that arise with a buy-out scheme; data finding costs, monitoring costs, enforcing costs, etc., were not included in this research. Further research is needed in order to estimate these costs and their impact on the set-up of a buy-out scheme.

In the calculations that were used to quantify the welfare change, the Pigouvian welfare function was used. This function is, however, theoretically incorrect since utility (and thus welfare) cannot be experienced by producers or by the government. Additionally, consumer surplus is not a correct welfare measure since it only considers the change in utility of the consumption of the product for which a change took place. Furthermore, the utility changes in markets of substitutes and/or complements are not taken into account, which is especially important in the dairy market with its great variety of dairy products. The income effect of price changes is not included as well. The changes in producer surplus and budget costs are approximations of these effects. However, the approximation is acceptable since the analysed product has a small share in total production or consumption. In further research, other methods can be considered.

Oligopsony

The European milk market structure is an oligopsonistic market structure with many suppliers, but a limited number of demanders. Since there are a limited number of demanders, the quantity they demand influences the price of the input, so with every additional unit of input demanded the price of the input goes up. Therefore, the demanders in an oligopsonistic market structure will thus use their market power and restrict the input quantity they demand, lowering the price below the competitive equilibrium. In addition to the oligopsonistic processing sector, the retail sector also represents an oligopsonistic market structure. Oligopsonistic retailers impose backward pressure on the dairy farms and the processing industry that are dependent on the retail chains for their sales. This backward pressure eventually leads to lower farm gate prices.

The objective of the buy-out scheme is to protect dairy farms from very low milk prices by adjusting the supply to demand ratio with the aim to increase the milk price. The mark-up is hereby important, since it indicates the difference between the price of the final dairy product expressed in units of milk and the farm-gate milk price. In the case the mark-up remains constant the increase in milk price results in an evenly increase in the raw milk price. In this case, the oligopsonistic market structure does not influence the working of the buy-out scheme. However if the mark-up increases, processors and retailers have increased the gap between the milk price and the farm-gate milk price. This has a negative effect on the effectiveness of the buy-out scheme. If the mark-up decreases, it has a positive effect on the effectiveness of the buy-out scheme. In a further research, it would be interesting to include the oligopsonistic market structure in the model. A first suggestion is already presented in Appendix B.

Funding the scheme

Due to a time-constraint, the funding of the scheme was not discussed in detail and future research into this feature is therefore recommended. Although, the funding of the scheme was only shortly highlighted in this thesis (sections 2.6.3 and 3.2.2), an indication about the possible funding can be made. Since all dairy farms will benefit from the increased market price under the buy-out scheme, it is likely that all dairy farms will face a levy to fund the scheme. In this way free-rider problems are prevented, and it does not influence the choice of participation.

Dairy farm model

In the calculations of the dairy farm model it was assumed that the remuneration was equal to the milk market price under the buy-out scheme minus the marginal costs of dairy farm i. However, there are also dairy farms for which the compensation exceeds the difference between market price and marginal cost. This makes the buy-out scheme more attractive. Therefore, it should be determined how to address these dairy farms, otherwise they will be overcompensated. A tender system can be used to address this system.

A last recommendation for further research is made with respect to the CWT program. This is because it used to included a program which attempted to reduce national milk supplies by accepting bids from producers who agreed to temporarily reduce their output by an agreed upon amount. However, this program was stopped due to little interest. Unfortunately, no information could be found about the set-up of this program and on the possible reasons why it failed. Since this information is very interesting with respect to the implementation of a similar program in Europe, further research is recommended.

5.2 – Conclusions

This thesis presents the possibilities for implementing a buy-out scheme in the EU milk market. This section concludes on the findings of this thesis and answers the research questions constructed in chapter 1.

What are the current EU policy measures in case of extreme market situations in the dairy sector?

The CAP currently consists of two pillars, pillar 1 containing the direct payments and market management measures and pillar 2 the rural development policy. The CMO regulates the European dairy market within the CAP. Three measures are in place to stabilise the European dairy market if needed, these measures are public intervention, private-storage and export subsidies. The current policy measures, however, were developed to offer a basic safeguard and were not designed for volatile prices and/or crises in the milk market.

Butter and SMP are the only products eligible for public intervention. Since there is no actual EU raw milk support price, the EU milk equivalent support price is based on the intervention prices and buy-up quantity thresholds for butter and SMP. This raw milk equivalent support price is currently € 215 per tonne of milk. The thresholds for buying-up butter and SMP are: 30,000 tonnes of butter and 109,000 tonnes of SMP. The private arrangements are in the form of storage aid, which may be granted for salted or unsalted butter produced from cream or milk and for certain cheeses. Currently no export subsidies are provided for dairy products. However, they are still a valid market stabilization tool and can be reactivated as was done in the years 2008/2009 during the last milk price crisis.

Are there different set-ups of buy-out schemes? If so, what are they?

There are multiple set-ups for a buy-out scheme, of which one can be found in the United States; the CWT herd retirement program. The CWT herd retirement program is a voluntary supply management approach that is privately funded. Because CWT is privately owned, it is not subject to World Trade Organization (WTO) regulations. Members of participating dairy cooperatives and participating independent dairy farms fund the program through a fee of 10 dollar cents per 100 kg of milk marketed. Participation in the CWT has ranged between 67% van 74% of all milk marketed in the U.S.

A second set-up can be found in a proposal by the European Milk Board. The Board elaborated on an EU supply management system in which a monitoring body is constructed on a European level. This body will set an upper and lower limit of the target farm-gate price, thus creating a price range of what is seen as an acceptable farm-gate price. If the market farm-gate price goes outside this price range, a buy-out scheme is activated to adjust the ratio of supply to demand. The desired reduction in milk production can be achieved through a mandatory process or a voluntary process. A mandatory process requires an individual farm volume limit which is universally binding, thus ensuring that every milk producer adheres to the stipulated volumes. This process is very similar to the milk quota system with the difference that the volume will be adjusted depending on the market situation.

A voluntary process requires financial incentives for dairy farms to cut back their production volume. An important issue hereby is the level of the remuneration. If the remuneration is too low, dairy farms will not participate in the scheme and the buy-out scheme will fail to reduce the overall supply. If the remuneration is set too high, the costs will be higher than necessary and dairy farms are overcompensated.

If implemented, what are the possible costs and welfare effects of a European buy-out scheme?

In order to simulate the implementation of a buy-out scheme in the European milk market, an excess demand model was constructed. This model is a stylized representation of the EU-world milk market, where the world market is represented by the excess demand of the rest of the world and this excess demand is met by the excess supply of the EU. The welfare changes are quantified with the help of the Pigouvian welfare function. Based on the calculations, it can be concluded that the buy-out scheme leads to a smaller reduction in producer surplus and a smaller increase in consumer surplus than in the base scenario, in which an excess demand shock of -25% in simulated. The outcome thus favours the implementation of a buy-out scheme. The export subsidy leads to very similar effects in producer surplus and consumer surplus as with the buy-out scheme. However, the costs of the export subsidies are much higher than the costs of implementing a buy-out scheme. As a result, the total welfare change is considerably more negative than the total welfare change in the base scenario and with the implementation of a buy-out scheme. Therefore, the implementation of a buy-out scheme is preferred over the reactivation of export subsidies.

The sensitivity analysis that was carried out by taking different values for the supply elasticity and the demand elasticity, also resulted in a strong preference for implementing a buy-out scheme over the reactivation of export subsidies. Again the scheme reduced the negative total welfare change due to the negative excess demand shock in the rest of world. However, this was done at a higher cost due to the more inelastic demand and supply (lower absolute value of the price elasticities of demand and supply).

If implemented, what are the effects of a European buy-out scheme for an individual dairy farm and would the dairy farm participate in the scheme?

The buy-out scheme leads to a new and higher milk market price. The dairy farm has to choose to participate or not. If the dairy farm participates, its supply is restricted with a certain amount. Since the dairy farm participates, a remuneration is received. This remuneration compensates the dairy farm for its restriction in production, and was assumed to be equal to $(\bar{P} - \overline{MC}) * (Y - \bar{Y})$. Due to the higher milk price, the reduction of costs caused by the supply restriction, and the remuneration received, the dairy farm has a positive profit change compared to the situation without the buy-out scheme. However, a dairy farm might also choose not to participate in the scheme. In that case, the farm does not face a supply restriction and since the milk market price increases under the buy-out scheme, the dairy farm will increase its supply. This results in a positive profit change compared to the situation without the buy-out scheme.

Dairy farms, however, cannot influence the implementation of the buy-out scheme, they can only decide to participate or not. Therefore, it is more interesting to compare the difference in profit obtained through participation and through non-participation. If dairy farms are to be convinced to participate in the scheme, the profit from participation must at least be equal or higher than the profit obtained through non-participation. The results indicate that the inefficient producing dairy farm will profit from participation and thus will reduce their supply quantity, and that the efficient producing dairy farms will not profit from participation and thus will refrain from participation. Additionally, it was concluded that from a dairy farm’s perspective, a higher percentage removal is preferred, as it increases profit most.

What are the possible practicalities or implementation issues that may arise from the implementation of a European buy-out scheme?

The first issue that arises with respect to a buy-out scheme, is its effectiveness. In the short run, the effectiveness of the buy-out scheme is subject to the reaction of the dairy farms. If farms anticipate the implementation, they are likely to increase their production, extending the downward pressure on the milk price. This increase in production, either before the implementation or during the buy-out scheme by farms that do not participate, results in higher costs to stabilise the milk market price at a higher level. The less anticipated a buy-out scheme is, the less likely non-participants are to increase their production. Additionally, the import of dairy products needs to be tempered, otherwise the milk and milk products from outside the EU may fill the production gap caused by the scheme. In the long run, the buy-out scheme will be taken fully into account by the market. This hinders structural changes, increases the probability that supply exceeds actual demand, and results in a negative impact on competiveness.

If it is chosen to implement an EU buy-out scheme, the main challenge is the large variability in raw milk prices as well as in milk production costs within the EU. First, the very diverse variable and fixed costs of milk production in Europe will lead to distributional impacts of the scheme. The least efficient dairy farms, those with high marginal costs, will participate in the scheme. So, in the least efficient milk producing regions, the production goes down. Large reductions in certain regions could negatively affect the production of processing and input delivering industries. This is likely to lead to political tension. Second, setting the remuneration level is a severe information problem due to the large differences in cost structures. A European wide remuneration level is therefore unlikely. Since dairy farms know which payments they find attractive enough to reduce their production, a solution could be to introduce a tender system.

Then there are also possible undesirable effects for other sectors. A decrease in milk production could lead to extra slaughtering of dairy cattle or a shift towards another production, creating market distortions in other markets.

What is the most preferable set-up for a European buy-out scheme?

Since the aim of the buy-out scheme is to temporary adjust the supply of raw milk to the market, and there is no structural oversupply of milk to the market, it is preferable to temporary withdraw milk production from the market instead of reducing the animal stock. This will also prevent market distortions in other markets. This implies that a herd reduction program like the CWT is not preferable. Furthermore, a voluntary scheme is preferred over a mandatory buy-out scheme. Thus a financial incentive, a remuneration, is needed to compensate dairy farms for their production restriction and to make them participate in the scheme. This remuneration can be best established through a tender system, in this way the hidden information of dairy farms, about the level of remuneration they are willing to accept the production restriction, is used.

Due to the diversity in the European milk market, a scheme implemented country by country seems to be more desirable from a political point of view. However, this comes at the cost of efficiency, since not only the producers with the highest marginal cost are participating. In order to keep the transaction costs as low as possible, the buy-out scheme can be implemented at the level of the dairy processing companies. This is because the infrastructure is already present and the raw milk centralizes here, making it easy to control and monitor the raw milk supply.

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Appendix A – Volatility of the SMP and WMP prices

SMP

Till 2006 the volatility of the EU SMP price remained below that of the world SMP price, during which the world price was rising and the price gap shrinking (see figure A.1). In the second half of 2006, the world market price rose above the SMP intervention price. Thereafter, the volatility of the EU SMP producer price increased and was almost as high as or sometimes higher than that of the world market price. This persisted as long as the world market price exceeded the intervention price. Export refunds were re-activated during 2009 bringing volatility down a little, but it remained well above the pre-2007 level (Jongeneel et al., 2011).

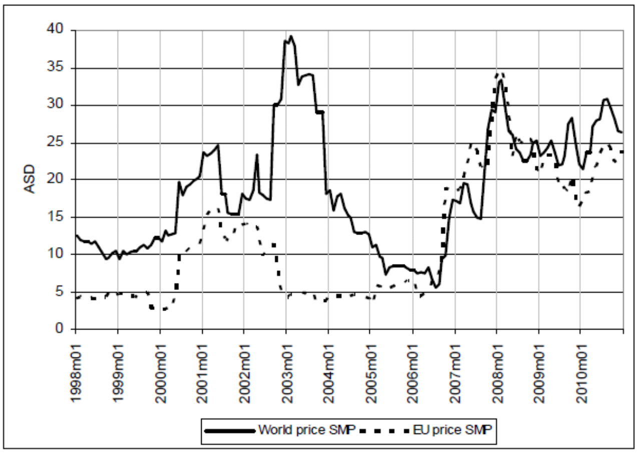

Figure A.1 – Annualised standard deviation for SMP prices. Source: Jongeneel et al., 2011.

WMP

Export refunds were the only CAP instrument available directly for stabilizing WMP prices and they played a role in keeping the EU prices above the world market up to 2007. The annualised standard deviation of WMP prices (Figure A.2) shows that until late 2006 the EU producer price for WMP was less volatile than the world market price. During 2006, the volatility of the EU price increased and reached the volatility level of the world market prices. Although world market volatility was greater in these last years, an important factor is that the additional volatility of EU butter and SMP prices, due to the world price being higher than the intervention price for these products, is transmitted via their substitutability in production to the WMP price. Thus, indirectly the lowering of the intervention prices for the two intervention products has also affected WMP price volatility (Jongeneel et al., 2011).

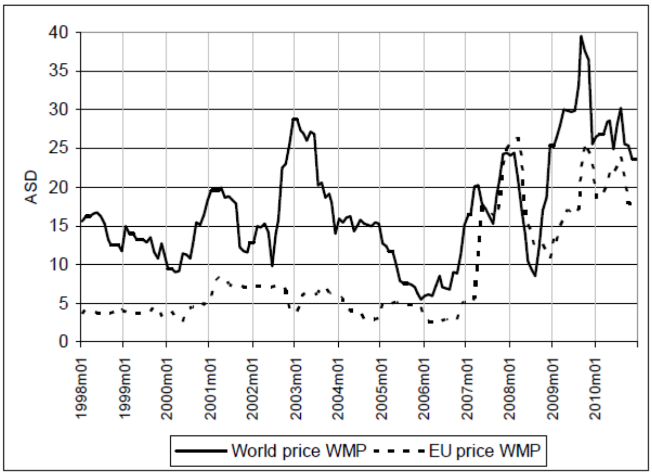

Figure A.2 – Annualised standard deviation for WMP prices. Source: Jongeneel et al., 2011.

Appendix B – Cournot's model

Here a possible start is presented about how to incorporate the oligopsonistic market structure. As stated before, the demanders can influence the price formation through the quantity demanded (quantity is the strategic variable). We assume that the strategic interactions between demanders form a simultaneous game. There is no leader among the demanders, there is not a firm who can set its input before the other firms. Instead, each demander bases his choice on the expected input of the other demanders (Varian, 2006: 481). If the expectations are incorrect, these will be adjusted. These adjustments continue until a stable market equilibrium is reached in which the expected input of the other demanders is in fact realized, this is known as a Cournot equilibrium. Since each firm optimally chooses the amount of input that the other firms expect, each firm maximizes its profits and none of the firms will find it profitable to change its input (Varian, 2006: 491).

In order to find the market power that a buyer possesses in an oligopsonistic market with quantity as the strategic variable (Cournot), the calculations provided by Gardebroek and Peerlings (2010) are used as the foundation of this section. We have the following profit function of buyer i $\forall i = 1, \ldots., N$:

$$\pi_i = (p - c_i - w) y_i - f_i \qquad \text{(B.1)}$$

Where:

π_i	profit of buyer i
p	output price
c_i	marginal other costs of buyer i
w	input price paid (farm-gate milk price)
y_i	quantity of input purchase by buyer i
f_i	fixed costs of buyer i
p, c_i	are assumed to be constant.

There are access barriers to the market, which are represented by the relatively high fixed cost (f_i). This implies that the difference between the variable costs and the revenue has to be higher than the fixed costs, otherwise a firm cannot enter the market.

In order to provide a clearer distinction between the raw milk and the end product, we can rewrite formula (B.1) into the profit function of, for example, a cheese producer. We then get:

$$\pi_i = (p - c_i - w) * (r * y_i) - f_i \qquad \text{(B.2)}$$

Where:

r	milk equivalent of the production process

However, since this section is only meant as a starter, we stay with formula (B.1). The total quantity demanded by the buyers (Y_d) equals the total quantity supplied by the suppliers (Y_s):

$$Y_d = Y_s = \sum_{i=1}^{N} y_i \qquad \text{(B.3)}$$

Assuming that both Y_d and Y_s are depending on the input price (w), the first order condition of buyer i is given by:

$$\frac{\partial \pi i}{\partial y_i} = p - c_i - w - \frac{\partial w}{\partial Y} * \frac{\partial Y}{\partial y_i} * y_i = 0 \qquad \text{(B.4)}$$

Rewriting formula (B4):

$$p = c_i + w + w * \frac{\partial w}{\partial Y} * \frac{Y}{w} * \frac{\partial Y}{\partial y_i} * \frac{y_i}{Y} \quad \text{(B.5)}$$

Recall that Cournot's model of oligopsony is based on the assumption that the input level chosen by one firm does not influence the input quantity demanded by the other firms. $\frac{\partial Y}{\partial y_i}$ indicates the buyer i's beliefs about how total demand would change when its own demand changes. Now recall formula (B.5) and insert $\frac{\partial Y}{\partial y_i} = 1$:

$$p = c_i + w + w * \frac{\partial w}{\partial Y} * \frac{Y}{w} * \frac{y_i}{Y} \quad \text{(B.6)}$$

The price elasticity of supply faced by the buyers is $\epsilon_S = \frac{\partial Y}{\partial w} * \frac{w}{Y}$ and the market share of buyer i (s_i) is indicated by $\frac{y_i}{Y}$. This implies that we can rewrite equation (B.5) as:

$$p = c_i + w + w * \frac{\partial w}{\partial Y} * \frac{Y}{w} * s_i \quad \text{(B.7)}$$

$$p = c_i + w + \frac{\partial w}{(\frac{\partial Y}{\partial w} \frac{w}{Y})} * s_i \quad \text{(B.8)}$$

$$p = c_i + w + \frac{w}{\epsilon_S} * s_i \quad \text{(B.9)}$$

$$p = c_i + w + [\frac{w}{\frac{\epsilon_S}{s_i}}] \quad \text{(B.10)}$$

$$p = c_i + w[1 + \frac{1}{\frac{\epsilon_S}{s_i}}] \quad \text{(B.11)}$$

Mark-up

The mark-up is the factor with which the input prices has to be multiplied to get the extra profit received of buying the last unit of input in the profit maximizing optimum (Gardebroek and Peerlings, 2010: p. 122). Thus it shows to what extent an individual firm in an oligopsonistic market is able to push down the price of the input below the competitively optimal price. The mark-up is calculated as follows:

$$p - c_i = mark - up * w \quad \text{(B.12)}$$

$$mark - up = \frac{p - c_i}{w} = [1 + \frac{1}{\frac{\epsilon_S}{s_i}}] \quad \text{(B.13)}$$

The mark-up of a buyer depends on its market share and the elasticity of supply. If the market share increases, the mark-up increases. If the price elasticity of supply increases, the mark-up decreases. When the price elasticity of supply becomes infinite, the mark-up equals 1. This reflects perfect competition.

The mark-up is important since it indicates the difference between the price of the final dairy product expressed in units of milk and the farm-gate milk price. The objective of the buy-out scheme is to protect the dairy farms from very low milk prices by adjusting the supply to demand ratio with the aim to increase the milk price. In the case the mark-up remains constant the increase in milk price results in an evenly increase in the raw milk price. In this case, the oligopsonistic market structure does not influence the working of the buy-out scheme. However if the mark-up increases, processors and retailers have increased the gap between the milk price and the farm-gate milk price. This has a negative effect on the effectiveness of the buy-out scheme. If the mark-up decreases, it has a positive effect on the effectiveness of the buy-out scheme.

Appendix C – Sensitivity analysis with second dataset

A sensitivity analysis was conducted in order to assess the results that were obtained in chapter 4. The second dataset (table C1) was used to recalculate the outcomes of the three different scenarios; base scenario, implementation of a buy-out scheme and the use of export subsidies. The market price and the market price under the buy-out scheme were given the same values (€ 341.60 and € 335.00 per tonne of milk). The sensitivity analyses addresses different elasticities, the supply elasticity is now 0.13 instead of 0.40, the demand elasticity is now -0.06 instead of -0.40.

Table C1 – Second dataset. Quantities in million tonnes of milk equivalents and price in euro per tonne of milk.

	EU
Supply	152.50
Demand	138.50
Export	14.00
Supply elasticity	0.13
Demand elasticity	-0.06
Price	€ 341.60

Sources: Supply quantities – Scheepstra, 2013, Export – PZ, 2013, Elasticities – FAPRI, 2014, Price – LTO, 2013.

Scenario I: base scenario

Table C2 – Results found through second dataset. Quantities in million tonnes of milk, price in euro per tonne of milk, and welfare changes in millions of Euros.

	EU	**ROW**
Demand (138.50)	139.20	
Supply (152.50)	150.82	
Export (14.00)	11.62	
Price (€ 341.60)	**€ 312.65**	
% change demand	0.51	**-17.03**
% change supply, including export	-1.10	
% change price	**-8.48**	
Change Consumer Surplus	**€ 4020.14**	
Change Producer Surplus	**€ -4390.96**	
Change total welfare	**€ -370.82**	**€ 421.48**

Table C3 – Results found in chapter 4, identical to table 4.1. Quantities in million tonnes of milk, price in euro per tonne of milk, and welfare changes in millions of Euros.

	EU	**ROW**
Demand (127.00)	128.54	
Supply (141.00)	139.29	
Export (14.00)	10.75	
Price (€ 341.60)	**€ 331.26**	
% change demand	1.21	**-23.18**
% change supply, including export	-1.21	
% change price	**-3.03**	
Change Consumer Surplus	**€ 1321.46**	
Change Producer Surplus	**€ 1449.47**	
Change total welfare	**€ -128.01**	**€ 146.11**

The outcomes show that a negative excess demand shock of 25% results in a price decrease of 8.48%. This decline is considerably larger than the -3.03% that was found with the use of the first dataset. As a result of this larger price decline, demand of the rest of the world falls with 16.59% instead of the decline of 23.32% that was found with the first dataset. The larger price decline also affects the changes in consumer and producer surplus. Consequently, the surplus changes are considerably larger and the total welfare change for the EU becomes € -370.82 million instead of € -128.01 million. The total welfare change for the ROW is also larger, € 421.48 million instead of € 146.11 million.

Scenario II: buy-out scheme

Table C4 – Results found through second dataset. Quantities in million tonnes of milk, price and marginal cost in euro per tonne of milk, and welfare changes in millions of Euros.

	EU	ROW
Demand (138.50)	138.66	
Supply (152.50)	149.42	
Export (14.00)	10.75	
Price (€ 341.60)	€ 335.00	
% change demand	0.12	-23.18
% change supply, including export	**-2.02**	
% change price	-1.93	
Marginal cost EU	**€ 288.44**	
Change Consumer Surplus	**€ 914.70**	
Change Producer Surplus	**€ -924.57**	
Costs of buy-out scheme	**€ 143.64**	
Change total welfare	**€ -153.51**	**€ 93.25**

Table C5 – Results found in chapter 4, identical to table 4.2. Quantities in million tonnes of milk, price and marginal cost in euro per tonne of milk, and welfare changes in millions of Euros.

	EU	ROW
Demand (127.00)	127.98	
Supply (141.00)	138.64	
Export (14.00)	10.66	
Price (€ 341.60)	€ 335.00	
% change demand	0.77	-23.70
% change supply, including export	**-1.67**	
% change price	-1.93	
Marginal cost of production	**€ 327.33**	
Change Consumer Surplus	**€ 841.41**	
Change Producer Surplus	**€ -913.75**	
Costs of buy-out scheme	**€ 18.08**	
Change total welfare	**€ -90.42**	**€ 92.93**

In order to stabilize the price at € 335 per tonne of milk, the buy-out scheme has to remove 2.02% of the original supply level (152.50 million tonnes of milk). Compared to the outcome found with the first dataset, the percentage of removal of the buy-out scheme is higher (2.02% compared to 1.67%). The main difference between the outcomes of the different datasets is the marginal cost of production in the EU (€ 288.44 of the second dataset versus € 327.33 of the first dataset). This large difference results in a large difference in the costs of implementing the schemes, € 143.64 million compared to € 18.08 million. As a result, the total welfare change in the EU is 914.70 - 924.57 - 143.64 = € -153.51 million. The change in overall welfare is more negative compared to the outcome of € -90.42 million found through the first dataset.

Although the overall welfare effect is more negative, the outcome favours the implementation of a buy-out scheme since the outcome of the base scenario was € -387.55 million. Thus implementing a buy-out scheme that stabilizes the price at € 335 per tonne reduces the decline in total welfare by € 218.61 million. The total welfare change in the ROW remains more or less the same, now € 93.25 million instead of the € 92.93 million found in chapter 4.

Scenario III: export subsidies

Table C6 – Results found through second dataset. Quantities in million tonnes of milk, price and marginal cost in euro per tonne of milk, and welfare changes in millions of Euros.

	EU	ROW
Demand (138.50)	138.66	
Supply (152.50)	152.12	
Export (14.00)	**13.46**	
Price (€ 341.60)	€ 335.00	**€ 264.86**
% change demand	**0.12**	**-23.18**
% change supply, including export	**-0.25**	
% change price	-1.93	**-22.47**
Change Consumer Surplus	**€ 914.61**	
Change Producer Surplus	**€ -1005.21**	
Costs of export subsidies	**€ 943.85**	
Change total welfare	**€ -1034.45**	**€ 1187.82**

Table C7 – Results found in chapter 4, identical to table 4.3. Quantities in million tonnes of milk, price and marginal cost in euro per tonne of milk, and welfare changes in millions of Euros.

	EU	ROW
Demand (127.00)	127.98	
Supply (141.00)	139.91	
Export (14.00)	**11.93**	
Price (€ 341.60)	€ 335.00	**€ 283.49**
% change demand	0.77	**-17.99**
% change supply, including export	-0.77	
% change price	-1.93	**-17.01**
Change Consumer Surplus	**€ 841.39**	
Change Producer Surplus	**€ -926.95**	
Costs of export subsidies	**€ 614.46**	
Change total welfare	**€ -700.02**	**€ 855.05**

If the EU decides to reactivate export subsidies in order to stabilize the price at € 335 per tonne, an export subsidy of 26.48% is needed. This 26.48% is considerable higher than the 18.17% that was found using the first dataset. As a result, the costs of the export subsidies become € 943.85 million instead of € 614.46 million. The overall welfare effect for the EU is significantly more negative than in the outcome based on the first dataset. The total welfare change in the EU with the second dataset is € 914.61 - € 1005.21 - € 943.85 = € -1034.45 million, while the outcome of the first dataset was € -700.02 million. So the outcome again rejects the implementation of export subsidies as an option to stabilize the price. Again the negative change in producer surplus is greater with the usage of export subsidies than with the usage of a buy-out scheme, this is again the result of the remuneration that is paid by the government to the producers. The total welfare change in the ROW is larger with the usage of the second dataset than with the usage of the first dataset, € 1187.82 million instead of € 855.05 million.