Stockholm School of Economics
Department of Economics
Bachelor's Thesis in Economics

Evaluating the 2006 EU sugar reform

A study of the linkage between the instruments and the objectives of the reform

Abstract

This thesis investigates to what extent sugar beet growers are affected by changes in sugar quotas within the EU during the 2006-2009 reform. A survey of previous research is conducted which concludes that none have found direct linkage between sugar production quotas and sugar beet production. Nevertheless, the EU proclaims the 2006 reform a success merely based on the fact that the reform has reduced production quotas. In contrast to previous research, this thesis uses actual data from the 2006 reform when evaluating the reform impact. The analysis suggests a strong linkage based on aggregate data. However, new evidence of non-quota production being unaffected in low-cost countries is found, confirming conclusions drawn in previous research. A direct linkage thus remains unproven. The thesis concludes by suggesting that future research should include EU-wide data on production costs on a farm level in order to more accurately predict the impact of the reform.

Keywords: common agricultural policy; sugar; reform; elasticity; evaluation.

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Table of Content

Table of figures and tables

Abbreviations and definitions

ACP	A group of African, Caribbean and Pacific countries
CAP	Common Agricultural Policy
CMO	Common Market Organisation, the sub-elements of CAP
EBA	Everything But Arms
EU	European Union
EUR	Euro (currency)
LDC	Least Developed Countries
Sugar beet grower	A farmer cultivating sugar beets
Sugar factories	Factories refining sugar beet into sucrose
Sugar producers	Both farmers and factories
Sugar sector	The total production value chain of sugar
WTO	World Trade Organisation
Year	The sugar production year goes from spring year 1 to spring year 2 e.g. 2009 refers to the period between spring 2009 and spring 2010

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1 Introduction

Sugar is one of the most heavily protected products in the world. Estimates show that 80 per cent of world sugar production benefits from some sort of government support (Mitchell, 2005: 151). In the European Union (EU) sugar has been part of the Common Agricultural Policy (CAP) since 1968. Sugar is extracted from sugar beets, produced in temperate areas such as in the EU, and sugar cane, grown in tropical areas. Sugar cane production has a considerable advantage over beet production, which explains the longstanding support of the EU to its sugar beet growers (Organisation for Economic Co-operation and Development, OECD, 2007: 11-12). The EU acknowledges that the sugar beet production has survived only due to the high tariffs protecting it from global competition (European Commission, 2003: 6). Consumers in the EU have to pay for this protection, not only through taxes but also through the artificially high internal consumer prices amounting to double, and occasionally three times the world market price.

Up until 2006, the EU sugar policy has never been fundamentally reformed (European Commission, 2003: 8). During recent years pressures to reform the sugar policy has been built up internally as well as externally. Since the beginning of 1990, policies of other sectors within CAP have undergone substantial change. This imbalance between sugar and other crops has contributed to the internal pressure to reform. The high subsidies to the European sugar sector have been challenged during recent World Trade Organisation (WTO) negotiations forcing the EU to limit its support policy (OECD, 2007: 73).

In 2006, a reform of the EU sugar policy was initiated. Ending in 2009, the reform was aimed at reducing annual total sugar production in the EU by approximately 6 million tonnes or 30 per cent annually. The main instruments were a reduction of the intervention price of sugar by 36 per cent as well as a quota buy-back scheme, providing incentives for producers to renounce their production quotas (OECD, 2007: 82).

In 2009, the EU Commissioner for Agriculture, Mariann Fischer Boel said "I am pleased to say that the sugar reform has been a success" (European Commission, 2009a). This conclusion was based on the fact that close to 6 million tonnes of sugar production quotas had been renounced. That being said, it is not clear that a quota cut will lead to a reduction of total sugar production. In particular, no previous research has found evidence of a direct linkage between production quotas and actual production. The alleged success of the reform may therefore be questioned.

The purpose of this thesis is to evaluate how the 2006 reform affected sugar beet production within the EU. This will be tested using actual data from the reform period, distinguishing this thesis from previous research in which conclusions were based on simulations.

1.1 Delimitations

This thesis focuses on countries within the EU27[1]. All countries included had completed their accession before the reform with the exception of Romania and Bulgaria that joined the EU in January 2007. Accordingly, 2006 results for Romania and Bulgaria are not included in the analysis.

The time period considered is the four years of the reform, 2006-2009. For obvious reasons this time period has been chosen in order to capture the effect of the reform. There is however the possibility that a portion of sugar beet growers' reaction to a reduction in sugar quota is lagged and can only be observed in production volumes in the years following the reform. No attempt to simulate such a lagged reaction is made and consequently, this thesis makes no claim of capturing the full effect of the reform, only the effect that can be observed in data from the reform period.

The thesis is conducted on an aggregate level of analysis and hence it is not possible to make a division between high-cost and low-cost growers on a farm-level or identify which of these that stop producing sugar beets. As a result, it is not possible to conclude whether the reform has led to a sugar beet production efficiency-increase within Europe, nor is it possible to pursue a deeper analysis of the income redistribution between sugar beet growers and sugar factories.

The case of reforming the sugar sector within the EU is unique and includes many caveats. The inferences and conclusions drawn from this thesis have limited external validity, i.e. they cannot be generalised from the population and setting studied to other populations and settings. Moreover, as the European sugar market becomes more liberalised and sensitive to world market prices, the inference and conclusions drawn from this thesis may not hold for future sugar reforms within the EU.

1.2 Contribution

The EU sugar policy has changed little since its establishment, making it difficult to estimate how sugar beet growers will respond to the reform. The OECD concludes that there is a need for additional research analysis of the implications of the sugar policy reform (OECD, 2007: 37).

This thesis contributes to previous research by combining the observed progress in previous reform simulations with actual data from the reform in an attempt to clarify the linkage between

[1] Austria*, Belgium*, Bulgaria*, Cyprus, Czech Republic*, Denmark*, Estonia, Finland*, France*, Germany*, Greece*, Hungary*, Ireland*, Italy*, Latvia*, Lithuania*, Luxemburg, Malta, the Netherlands*, Poland*, Portugal*, Romania*, Slovakia*, Slovenia*, Spain*, Sweden* and the United Kingdom*.
*Indicates that the country had sugar production in 2006, in total 23 countries.

sugar quota reduction and sugar beet production. This thesis is the only known study, up to this date, that considers the entire reform period using actual data. Thus, it is possible to make a valuable contribution to the ongoing discussion of how sugar beet production is affected by changes in sugar quotas.

Although the settings of future reforms may differ from the current state, conclusions drawn concerning the impact of the 2006 reform are likely to be used as a framework for future reforms. This thesis hopes to contribute to the design of future reforms.

1.3 Outline

This thesis will be constructed in the following way. In chapter 2, the CMO of sugar and the 2006 reform are introduced together with a brief overview of the CAP and of the process of producing sugar. Chapter 3 presents previous research on the topic and economic theory underlying the discussion of trade policy. Chapter 4 summarises previous chapters and introduces the research question. Chapter 5 describes and discusses the methods and data used in the analysis while the results are presented and in chapter 6. The implications of these findings are discussed in chapter 7. In chapter 8, the conclusions of this thesis and suggestions for future research are presented.

2 Background

In this chapter an overview of the CAP is provided, together with a presentation of relevant elements of the EU sugar policy. The 2006 reform is given considerable attention. Additionally, a detailed description of the sugar production is presented.

2.1 The common agricultural policy

A major part of the Treaty of Rome[2] was the establishment of the common market in the EU. In order to harmonize the intervention policies in the agricultural sectors of each country, CAP was created. The CAP was put in place in 1962 and has come to include several separate sets of regulations for different agricultural products, called Common Market Organisations (CMOs).

The objectives of CAP have remained largely the same as they were initially outlined in the Treaty of Rome (current version in EU, 1992: art. 39). They are:

[2] The Treaty of Rome was the treaty that provided the basis for the establishment of the EU. The current version of the Treaty is in reference EU (1992).

(a) to increase agricultural productivity by promoting technical progress and by ensuring the rational development of agricultural production and the optimum utilisation of the factors of production, in particular labour;

(b) thus to ensure a fair standard of living for the agricultural community, in particular by increasing the individual earnings of persons engaged in agriculture;

(c) to stabilise markets;

(d) to assure the availability of supplies;

(e) to ensure that supplies reach consumers at reasonable prices.

During the first three decades of the existence of the EU, the proportion of its budget allocated to CAP amounted to approximately two-thirds of total expenditures. Lately, this share has decreased gradually and to this date CAP expenditures amount to 40 percent of the total budget, corresponding to EUR 55 billion per year (EU, 2009: 18). During the 1980s a number of reforms were implemented to reduce the overall cost of CAP. However, it was not until the mid 1990s that significant changes were made to the original structure of the policy. Further reforms were implemented in 2003 with the aim of increasing the market orientation in the EU agricultural sector (Swedish Institute for European Policy Studies, SIEPS, 2009: 2). Although the implementation of these reforms occurred at different times for several products, the only product left completely unaffected by them was sugar (European Commission, 2003: 8).

2.2 The European sugar economy

In the beginning of the 1970s, the EU was a net importer of sugar, with imports exceeding exports by 2.5 million tonnes (Mitchell, 2005: 141). However, soon thereafter the European sugar sector gained an advantage over foreign producers through the relative increase of production subsidies, swiftly turning the sugar trade balance into a surplus. By 2006, the EU was the second largest exporter of sugar globally, with exports of 5 million tonnes and a surplus of about 3.5 million, with 20 per cent of global sugar production.

2.2.1 The CMO of Sugar

The element of the CAP which regulates sugar production is the CMO of sugar. This came into place in 1968. Its purpose is to ensure a fair income to growers and factories within the EU as well as to secure self-supply of the EU's domestic demand (European Commission, 2003: 8). Moreover, it is designed to protect the EU from the volatile world market sugar prices. The CMO of sugar consists of the following instruments (European Commission, 2004: 5, 9, 15, 21):

Intervention Price. The intervention price is a guaranteed minimum price set by the Ministers of Agriculture in the EU Council each year running from 1 July to 30 June. At this price, the EU is obliged to buy quota-sugar that is offered to the national intervention agencies in each country. Since 1993 and up until 2006, the intervention price has been frozen at EUR 632 per tonne. This price has been equal to two, and even three, times the world market price for sugar.

Minimum Price. The minimum price is the price at which sugar factories are required to buy beets from growers. Since beet growers are dependent on sales to sugar factories, sugar factories hold a considerable market power over the sugar beet price. The purpose of the minimum price is to limit this effect and to ensure some profit-sharing of the production subsidy. It is set by the EU Council of Ministers of Agriculture each year and designed to ensure a fair income to growers and to create stability in the allocation of income between the growers and the factories.

Sugar production quota. The sugar production quota system limits the total quantity eligible for price support. The system is designed to limit over-production within the EU, in effect maintaining the relatively high minimum prices. Each country is allocated a national quota, at the outset based on historical production volumes. The quota is split into two categories: A and B. The 'A quota' was originally designed to guarantee each country a share of the EU's market. The 'B quota' was initially supposed to be the part of the EU production that could be exported with a subsidy. However, actual production exceeds the A and B quotas in a majority of the EU countries. The non-quota sugar is labelled C sugar and does not qualify for any direct forms of production subsidies. C sugar must either be traded at world market prices or be converted into part of next year's A sugar quota. The beets used to produce C sugar are paid for at non-guaranteed prices. Total C sugar production is about 20 per cent of total quota production annually.

Export refund. The total production quota is set at a higher level than the domestic consumption and thus, in order to maintain the price level set by the EU, the surplus must be exported. The export refund is equal to the difference between the domestic price and the world market price. Prior to the 2006 reform, EU exports were on average 5 million tonnes per year, making the EU the second largest exporter in the world after Brazil.

Import tariff. The import tariff is designed to maintain the price set by the EU. The toll price is equal to the difference between the intervention price and world market price. Prior to the reform 2006, EU imported 2 million tonnes each year, making the EU the third largest sugar importer in the world after Russia and Indonesia.

Due to colonial ties, the EU has trade commitments with countries in Africa, the Caribbean and the Pacific Islands (ACP). These give the ACP countries preferential access to the higher prices within the EU. However, there is no demand for these imports within the European market, resulting in the EU exporting corresponding volumes.

The costs of the instruments in the CMO of sugar have in part been self-financed through levies directed at growers and producers.

2.2.2 How the instruments of the CMO of sugar is intended to affect sugar production

There are no actual quotas for sugar beet production. However, sugar beet production is affected by the sugar production quotas since beets in themselves have little value unless processed into sugar. Factories are willing to buy sugar beets as long as they can produce sugar from them with profit. The profitability of the factories' production is determined by the sugar beet price and the factories' production costs as well as the intervention price set by the EU. A reduction in the intervention price may lead to a reduction in the factories' profits. Therefore factories will lose incentives to produce, holding costs constant, and will renounce their production quotas if rewarded for doing so. This decline in sugar production will be translated into a lower quantity of sugar beets demanded. Sugar beet growers will thus lose incentives to produce leading to a decline in sugar beet production.

2.2.3 Sugar beet, sugar cane and its derivatives

What is commonly known as sugar is actually sucrose, which is extracted from sugar beet or sugar cane (European Commission, 2006: 3). Many plants produce sugar as a means to store energy that is not immediately needed, but it is only the sugar beet and sugar cane that have a sufficiently high sugar concentration (above 16 per cent) to enable profitable industrial extraction (Larsson, 1989). Chemically, sucrose extracted from sugar beet is equivalent to that extracted from sugar cane. An important feature of sugar beet and sugar cane is their perishability when unearthed. In order to maximize their amount of extracted sugar, both crops need to be processed within a relatively short period of time after harvest. Thus, international trade volumes of unprocessed sugar crops are very small. Over the years 2002-2004, an average of 26 million hectares of land were devoted to sugar production worldwide, and 140 Mt of sugar were produced in the world from this area (OECD, 2007: 11).

Sugar beet

The sugar beet is a biennial plant, meaning it blooms every second year. During its first growing season it produces a 1 to 2 kilogram taproot containing 15 to 20 per cent sucrose. In the

following growing season, the stored sucrose is used for blooming, thereby decreasing the size of the taproot. Beets farmed for commercial purposes are harvested during the first growing season.

The sugar beets need a long growing season with sun and heat. In temperate climates the sugar beet is planted in the spring and harvested in the fall. High economic returns are not only dependent on good weather and soil conditions but also on the farmer's knowledge of tillage, input of nutrients and maintenance (Nilsson, 2006: 8). The sugar beet is one of the crops most dependent on chemical pesticides and is highly vulnerable to harmful fungus during the first period after sowing (Microbial Activity for a Sound Environment, MASE, 2006: 16). Furthermore, relatively expensive and specialised machines are needed in several of the different cultivation phases. The cultivation is therefore both capital and labour intensive. Commonly, cultivation of sugar beets used to produce quota sugar is regulated through contracts between the farmer and the sugar factories (Nilsson, 2006: 18).

Since the sugar factories have limited storage space, a large portion of the sugar beet harvest must be stored at the farm. The potential decrease of sugar concentration in the sugar beets are high when unearthed, making the storage period particularly delicate considering that the sugar beets must have a minimum average sugar concentration of 16 per cent in order to be processed efficiently. Furthermore, sugar beets need to be transported from the farm to the sugar factories. Transportation costs are commonly paid for by the factories. Then, the sugar beet is refined by the sugar factories, where approximately 85 per cent of the sugar from the sugar beet is turned into white or brown sugar (Nilsson, 2006: 22).

Sugar beets account for around 23 per cent of the total harvested area devoted to sugar production and 25 per cent of the total sugar production worldwide. In the EU, sugar beets are grown on approximately 1.8 million hectares of land, constituting 1.2 per cent of the total agricultural area (European Commission, 2003: 6). Up until 2006, all countries in the EU15, except Luxembourg, cultivated sugar beets, and six of the ten new member states of 2004 cultivated sugar beets. Both Bulgaria and Romania, who joined the EU in 2007, produced sugar beets.

Sugar cane

Sugar cane is a tall perennial grass that requires a tropical or subtropical climate for cultivation (SLI, 2006: 8). Sugar cane is refined into white sugar in a two-stage process. Raw sugar is an intermediate product that can be stored before being refined into white sugar, the second stage of the process. Processing and refining sugar cane in the two-stage process yields sucrose identical to beet sugar. Sugar cane is the basis for around 75 per cent of the total sugar production.

2.3 The 2006 reform

Even though the CMO of sugar, prior to the 2006 reform, had not been fundamentally changed since 1968, an increasing pressure for reform had been built up both internally and externally.

2.3.1 Internal pressure for reform

The internal pressure for reform came mainly from other agricultural sectors within the CAP. These had undergone significant reform since the beginning of the 1990s, creating a considerable discrepancy between the support received by sugar beet farmers and farmers of other arable crops. A cornerstone in previous reforms had been to transform the price subsidy into a direct and decoupled payment.[3] The payments were decoupled from production volumes in order to relieve the market from over-production. The primary goals of the reforms was to let the prices within the EU converge with world market prices, making the farmers' choice of crop to be influenced by market demand instead of the magnitude of the price support (SLI, 2006: 16). Internal pressures emerged to bring the sugar sector in line with the rest of the CAP to improve its consistency. The EU acknowledged the disparity and concluded that the exclusion of reform had created competitive distortions among farmers, encouraging farmers to grow sugar beets even though it would be more profitable to grow other crops (European Commission, 2003: 9). Furthermore, industrial users of sugar had put pressure on the EU to increase the competitiveness of the sugar sector in order to bring down sugar prices in the EU.

2.3.2 External pressure for reform

There were many sources of external pressure for reform. Following the Uruguay round of WTO negotiations between 1986 and 1994, export refunds from the EU were restricted to 1.3 million tonnes per year. However, the EU interpreted the restriction to only include B quota sugar, still enabling C sugar exports. In addition, the EU had forced through a safeguard clause, stipulating that the imports from the ACP-countries would not be included in the export refund restriction. Consequently, the Uruguay round had only minor impacts on EU trade policy. In 2002, a WTO dispute panel brought forward by Australia, Brazil and Thailand challenged the EU's interpretation, and in 2004 the WTO ruled in favour of the appealing countries. The WTO ruling found that C sugar exports were benefiting from subsidisation of in-quota production and that the imports made under the sugar protocol had to be included in the export refund restrictions. As a result, the EU was forced to cut yearly exports by approximately 4 million tonnes (SLI, 2006: 20).

[3] The MacSharry reform (1992), Agenda 2000 (1999) and The CAP reform of 2003. See NEI, 2003: 3-6 for an overview of the previous reforms to the CAP.

Moreover, LDC countries were to be allowed full access to the EU market. Finally, the Doha round of trade negotiations in the WTO led the EU to agree upon a conditioned elimination of all forms of agricultural export support by 2013, given the compliance of other key parties in the round. These reductions of EU exports were expected to make the domestic sugar production too high without a reform (OECD, 2007: 59). In November 2005, an agreement was reached by the EU Council of Agricultural Ministers to carry out a reform of the CMO of sugar.

2.3.3 Objectives of the reform

The opening paragraph of the reform regulation (EU, 2006: 1) states that "In order to pursue the objectives set out in Article 33 of the Treaty[4] […] it is necessary to fundamentally review the common organisation of the market in the sugar sector" (EU, 2006: art. 33). The reference to Article 33 of the Treaty is referring to the general objectives of CAP as listed in section 2.1. Building on top of these objectives, the reform regulation specifies further objectives of the reform (European Commission, 2006: 7):

i. guarantee a regular supply of sugar while protecting the European market from extreme price fluctuations;
ii. make the sugar sector more competitive, able to withstand international competition;
iii. move towards more market orientation while restructuring the sector;
iv. provide a fair standard of living for farmers and maintain rural communities;
v. maintain preferential access for ACP and LDC producers to the high value EU market;
vi. simplify the regime and make it more transparent;
vii. limit budget cost.

Although the reference to the general objectives of CAP indicates that the objectives of the reform are aimed at the agricultural sector, as opposed to the sugar factories, there is no detailed description of how the objectives are to be achieved. No official regulation document specifies what adjustments of the beet growers will be needed to achieve the objectives. This may be a result of the political imbalances affecting the composition of the reform (SLI, 2006: 17).[5]

One way of fulfilling the objectives is to reduce the subsidy to sugar beet production, so that sugar beet production volumes will decrease. This is verified by the EU's acknowledgement prior to the reform that a competitive distortion among farmers was present, encouraging farmers to grow sugar beets even though it would be more profitable to grow other crops (European Commission, 2003: 9). In a report financed by the EU, it was concluded that the CMO of sugar

[4] Referring to the Treaty establishing the European Community, see EU (2009).
[5] The EU itself noted, three years before the reform was implemented, that the planned objectives were unable to "provide answers to a number of basic questions and dilemmas" (EU, 2003).

had a significant impact on the profitability of sugar beet production leading to an over-production of sugar beets (The Netherlands Economic Institute, NEI, 2000: 149). Furthermore, the EU communicated that sugar production in several EU regions was unsustainable in the long-term, referring to sugar beet growers and some sugar factories. The objective of restructuring the sector was to remove "from production those growers and processors [factories] that will be unable to operate in a business environment in which prices have been severely cut" (European Commission, 2006: 23).

Objectives i. and iv. could possibly be viewed as going against a reduction of the sugar beet production, by stressing the need for continued production subsidies to sugar beet growers without any reduction in production volumes. However, three years prior to the reform the EU recognised that, even given a full liberalisation of the European market, there would be no serious challenge to the security of sugar supply to the EU (European Commission, 2003: 33). Further on, the EU noted that sugar beet growers are at no risk of a sub-standard way of living since they are better-off than the average EU taxpayer (European Commission, 2003: 12) and have a higher income than the average EU farmer (European Commission, 2003: 6). In other words, the fulfilment of objectives i. and iv. can be said to be at no serious risk even given a reduction of sugar beet production.

2.3.4 Reform instruments

The reform came into effect in July 2006 and was completed as of the end of the year 2009. There were two main instruments in the reform both aimed at reducing the quotas held by sugar producers: a price reduction and a sugar quota buy-back scheme.

The intervention price for refined sugar was cut by 36 per cent and the minimum price of sugar beets reduced by no less than 39.5 per cent, both in two steps during years 3 and 4 of the reform. The declining support prices were supposed to decrease the production of sugar by making it unprofitable to producers with high production costs. These producers would then not be able to fill their sugar production quotas. Sugar beet growers were to a large extent to be compensated through a direct payment covering 64.2 per cent of the revenue loss from the price cut. These compensational payments were decoupled from production volume and thus made part of the decoupled payments in the other CAP sectors.

In addition to the reduced support prices, the sugar quota buy-back scheme presented sugar producers with further incentives to voluntarily reduce their sugar quotas. A producer with unfilled production quotas due to the reduced support prices could renounce their quotas to the EU and receive a set price for them. The buy-back price was declining over the four year period

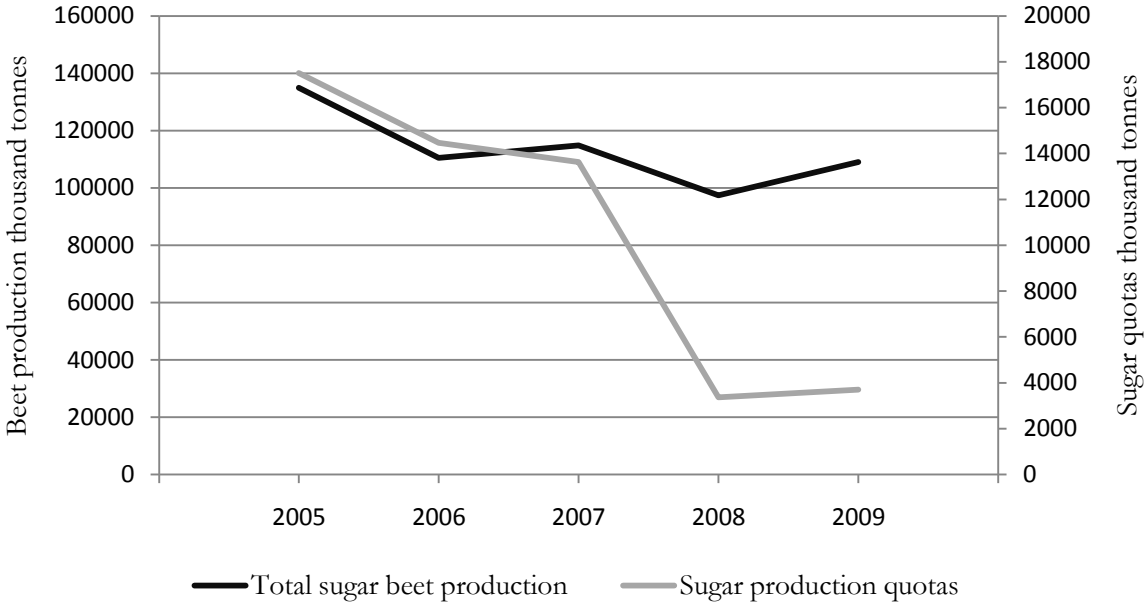
to encourage quota reductions in the first years of the reform. The quota reduction required to balance the EU market in light of the export restrictions was estimated by the EU at around 6 million tonnes (OECD, 2007: 62). Also, following the reform, the A and B quotas were merged into one quota, henceforth referred to as in-quota production.

The reform meant no radical change to the structure CMO of sugar. It still consists of production subsidies, production quotas and protective trade policies (SLI, 2006: 31).

2.3.5 Effects of the reform

The reform was completed as the sugar production of 2009 was harvested and brought to the market 2010. By 2010, the intervention price for sugar had been reduced by 36 per cent and the minimum beet price had been reduced by 45 per cent. Production under quota was reduced to 13 million tonnes, a 30 per cent reduction. The land utilised by beet growers was reduced by 700 thousand hectare, a 31 per cent reduction, and the number of beet growers was reduced as well. Countries that stopped producing sugar beets altogether were Bulgaria, Ireland, Latvia, Portugal and Slovenia (OECD, 2010: 4). Countries that decreased the sugar beet production by more than 50 per cent were Czech Republic, Finland, Greece, Italy, Lithuania and Slovakia. The number of factories producing sugar declined from 188 in 2005 to 106 in 2009. In Figure 2.1, the amount of total sugar beet production and the changes in sugar production quotas on the EU27-level during the reform years are depicted. Notably, the sugar production quotas declined considerably in 2008, with little corresponding change in the sugar beet production.

Table 2.1. Total sugar beet production and sugar production quotas 2006-2009.



The total sugar beet harvest of the last year of the reform was unusually high due to exceptionally good weather conditions for sugar beet production in Europe. Moreover, the world market price of sugar was remarkably high, at several times even above the market price within the EU, partly due to harvest failures in Brazil and India (OECD, 2010: 5).

3 Previous Literature

In this chapter the economic theory related to the CAP is described, followed by a detailed overview of the previous reform research having been performed to this date.

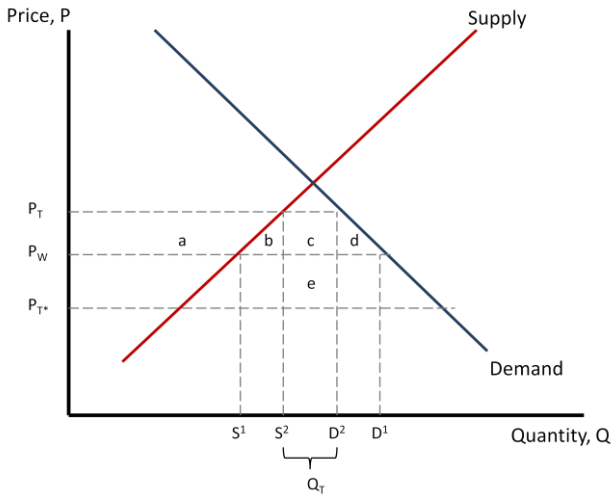
3.1 Economic framework

In order to understand how the CAP affects the European market this section will introduce fundamental economic theory of how governmental policies affect countries, production levels and prices within an economy. These economic theories should be born in mind when studying the models used in previous research, presented in section 3.2. In the descriptions below sugar is used as the commodity affected by the trade policy, EU as the economy introducing the trade policy and the world market as the counterparty. The different trade policies are analysed one at a time. Furthermore, given the significant size of EU's trade flows of sugar it is reasonable to assume that EU trade policies impact world prices (Buckwell *et al.*, 1982: 41).

3.1.1 Import tariff

An import tariff is a trade policy where goods are levied with a tax when imported to an economy, as illustrated in Figure 3.1. In the absence of a tariff, the price of sugar will be the world market price P_w in both the EU and on the world market. Introducing a tariff, it will act as a wedge between the two trading parties. In the EU, producers will produce more and consumers demand less given the higher price P_T. Consequently, less import is needed from the world market lowering the world market price P_{T^*}. The welfare costs and benefits of different groups are illustrated as sums of areas labelled *a, b, c, d, e*. The producers gain *a* since they can get higher prices for their product that they produce in greater quantities. Consumers are worse off by a, b, c, d because of the higher prices. The EU gains by collecting tariff revenue, equal to the areas *c* and *e*. The net cost of a tariff is $b + d - e$. The area *b* represents a production distortion loss resulting from domestic producers producing too much. Area *c* is a consumption distortion loss resulting from consumers consuming too little. The rectangle *e* represents gains from terms of trade arising from reduced import prices (Krugman and Obstfeld, 2009: 191).

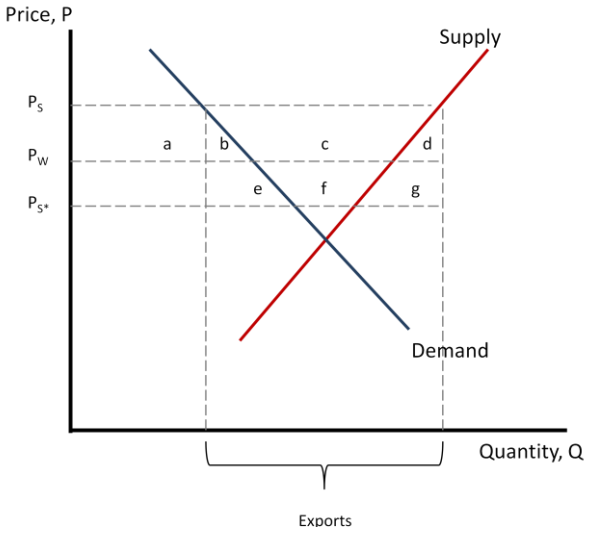
Figure 3.1. Import tariff illustration.



3.1.2 Export subsidies

An export subsidy is a payment paid to an exporting party, as shown in Figure 3.2. The consumers' loss is the area *a* and *b*. The producers gain area *a, b* and *c*. The EU's subsidy costs are represented by the area *b, c, d, e, f, g*. Consequently the net cost of an export subsidy is *b, d, e, f, g*. As with the case of a tariff, the triangles *b* and *d* represent consumption and production distortion losses. However, in contrast to the effects of a tariff, an export subsidy worsens the terms of trade by lowering world market prices thereby increasing the cost of the export subsidy. In other words, the costs will unambiguously outweigh the benefits of an export subsidy(Krugman and Obstfeld, 2009: 192).

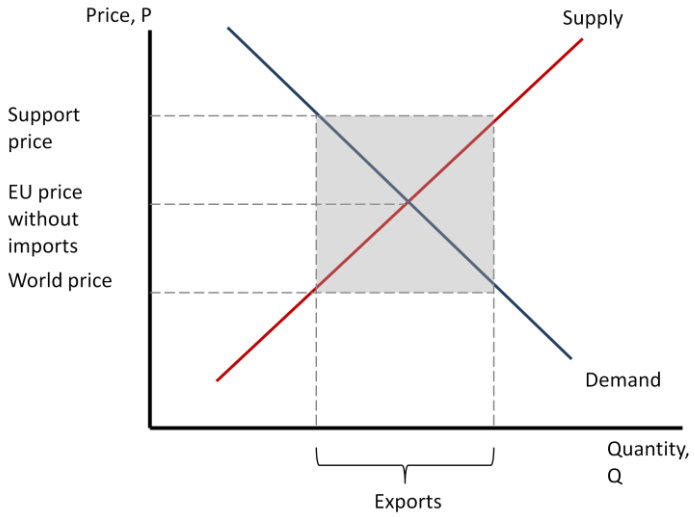
Figure 3.2. Export subsidy illustration.



3.1.3 The specific case of CAP

When applying the models described above on the specific case of the CAP one must consider the fact that EU would be a net importer under free trade. In the CAP, prices for agricultural products are fixed, not only above the world market price, but also above the price where European consumption meets production, see Figure 3.3[6]. In order to ensure the high prices constructed through the import tariffs, the excess supply must be exported with a subsidy off-setting the difference between European and world market prices (Krugman and Obstfeld, 2009: 194).

Figure 3.3. The specific case of CAP



There are two features of the CAP distinguishing it from other price support systems. The first feature is that trade within the EU occurs at the intervention price rather than at world market prices. The other feature is that all countries commonly finance the CAP. Without common financing there would be a clear incentive for countries to satisfy local demand by import, thereby collecting import levies, rather than purchasing at high price from within the community. Furthermore, importing countries would avoid sharing the export subsidy costs from countries exporting to the world market (Buckwell *et al.*, 1982: 31).

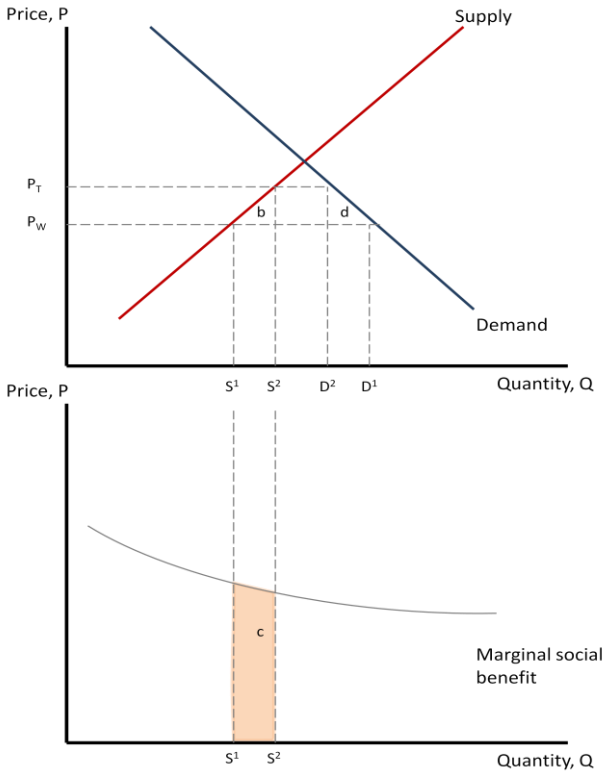
3.1.4 The domestic market failure argument for a tariff

A common argument supporting tariffs is the possibility of high unemployment if an industry sector is not supported. It argues that by supporting one sector in its production the economy as a whole may benefit. These improvements are not considered by the sector, and therefore not

[6] However, in 2009 the world market price rose exceptionally, making this illustration inapplicable to that particular period.

taken into account when deciding production levels (Krugman and Obstfeld, 2009: 220), see Figure 3.4. There are additional benefits to producer surplus known as marginal social benefits.

Figure 3.4. Social benefits of a tariff illustrated.



Blomqvist and Lundahl (2002: 49) present other situations when free trade may lead to welfare losses. An example of this occurrence is when free trade is introduced yet farmers refuse to accept falling wages as a result of relative prices of agricultural goods falling. Such inflexibilities may call for a market intervention in order to avoid a welfare loss.

3.2 Previous reform research

Several studies on the effects of a reform of the CMO of sugar have been made. None of the studies published to this date have been able to use actual data of the reform due to its recent ending. Instead, the focus of these studies has been to simulate the effects of reform. Since the specific structure of the actual 2006 reform was unknown to the authors of these studies, the simulations had to be based on the authors' anticipations of the reform structure and not on its actual structure. Consequently, the formal description of the EU sugar market and the assumptions made about it in these studies are of relevance to this paper. The results of the simulations are also reported, however it is the directions of these rather than their magnitude that are important, due to the differences between the actual reform and the reform simulations.

3.2.1 The reform simulations

The first study to analyse the effects of a reform of the CMO of sugar was Frandsen *et al.* (2003), however this study simulated the reform only as a 25 per cent reduction of the support prices for sugar. Building on the specification of that study, Gohin and Bureau (2006) simulated the effects of the full 36 per cent sugar price reduction, without taking the voluntary quota buy-up scheme into account. Another study by Buysse *et al.* (2007) used a 39.5 per cent sugar price reduction as well as the transfer of quotas between growers to simulate the impacts of the reform on the farm-level. However, the way in which the voluntary quota buy-up scheme provides further incentives for sugar factories to reduce the sugar production quotas was not included in this study. Drawing from these three studies, it is clear that the effects of the actual 2006 reform have not been completely simulated in previous research.

3.2.2 The reform's impact on sugar beet production

Common for all three studies are the central role played by the sugar beet production in the reform simulations. Frandsen *et al.* (2003: 3) noted that the total production of sugar beets is of key importance in determining the effects of a reform. In the study by Buysse *et al.* (2007), the sugar beet production is the main variable in the simulation of the 2006 reform. Similarly, Gohin and Bureau (2006: 226) acknowledge that the results of the reform evaluation to a large extent depend on how the supply of sugar beets is simulated. Furthermore, these authors stress that since producers have been insulated from world market prices since the 60s, there have been little statistical variations to exploit in simulations, why sugar production has had to be modelled on assumptions based on thin evidence.

In particular, two aspects of the sugar beet production have been difficult to accurately model. First, the level of production costs and rents under production quotas have been treated differently. The simulations of production costs have been based either on aggregate country-level historical production data (in Frandsen *et al.*, 2003 and Gohin and Bureau, 2006) or on estimates of marginal costs at the farm level (Buysse *et al.*, 2007). The rents under production quota are defined as the difference between price received and the marginal cost multiplied by the quota quantities. The effects of a reform reducing the received price on the quota rents were therefore dependent on how marginal costs were treated. Using country-level cost simulation implicitly assumed similar costs in farms from the same country, which has been shown to badly represent the real diverse production costs between farms in the same country (Bureau *et al.*, (1997).

Furthermore, the simulation of the quota rents was dependent on for what market player the price reduction of sugar was modelled to have the most significant effect. The relationship between sugar factories and sugar beet growers meant that it was not clear if the reduced sugar price would imply a proportionate reduction of the price for sugar beets. Gohin and Bureau (2006: 240-241) assumed that the price for sugar beets would decrease more than proportionally since the factories are able to put pressure on the beet growers due to their market power. Frandsen *et al.* (2003: 6) instead assumed that the prices for beets followed the prices for sugar, while acknowledging that the split of the quota rent between factories and growers in reality was much more difficult to determine. In the study by Buysse et al (2007: 45) both of these alternatives were simulated separately. The validity of the simulations of quota rents was therefore dependent on the assumptions made about the production costs as well as about the relationship between factories and beet growers.

Second, the supply of sugar beets outside the production quotas has been treated differently in the studies. The non-quota production does not receive any subsidy from the EU and must therefore be sold at the world market price of sugar. However, it has often been claimed that the quota system induces a cross-subsidisation of non-quota production (Gohin and Bureau, 2006: 228). During times of relatively high world market prices and high in-quota production, the average cost of non-quota production is lowered because of a larger production scale. This implied that the quota system allowed producers to use their quota rents for over-production. However, several studies have recognised that during periods of low world market prices for sugar, these hardly covered the marginal costs of non-quota production, why other factors must have driven this production.[7] Frandsen *et al.* (2003: 9) noted that in the case of bad harvests that leave the quotas of a beet grower unfilled, the grower risks losing their future contracts. As a result, the production simulation included a fixed over-production linked to the yield variability for all growers, which provided some information on the reasons for non-quota production. Gohin and Bureau (2006: 232) discussed this insurance strategy in depth and were able to conclude that the higher the support price of in-quota sugar, the more profitable it becomes to produce non-quota sugar as insurance. However, this insurance strategy was unlikely to explain all the observed non-quota sugar production. Therefore, these authors introduced in their model the possibility that non-quota sugar was produced by farmers to ensure they will be allocated a higher production quota in the future.[8] Such 'reference building' behaviour was thus included as

[7] See Adenäuer and Heckelei (2005: 3) for an attempt to mathematically describe non-quota production.

[8] Growers anticipating that the ongoing reform will lead to a redistribution of future production quotas by the EU, know from experience that such reallocations historically have been based on actual production levels, as mentioned in section 2.2.1. Given that the prices set for those future quotas are above world market prices, a low-cost producer may reasonably expect a positive quota rent from them.

contributing to some of the observed high levels of non-quota production despite low world market prices (Gohin and Bureau 2006: 233). In the study by Buysse *et al.* (2007) both the insurance and the reference building strategy were included to simulate the total sugar beet production on the farm level.

In evaluating the effect of the 2006 reform on the total sugar beet production, the assumptions about production costs and quota rents and the different explanations for the production of non-quota sugar beets in previous research are of high relevance. Since the 2006 reform focused on the in-quota prices and the production quotas, its effects on the total sugar beet production should be analysed bearing the linkages between in-quota and non-quota sugar beet production in mind. Further on, the previous simulations of a reform made different assumptions concerning the changes of the production quotas. These will be reported below followed by a summary of the results of the previous studies.

3.2.3 The simulations of sugar quota changes

In the two studies by Frandsen *et al.* (2003) and Gohin and Bureau (2006), the production quotas were not changed. Instead, they showed how the reform made the production quotas in several countries unfilled. As the sugar price declined to the marginal cost of production, the quota rents were eliminated and production took place at a level where price equalled marginal cost. In countries where the marginal costs were above the minimum price, the production quotas were unfilled. No account for what would happen to the unfilled quotas at the country level was included in either of these studies.

Given the farm-level approach of the simulation in Buysse *et al.* (2007), the authors were able to simulate the consequences of unfilled production quotas due to the reform. The simulation allowed unfilled quotas of inefficient beet growers to be transferred to beet growers who still could obtain positive quota rents by increasing their production. According to the model, quotas were renounced only when no beet grower could obtain positive rents from filling them (Buysse *et al.* 2007: 37). The simulation results suggested that very few production quotas were left unfilled in the Belgian sugar market because of the reform (Buysse *et al.* 2007: 45).

However, it should be noted that this conclusion was dependent on the mathematical simulation, with unfilled quotas being redistributed equally from growers with negative quota rents to those with positive rents (Buysse *et al.* 2007: 37). This process may differ significantly from how factories redistribute quotas among their supplying beet growers in practice. Gohin and Bureau (2006: 226) noted that interactions between growers and factories could be affected by distances between them as well as the high fixed costs of factories.

In light of the recently available data on the changes in production quotas that occurred as a result of the reform, the impact of the quotas in achieving the reform objectives may be more directly evaluated. Despite the misrepresentation of the actual 2006 reform in the previous reform studies, the obtained results of them are of relevance to determine in what direction the assumptions in the studies affected the outcome of the reform.

3.2.4 The results of the reform simulations

The results of the simulation by Frandsen *et al.* (2003) was a reduction of total sugar beet production in the EU primarily caused by unfilled production quotas in countries with high production costs. Non-quota production was to a large extent unaffected by the reform because farmers with such production, of which a majority work in low-cost countries, produce close to the world market price. Gohin and Bureau (2006) obtained similar results concerning in-quota production in countries with high production costs. However, non-quota production was completely eliminated in this simulation. The modelling of non-quota production as dependent on the in-quota price and on the quota levels, demonstrated that the reduction of the support prices significantly reduced the prevalence of cross-subsidisation and the value of the insurance strategy of beet growers. The farm-level simulation by Buysse *et al.* (2007) on Belgian farms primarily affected quota rents of growers. However, these effects were not enough for producers to start renouncing production quotas. Total sugar beet production in the sample was significantly reduced due to the declined quota rents, reducing the cross-subsidisation of non-quota production.

4 Summary and research question

Prior to the reform, the CMO of sugar had remained unchanged since its establishment in 1968. A strong case for reform had been built up by internal and external parties alike, reacting to the discrepancy between the protectionist policies for sugar in comparison to other crops as well as its distorting affects on the world market. The EU acknowledged the negative consequences of the protectionist policy that had created an increasingly imbalanced domestic market. Objectives of the reform were specified. However, no detailed description of how the objectives were to be achieved was included in the regulation. One way of directly fulfilling the reform objectives is to reduce sugar beet production. This way is in line with economic theory of trade and previous reform research, as well as with the conclusions drawn by the EU prior to the reform.

The 2006 reform introduced two instruments: a reduction of the support prices and a sugar quota buy-back scheme. The instruments were to a large extent aimed at reducing the sugar quota, and

not directly at decreasing sugar beet production. In other words, the EU focused on the sugar quotas of the sugar factories and not primarily on the sugar beet growers.

There is no challenge to the notion that there is a linkage between sugar quotas and total sugar beet production. However, previous studies only provide limited insight into to what degree a change in sugar quota affect sugar beet production. The completion of the reform provides an excellent opportunity to shed light on this matter. In order to explore the aim of this thesis, the following questions will be investigated:

To what extent did the sugar quota reduction of the 2006 reform affect sugar beet production volume within the EU?

5 Method and data

This chapter describes the model that will be used to respond to the research question followed by a report of what data are used to measure the model variables.

5.1 The model

To evaluate the effects of the sugar quota reduction of the 2006 reform on the total sugar beet production within the EU the following econometric model will be employed:

$$\Delta beet_{i,t} = \beta_1 \Delta sugarquota_{i,t} + \beta_2 temp_{i,t} + \beta_3 factoryclose_{i,t} + \delta_t + \varepsilon_{i,t} \quad (1)$$

$\Delta beet_{i,t}$: Yearly change of sugar beet production in country i year t (percentage change)

$\Delta sugarquota_{i,t}$: Yearly change of sugar production quota for sugar factories in country i year t (percentage change)

$temp_{i,t}$: Mean temperature during beet growing months April to October in country i year t (degrees Celsius)

$factoryclose_{i,t}$: A dummy variable indicating if any sugar factories have been closed down in country i year t (value 1 if closed factory, value 0 otherwise)

δ_t: A dummy variable capturing the unobserved, year-specific effect in year t (note that the intercept in the estimated model will be different for all years due to this variable)

$\varepsilon_{i,t}$: An error term

The analysis will provide evidence that yearly changes in the sugar quota does affect yearly changes in the sugar beet production, by testing if the estimate of β_1 is significantly different from zero. The magnitude of the estimate of β_1 will indicate the strength of the linkage between sugar quotas and beet production. A positive value of the estimate of β_1 will indicate that a percentage decrease in the sugar quota leads to a percentage decline in the sugar beet production. A positive sign on β_1 is expected by the way the EU structured the reform.

The model assumes a causality were sugar quotas determine sugar beet production. This is in line with the structure of the CMO of sugar as outlined in section 2.2.2. However, it could be argued that the causality goes in the other direction. In a scenario where sugar beet production is substantially reduced due to some external factor, the cost of beets for factories producing sugar may increase to a point where quotas are renounced since production no longer can be made profitable. In all econometric applications, the problem of reversed causality is in general hard to control for. If the causality really is going in the reverse direction, the 2006 reform will only be possible to evaluate with another model specification.

5.1.1 The dependent variable: Sugar beet production

The dependent variable of the model is the yearly changes in total sugar beet production volume. This measure includes both in-quota and non-quota production of beets. For each country, one year's change of production is related to the production of the previous year, as in equation (2).

$$\Delta beet_{i,t} = \frac{beet_{i,t} - beet_{i,t-1}}{beet_{i,t-1}} \quad (2)$$

This construction of the variable provides the possibility to observe the relative impact of the reform on the total production level, which would not be possible if for instance the absolute decline in production was used instead.

5.1.2 The independent variable: Sugar production quotas

The independent variable that will represent the reform instruments' impact on the total sugar beet production in the model is the yearly changes in sugar production quotas. The yearly change of the production quota is related to the previous year's quota for each country, as shown in equation (3).

$$\Delta sugarquota_{i,t} = \frac{sugarquota_{i,t} - sugarquota_{i,t-1}}{sugarquota_{i,t-1}} \quad (3)$$

The variable for the sugar production quotas is defined in the same way as the variable for beet production, to enable a relative evaluation of the reform's impacts. By using relative changes in

both variables the model will estimate the sugar quota elasticity on beet production. It will explain the percentage change that can be expected in beet production given a one per cent change in the sugar quota.

5.1.3 Control variables: temperature, factory closedowns and year fixed effects

To reduce the risk of omitted variable bias in the model and to increase the accuracy of the estimated coefficients, control variables are included. Control variables are used to take into account factors that affect the total sugar beet production while being uncorrelated with the sugar quotas. The variables that are controlled for in the model have been discussed in previous reform research as potentially affecting total sugar beet production.

As noted in section 2.2.3, sugar beet production is highly affected by climatic conditions such as temperature or number of sun hours. Buysse *et al.* (2007: 30) noted that production decisions are made before weather conditions affect the production output. Therefore, the average mean temperature during summer months in each year in each country is included in the model to control for the effects on sugar beet production of weather. Otherwise, for instance a decline in sugar beet production due to bad weather, in combination with unchanged sugar quotas, would upset the estimated relationship between beet production and quotas.

The modelling of sugar beet production should take the dependency of beet growers on factories into consideration, as explained in sections 3.2.2 and 3.2.3. As the distance between the farms and factories gets bigger, the transportation costs and risk of loss in sugar beet quality increase. In a scenario of a factory closedown in a country where alternative factories are unavailable because of long distances, sugar beet production in that country should decrease to a large extent, potentially more than what is accounted for in the decline in production quotas due to the factory closedown. The effect of a factory closedown has a non-reversible effect on sugar beet production (OECD, 2007: 20). Therefore, factory closedowns are controlled for in the model. This variable has been discussed in previous research (e.g. Gohin and Bureau 2006: 226) but because of difficulties simulating the effects in equilibrium models it has been excluded. Due to better data availability this variable may now be included.

There is reason to believe that the sugar beet production in different years is affected by unobserved, time-specific factors. Such factors could be shocks to sugar markets outside the EU, or changes in production technology. Other factors that are hard to observe could also affect sugar beet production in one particular year. Due to these factors' influence on sugar beet production, there is a need to control for year specific effects in the model, otherwise the estimated relationship between beet production and sugar quotas may be flawed because of

unobserved effects in each year. This is done by including dummy variables for each year, δ_t. Fixed effects estimations are used to obtain unbiased estimators when there are unobserved time factors that are correlated with other variables. If the fixed effects are not taken into account in the econometric analysis, biased results will be obtained due to the omission of the unobserved variables (Woolridge, 2009: 457). By including year fixed effects, the average differences across years are controlled for and the estimated coefficient will show the average effect of the independent variable in all years (Woolridge, 2009: 482).

By including year fixed effects in the model, instruments of the reform that are implemented at the same time in all countries will be captured by the year dummy variables. To not be captured by the year fixed effects, the independent variables must change across countries for any yearly observation (Woolridge, 2009: 458). This implies that the reduction of the support prices of the 2006 reform will be captured by the year fixed effects.

5.1.4 Possible extensions of the model: country fixed effects and country groups

In order to test for further aspects influencing the relationship between beet production and sugar quotas some extended regressions of the model will be run. Buysse *et al.* (2007: 31) recognised that beet production is dependent on farm-specific characteristics such as soil composition, grower risk aversion and cost structure. Other studies have assumed that these characteristics were dependent on the countries in which the farms operated (e.g. Gohin and Bureau, 2006). This could motivate that there are unobserved, country-specific factors in the model that can be controlled for using country fixed effects. In the model, this is done by including dummy variables, α_i, for all countries.

As noted in section 3.2.2 previous studies have stressed the importance of production costs in determining quota rents and thus the change in the sugar quotas. Given the difficulties in assessing production costs accurately previous research has grouped countries based on historical production data indicating levels of production costs in different countries (Frandsen *et al.*, 2003). According to the specifications of previous research, the extent to which the reform influences beet production is related to the level of production costs in different countries. This will be accounted for in an extended regression, by including dummy variables for groups of countries, with different production costs, $group_k$ (k indexes the country groups). These dummy variables will be interacted with the slope coefficient of the independent variable to allow for different impacts of sugar quotas for different country groups, $\beta_k group_k \Delta sugarquota_{i,t}$. Since the usage of all country groups imply perfect multicollinearity in the model, the baseline β_1 will be excluded from the model. Furthermore, there is no need to allow for varying intercepts between

the groups in this extended regression since the model employs relative changes to both the dependent and the independent variable, implying that the constant should be zero for all groups. Therefore, the focus will be the differences in the slope coefficient between the groups.

Finally, two econometric issues will be tested for in the regression of the model that is of most relevance to the discussion of the results. The Hausman test will be performed to see if it is correct to control for year fixed effects rather than random effects. The regression will also be run with robust standard errors to see if this method would increase the significance of the estimators.

5.2 Data

The evaluation of the 2006 reform will be based on observed changes in the sugar beet market during the implementation years. A panel data set consisting of data on the variables of the model for the 23 sugar producing countries in the EU as of 2006 has been compiled. In the following, the data sources of these variables are described. Summary statistics are reported in Appendix A. A comprehensive overview of the data collection and variable construction is presented in Appendix C.

5.2.1 Sugar beet production

Data on the annual total sugar beet production in all 23 EU countries where production takes place have been compiled from the Eurostat agricultural database (Eurostat, 2010). The database is a collection of reported statistics from the national agencies responsible for agricultural data in each country. Across countries there is some variation in the quality of the statistics. Where observations were missing, the report Sugar Statistics 2009 produced by the Comité européen des fabricants de sucre (CEFS) was used as a complementary source of information (CEFS, 2010). The two sources report the same values for most years, but for some there are differences reducing the comparability of the two sources. However, since this paper uses relative changes, minor differences in magnitude should not significantly affect the reliability of the estimations. The summary statistics of the variable as well as the average absolute production levels in tonnes of sugar beets of each EU country are reported in the appendix in Table A.1.

5.2.2 Sugar production quotas

The data on the sugar production quotas have been compiled from a combination of EU administered resources. The allocated quotas as of the production year before the reform was used as the basis of the data, found in the EU legislation of the CMO of sugar European Commission (2006: 10). The total amount of quotas renounced in each country each year was reported as an appendix to the EU press release of 2009 (European Commission, 2009a) and may

be found in the archives of the Directorate-General of Agriculture provided on the internet (European Commission, 2009b).[9] The summary statistics of the variable as well as the average absolute production quotas in tonnes of sugar of each EU country are reported in the appendix in Table A.2.

Some caution is required when using the data of this variable since it may include a small misrepresentation of the actual production quotas. This is due to the fact that under the CMO of sugar the regulators have an option to allow a temporary increase in production quotas under certain circumstances. For instance, in the first year of the reform additional quotas were made available to factories that obtained levels of production significantly larger than the quotas allowed according to the regulation. Also, following the high production levels of 2009 the EU offered additional quotas to some factories. This problem is encountered in all studies evaluating policy reforms where some exceptions from the rules are allowed (see e.g. Buysse *et al.* 2007: 44).

5.2.3 Control variables

Data on the temperature variable were collected from the EU-FP6 project Millenium resource (EUFP-6, 2010).[10] Due to the unavailability of time-series of national average temperatures, the data from a representative climate station in each country's sugar beet production area were used. Time-series of average temperatures during the six summer months of each country were thus obtained.

The data on factory closedowns in the countries were compiled from the CEFS report Sugar Statistics 2009 (CEFS, 2010). A dummy variable was constructed taking the value one if any factory was closed down in one country in one year and the value zero otherwise. The summary statistics of the control variables of this paper are presented in the appendix in Table A.3.

The grouping of countries according to their production costs was based on the study by Frandsen *et al.* (2003: 9). However, this study only grouped the EU15 countries, why the other countries were allocated to the different groups in this thesis using similar decision rules as Frandsen *et al.*. The summary statistics of the country groups is presented in Table 5.1 below, and the basis for the grouping process is described in the appendix in Table B.1.

[9] Bulgaria and Romania became members of the EU in the year of 2007. Therefore they were included in the 2006 reform from that year. They were allocated quotas according to source 43 in the year 2007 and were allowed to begin renouncing their quotas in the same year (EU, 2007).

[10] We acknowledge the climate dataset from the EU-FP6 project Millenium (geography.swan.ac.uk/millennium/index.htm) and the data providers in the ECA&D project (eca.knmi.nl).

Table 5.1. Summary statistics of the country groups used in the extended model.

		Obs	Mean	Std. Dev.	Min	Max
Group 1	Δbeet	22	-0.3111	0.3496	-1	0.1944
	Δsugarquota	22	-0.2132	0.3085	-1	0
Group 2	Δbeet	23	-0.0834	0.3420	-0.9452	0.8826
	Δsugarquota	23	-0.0975	0.2192	-1	0
Group 3	Δbeet	23	-0.1043	0.1849	-0.6614	0.2355
	Δsugarquota	23	-0.1054	0.1630	-0.6580	0
Group 4	Δbeet	16	0.0100	0.1395	-0.2041	0.2370
	Δsugarquota	16	-0.0431	0.0789	-0.2216	0

Group 1: Bulgaria, Finland, Greece, Italy, Latvia, Portugal, Slovenia

Group 2: Ireland, Lithuania, Netherlands, Romania, Slovakia, Sweden

Group 3: Belgium, Czech Republic, Denmark, Hungary, Poland, Spain

Group 4: Austria, France, Germany, United Kingdom

6 Results and discussion

Before running the regression of the basic model, a simple bivariate regression of the sugar beet production on the sugar quotas is run. Table 6.1 reports the result of this bivariate regression. The coefficient of the sugar quota is significantly different from zero at all generally acceptable levels of significance and the explanatory power of the model is not particularly low, at 0.477 for the adjusted R^2. The magnitude of the coefficient is close to one, implying that a one per cent reduction in the sugar quotas will lead to a 0.934 per cent decline in sugar beet production. However, the results of this simple regression are highly likely to be biased due to the omission of factors that are correlated with the independent variable.

Table 6.1. Results of bivariate regression.

	Δbeet	
	Coefficient	t-statistic
Δsugarquota	0.934***	(8.76)
β0	-0.0192	(-0.72)
N	84	
R^2	0.484	
adj. R^2	0.477	

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Next, the outcome of the regression of the basic model is reported. As can be seen in Table 6.2, the coefficient of the independent variable remains similar, although its magnitude has decreased slightly. The basic model has an explanatory power, as shown by the adjusted R^2, of 0.566,

however some of this increase from the simple regression is attributed to the added number of independent variables.

Table 6.2. Results of regression of the basic model.

	Δbeet	
	Coefficient	t-statistic
Δsugarquota	0.854***	(7.98)
temp	-0.00424	(-0.58)
factoryclose	0.0299	(0.64)
δ2006	-0.288***	(-4.57)
δ2007	-0.188**	(-2.92)
δ2008	-0.208**	(-3.19)
β0	0.205	(1.58)
N	84	
R^2	0.597	
adj. R^2	0.566	
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$		

The impact of the average temperature is insignificant in this regression. Weather was included as a control variable to control for variations in temperature between countries and years affecting beet production. However, the results imply that no country specific weather variation significantly affecting sugar beet production can be found when also controlling for year effects as captured by the year dummy variables. The control variable for temperature will thus be excluded in further regressions. Moreover, the control variable for factory closedowns is insignificant, an unexpected result due to the interdependency of sugar factories and beet growers. For this reason the variable will be reintroduced when regressing the extended model with country fixed effects, however in further analysis of the basic model it will be excluded. Finally, the impacts of the year dummy variables tend to be significant, however the base year of 2009 is insignificant at the 10 per cent significance level making the inference of all year effects difficult since they have to be related to the base dummy variable (Woolridge, 2009: 234). In the regression of the basic model where all control variables except for year effects have been excluded, the significance of all year dummy variables allows for interpretation. The result of this regression is reported in Table 6.3.

Table 6.3. Results of regression of the basic model only with year effects.

	Δbeet	
	Coefficient	t-statistic
Δsugarquota	0.845***	(8.28)
δ2006	-0.283***	(-4.57)
δ2007	-0.178**	(-2.86)
δ2008	-0.201**	(-3.14)
β0	0.140**	(3.15)
N	84	
R^2	0.594	
adj. R^2	0.574	
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$		

The explanatory power of this regression is greater, adjusted R^2 of 0.574, than in Table 6.2, notwithstanding the reduction in the number of variables. The impact of sugar quotas remains significant, however the coefficient reduces slightly magnitude. The year effects, captured in the coefficients of the year dummy variables y1-y3 and the constant, are all significant at the 1 per cent level of significance or lower. To avoid perfect multicollinearity between the four year dummy variables, the effect of the final year is captured in the constant while the effects of the other years are captured by adding the year dummy variable to the constant. The year effects of 2006-2008 are negative, indicating the sugar beet production decreased in those years due to year-specific factors. These results are in line with the assumed impact of the reform instruments. The year effect is the highest in 2006 which can be explained by the EU's decision to pay a higher price for quotas in the first year of the reform. The effect of a declining buy-back price, as explained in section 2.3.4, may be indicated in the lower year effect of 2007. In 2008, the year effect increases compared to the previous year. This may be explained by the fact that the first price reduction of the intervention price occurred in 2008. The effect of year 2009 is positive, representing an opposite effect to the EU's sought after reform impact. This observed effect can possibly be explained by the exceptionally good weather conditions for sugar beet production over large part of Europe in 2009, resulting in a large harvest.

Despite the relatively high explanatory power of the regression and the significance of all independent variables in Table 6.3, further tests are conducted to reduce the risk of bias from omitting relevant variables. The outcome of the regression of the basic model with temperature excluded adding country fixed effects is presented in Table 6.4.

Table 6.4. Results of regression of the basic model without temp and with country effects.

	Δbeet				
	Coefficient	t-statistic		Coefficient	t-statistic
Δsugarquota	0.656***	(5.53)	αGreece	-0.107	(-0.74)
factoryclose	-0.0187	(-0.35)	αHungary	-0.127	(-0.94)
δ2006	-0.323***	(-5.09)	αIreland	-0.197	(-1.45)
δ2007	-0.198**	(-3.12)	αItaly	-0.0415	(-0.28)
δ2008	-0.238***	(-3.71)	αLatvia	-0.376**	(-2.76)
β0	0.219*	(2.14)	αLithuania	0.0890	(0.67)
αAustria	0.00475	(0.04)	αNetherlands	-0.00589	(-0.04)
αBelgium	-0.0453	(-0.34)	αPoland	-0.0122	(-0.09)
αBulgaria	-0.310*	(-2.09)	αPortugal	-0.186	(-1.38)
αCzech Republic	-0.0149	(-0.11)	αRomania	-0.198	(-1.34)
αDenmark	-0.0163	(-0.11)	αSlovakia	-0.0401	(-0.30)
αFinland	-0.0940	(-0.70)	αSlovenia	0.112	(0.52)
αFrance	0.0296	(0.22)	αSpain	-0.0476	(-0.35)
αGermany	0.0413	(0.30)	αSweden	0.0297	(0.22)
N	84				
R^2	0.725				
adj. R^2	0.592				

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note that the United Kingdom is not included in this regression due to perfect multicollineraity between the country dummy variables. Its effect is instead captured in the constant together with the year effect of 2009.

The explanatory power of this regression is 0.592, however it is pushed upwards due to the high number of variables. All except two country dummies, Bulgaria and Latvia, are insignificant. The strength of the linkage between sugar production quotas and beet production is reduced to 0.656 as country specific effects are controlled for. This indicates that unobserved variations across countries reduce the linkage between sugar quotas and beet production. Previous research has explained the differences in the linkage between countries as dependent on the different levels of production costs. To be able to control for the different production costs in countries, a regression will be run where the countries are grouped according to their production costs in line with previous research. The effect of the country groups is related to the linkage between sugar quotas and beet production and not to the intercept. Another argument to alter how the country specific factors are included in the regression is that a vast majority of the country dummy variables are insignificant in this regression. Moreover, the degrees of freedom in this regression fall due to the high number of independent variables used on a data set of such limited size.

The effect of a factory closedown changes sign depending on what model is used, but is not significant at any reasonable level in any previous regression. By including fixed effects for countries the variable becomes more significant. This suggests that the effect of a factory closedown is independent of what country it occurs in. Due to the low significance of the variable it will be excluded in following regressions.

The result of the final regression of the extended basic model is presented in Table 6.5.

Table 6.5. Results of regression of the extended model with groups and year effects.

	Δbeet	
	Coefficient	t-statistic
group1Δquota	0.884***	(7.35)
group2Δquota	0.787***	(4.45)
group3Δquota	0.679**	(2.90)
group4Δquota	-0.558	(-0.91)
δ2006	-0.283***	(-4.63)
δ2007	-0.177**	(-2.89)
δ2008	-0.254***	(-3.79)
β0	0.138**	(3.16)
N	84	
R^2	0.623	
adj. R^2	0.588	
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$		

The explanatory power of this regression is slightly higher than all previous regressions with the acceptable amounts of degrees of freedom. The slope coefficient is different between the groups, implying that the linkage between sugar quotas and beet production may differ between country groups. The impact of sugar quotas on beet production is significant at the one per cent significance level for all but the forth group. The direction of the linkage in the first three country groups is in line with the reform objectives reducing the beet production as quotas fall. The magnitude of the linkage is highest for the first groups and declines gradually in group two and three. Concerning group four, according to this regression the linkage is insignificant at all generally acceptable levels of significance. In contrast to the other groups, the impact of sugar quotas on beet production is negative. This implies that the sugar beet production increases as quotas decline, going in the reverse direction than what the reform sought to achieve.

Regarding the significance and magnitude of the year effects, no different results are obtained in this regression compared to previous ones. Hence, no modification to the interpretation of the results is required. Furthermore, as can be seen in Appendix D.1, the results of the Hausman test

and the robust standard errors test of this regression provided evidence that year fixed effects should be used and that the significance of our estimators were sufficiently high without assuming robust standard errors.

7 Concluding discussion

In this section the implications of the results presented in section 6 will be employed to discuss the impact of sugar production quotas on sugar beet production during the 2006 reform. Bearing in mind that it is the estimated coefficient of the independent variable that provides information on this linkage, the regressions where this coefficient is significant and unbiased will be in focus.

According to the regressions, the significant control variables in the basic model are year effects. Thus, by including the year effects the risk of omitted variable bias of the regression is reduced. Also, the coefficient of the independent variable is made more representative of the true linkage between sugar quotas and beet production by controlling for year effects. The linkage is close to one and significant according to the regression of the basic model, implying that the sugar quota reduction impacts beet production to a large extent in this setup. In other words, the sugar quota elasticity of sugar beet production is strong. However, in section 5.1.4 it was noted that previous research suggests that country heterogeneity affects the linkage. Should that be the case, the regression of the basic model is biased and the conclusion that the linkage is strong becomes questionable.

When including country effects in the regression the significance of the independent variable remains high. However, the strength of the linkage is reduced as represented by the decline of the coefficient's magnitude. This can be seen as evidence that the impact of quota reductions on beet production is dependent on country specific variation and that this dependence reduces the impact's strength. Yet, in this setup, the significance of most of the country effects is too low to be able to draw any conclusions about the linkage.

The country heterogeneity in production costs motivates the final regression of the extended model. In this setup, the country groups are interacted with the independent variable to see how the linkage varies between different groups. The first country group is the one with highest production costs and the fourth group consists of countries with the lowest costs, with the second and third group ordered in between them. The linkage is significant and in the expected direction for country groups 1-3, indicating a strong impact of sugar quotas on beet production. The magnitude of the linkage is strongest for the group with highest costs and gradually decreasing for groups 2 and 3 as costs go down. The result that the impact of the reform

instrument on its objective is highest in high-cost countries is in line with the discussion about reducing quota rents in previous research. For the low cost-countries however, the impact is insignificant and in the opposite direction. The importance of differences in production costs when evaluating the reform can thus be said to be confirmed.

According to the obtained results, the reduction in sugar production quotas negatively effects total sugar beet production in countries with relatively high levels of production costs. As the reform reduces the return to in-quota beet production in combination with incentives to reduce sugar quotas, beet production in countries with high costs becomes unprofitable and declines. Also, the non-quota beet production is reduced due to the cross-subsidisation between it and the in-quota production. The conclusion that the impact of sugar quotas on beet production during the 2006 reform was high in countries with relatively high costs can thus be drawn.

In the low cost countries, however, this linkage cannot be confirmed in the performed regressions. In contrast to other countries, the null-hypothesis that the slope coefficient is zero cannot be rejected at any reasonable level of significance in low cost countries. Consequently, it can be concluded that a reduction of sugar quotas have no impact on sugar beet production in low-cost countries. One possible explanation for this may be the use of aggregate country-level data.

By using aggregate country-level data, it is assumed that the average costs for all farms in one country are the same. However, previous research has found evidence that this may not be the case, since beet growers in the same country may have different levels of production costs. This is not included in the specification of the model used in this thesis. For a high-cost grower, the reform may lead to the need to renounce quotas, while low-cost producers with marginal costs below the new minimum price have no need to reduce their quotas and can continue producing the same volumes profitably. Given that high-cost producers represent a limited fraction of all producers within these countries, the overall impact of quota reductions on beet production may remain insignificant on the aggregate level.

Another factor that may contribute to the insignificance of the linkage for low-cost countries is related to the argument of cross-subsidisation between in-quota and non-quota production as discussed in section 3.2.2. The reduction in the minimum price lowers the quota rent of in-quota production. With a decreased quota rent, the indirect subsidisation of non-quota production declines, thus limiting the amount non-quota production that may be produced profitably. Consequently, a reduction in total sugar beet production may be explained by a reduced quota rent rather than a change in sugar quotas. There is no data available on individual quota rents for

farms in the EU, why this factor was not included in the model. If the argument of cross-subsidisation is true, then the omission of changes in quota rents causes the model to be biased. This may be captured in the model since the data in fact shows that quotas are reduced in the low-cost countries. In combination with the reduced cross-subsidisation, these quota reductions would lead to a substantial decline in sugar beet production, represented by a positive coefficient of the independent variable close, or even above, one.

However, despite the insignificance of the linkage in low-cost countries, it has a negative coefficient. This suggests that the impact of sugar quota reductions is to increase beet production. Such a linkage is hard to imagine given the structure of the CMO of sugar, but some explanations for it is needed to confirm the strength of the analysis in this thesis. Firstly, the world market price for sugar has been exceptionally high during the last years of the reform. This may have meant that the number of beet growers with marginal costs below the world market price increased. Those growers were then able to increase their non-quota production, pushing total sugar beet production upwards. In a scenario where EU beet growers renounce their quotas in the winter and get the information about the rising world market price just before they sow their lands, the quota reduction may coexist with increased total beet production.

Secondly, as indicated by previous research, the sharing of quota rents between factories and beet growers is difficult to include in models of the sugar market. In some of the low-cost countries, the concentration of sugar companies is relatively high, potentially leading to an increased market power of beet growers and thereby a larger share of the quota rents. With high quota rents the beet growers may continue to produce non-quota sugar beets even if sugar producers renounce their production quotas.

Thirdly, previous research has indicated that some non-quota production may be explained by reference building behaviour, as reported in section 3.2.2. If such behaviour was present relatively more in low-cost countries, these producers would be producing more non-quota sugar at a loss anticipating future gains in terms of relative quota volumes.

Regarding the impact of a closed down factory on sugar beet production, the low significance does not mandate a conclusion on whether the intuition behind the variable is faulty or not. A more detailed data set and a more in-depth study of the cost of transport and other bearing factors affecting the relationship between sugar factories and sugar beet growers is needed to shed light on the plausibility of the intuition presented in section 5.1.3.

8 Conclusions and future research

The purpose of this thesis was to evaluate how the 2006 reform affected sugar beet production within the EU. The sugar policy of the EU has been left without major changes since its establishment in the 1960s. During recent years pressures to reform the sugar policy has been built up both externally and internally, leading to the 2006 reform. Prior to the reform simulations were run attempting to estimate how the sugar beet growers would respond to it, with differences in the obtained results. As the reform was completed in 2009, its actual effects on sugar beet growers were recently made available. Using this data, the purpose of this thesis was fulfilled by evaluating to what extent the sugar quota reduction of the 2006 sugar reform affected sugar beet production volume within the EU. Furthermore, drawing from the evaluation, the validity of fundamental assumptions in previous research was discussed.

On an aggregate level the sugar quota elasticity on sugar beet production is elastic and significant. Sugar beet production is affected by sugar quota reduction to a great extent. However, taking into account the differences in production costs across countries, the conclusion does not apply to all EU countries. This study concludes that low cost countries do not reduce total beet production in response to the 2006 reform. The conclusions drawn in this thesis go in line with reform simulations performed in previous research. Most notably, the prediction by Frandsen *et al.* (2003) is confirmed since non-quota production is unaffected in low-cost countries while the reform did reduce production in other countries. This is contrary to the results obtained by Gohin and Bureau (2006) that non-quota production would seize throughout all countries. The invalidity of these authors' conclusion may be due to the exceptionally high world market prices during the last years of the reform, making the cross-subsidisation of non-quota production unexpectedly large.

The reallocation of sugar beet production from high-cost to low-cost countries indicates an efficiency-improvement within the EU sugar market. Nevertheless, it does not directly imply a reduction in sugar beet production, one way of directly fulfilling the reform objectives. Bearing in mind that the quota reduction did not lead to declining sugar beet production in one of the country groups, the claim by Fischer Boel that the 2006 reform was a success based on the fact that quotas had been reduced may be questioned. Even more so since the countries where the reform instrument had no impact are those with the highest levels of sugar production, such as France, Germany and the United Kingdom. The quota reduction did lead to reduced production in some countries. However, their volumes were small already before the reform. As a result, the overall success of the 2006 reform is hard to evaluate. This conclusion should be taken into account when further studies of the 2006 reform are made.

If the true reform objectives of the EU are aimed at integrating the European sugar economy into the global market, it should carefully consider the choice of instruments and aim of the reform. A complete liberalisation of the CAP cannot happen overnight, making it of particular importance that the steps taken in that direction, such as the 2006 reform, are exhaustively evaluated.

8.1 Future research

The results from this thesis suggest that differences of production costs on a farm-level within countries have a bearing on the results of the reform. Studies on the aggregate level should therefore be complemented with farm-level data. Buysse *et al.* (2007) took this into account when studying the reform impact of Belgian farms and future research should expand to include farm-level data on all European countries.

In a similar fashion more detailed data on the relationship between sugar beet growers and sugar factories should be included in future studies in order to more accurately assess the impact of a factory closedown.

A possible explanation for why the reform was directed towards sugar factories and not directly at farmers may be the political situation in the EU. Farm groups have traditionally had a strong influence on EU politics and this may have affected the chosen structure of the 2006 reform. In hindsight, the uncertain results of the 2006 reform may have been highly dependent on the choice of reform instruments. Further research into what determined the EU choice of reform instruments is therefore relevant to evaluate the role played by influence groups in future reforms.

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Appendices

A.1 Summary statistics: Sugar beet production

The summary statistics of the variable as well as the average absolute production levels in tonnes of sugar beets of each EU country are reported below.

		Obs	Mean	Std. Dev.	Min	Max
Austria	Δbeet	4	0.0056	0.1556	-0.2041	0.1638
	Beet in '000 tonnes	4	2 831	303	2 493	3 091
Belgium	Δbeet	4	-0.0625	0.0812	-0.1775	0.0113
	Beet in '000 tonnes	4	5 170	614	4 569	5 731
Bulgaria	Δbeet	3	-0.4619	0.5006	-0.9939	0
	Beet in '000 tonnes	3	5	9	0	16
Czech Republic	Δbeet	4	-0.0325	0.0715	-0.1022	0.0532
	Beet in '000 tonnes	4	2 988	123	2 885	3 138
Denmark	Δbeet	3	-0.0987	0.0689	-.1623109	-0.0255
	Beet in '000 tonnes	3	2 194	161	2 011	2 314
Finland	Δbeet	4	-0.1493	0.2345	-0.3047	0.1944
	Beet in '000 tonnes	4	663	210	468	952
France	Δbeet	4	0.0193	0.0986	-0.0875	0.1119
	Beet in '000 tonnes	4	31 670	1 793	29 900	33 200
Germany	Δbeet	4	0.0150	0.1822	-0.1834	0.2176
	Beet in '000 tonnes	4	23 600	2 254	20 600	25 500
Greece	Δbeet	3	-0.2792	0.2916	-0.4818	0.0550
	Beet in '000 tonnes	3	1 136	446	855	1 650
Hungary	Δbeet	4	-0.2595	0.3701	-0.6614	0.2355
	Beet in '000 tonnes	4	1 357	885	573	2 454
Ireland	Δbeet	4	-0.3375	0.4478	-0.9452	0
	Beet in '000 tonnes	4	53	15	45	76
Italy	Δbeet	3	-0.2761	0.3393	-.6630615	-0.0293
	Beet in '000 tonnes	3	4 467	410	4 000	4 770
Latvia	Δbeet	4	-0.5163	0.5463	-1	0
	Beet in '000 tonnes	4	121	235	0	474
Lithuania	Δbeet	4	0.0800	0.6080	-0.5761	0.8826
	Beet in '000 tonnes	4	624	201	339	800
Netherlands	Δbeet	4	-0.0058	0.0825	-0.0872	0.0990
	Beet in '000 tonnes	4	5 470	215	5 219	5 735
Poland	Δbeet	4	-0.0382	0.1939	-0.3128	0.1052
	Beet in '000 tonnes	4	10 600	1 811	8 715	12 700
Portugal	Δbeet	4	-0.2845	0.2257	-0.4710	0
	Beet in '000 tonnes	4	212	91	137	320
Romania	Δbeet	3	-0.1458	0.1774	-.3501128	-0.0310
	Beet in '000 tonnes	3	713	33	685	749
Slovakia	Δbeet	4	-0.1163	0.3054	-0.3825	0.3239
	Beet in '000 tonnes	4	949	297	679	1 371
Slovenia	Δbeet	1	0.0073	-	0.0073	0.0073
	Beet in '000 tonnes	1	262	-	262	262
Spain	Δbeet	4	-0.1331	0.1139	-0.2498	0.0045

	Beet in '000 tonnes	4	4 784	933	3 988	5 827
Sweden	Δbeet	4	0.0095	0.1416	-0.0807	0.2182
	Beet in '000 tonnes	4	2 177	178	1 975	2 406
United Kingdom	Δbeet	4	0.0003	0.1730	-0.1715	0.2370
	Beet in '000 tonnes	4	7 248	753	6 733	8 330

A.2 Summary statistics: Sugar production quotas

The summary statistics of the variable as well as the average absolute production quotas in tonnes of sugar of each EU country are reported below.

		Obs	Mean	Std. Dev.	Min	Max
Austria	Δsugarquota	4	-0.0354	0.0707	-0.1414	0
	Quota in tonnes	4	359 935	31 630	332 542	387 327
Belgium	Δsugarquota	4	-0.0628	0.1257	-0.2514	0
	Quota in tonnes	4	716 779	118 972	613 746	819 812
Bulgaria	Δsugarquota	3	-0.3333	0.5774	-1	0
	Quota in tonnes	3	1 584	2 744	0	4 752
Czech Republic	Δsugarquota	4	-0.0563	0.1126	-0.2253	0
	Quota in tonnes	4	378 007	51 236	352 389	454 862
Denmark	Δsugarquota	3	-0.0634	0.1099	-0.1903	0
	Quota in tonnes	3	394 052	46 236	340 663	420 746
Finland	Δsugarquota	4	-0.1210	0.1815	-0.3839	0
	Quota in tonnes	4	99 520	31 332	80 998	146 086
France	Δsugarquota	4	-0.0453	0.0907	-0.1814	0
	Quota in tonnes	4	3 427 163	394 709	3 085 336	3 768 991
Germany	Δsugarquota	4	-0.0554	0.1108	-0.2216	0
	Quota in tonnes	4	3 038 295	437 170	2 659 695	3 416 895
Greece	Δsugarquota	3	-0.2000	0.2919	-0.5349	0
	Quota in tonnes	3	191 000	91 683	138 066	296 866
Hungary	Δsugarquota	4	-0.2318	0.3112	-0.6580	0
	Quota in tonnes	4	224 029	149 397	100 420	401 684
Ireland	Δsugarquota	4	-0.2500	0.5000	-1	0
	Quota in tonnes	4	0	0	0	0
Italy	Δsugarquota	3	-0.2859	0.2366	-0.5000	-0.0319
	Quota in tonnes	3	680 310	149 415	508 379	778 706
Latvia	Δsugarquota	4	-0.2500	0.5000	-1	0
	Quota in tonnes	4	16 626	33 253	0	66 505
Lithuania	Δsugarquota	4	-0.0504	0.1008	-0.2015	0
	Quota in tonnes	4	92 631	11 985	82 252	103 010
Netherlands	Δsugarquota	4	-0.0366	0.0732	-0.1464	0
	Quota in tonnes	4	801 286	73 062	738 012	864 559
Poland	Δsugarquota	4	-0.0549	0.1097	-0.2194	0
	Quota in tonnes	4	1 488 492	211 812	1 305 057	1 671 926
Portugal	Δsugarquota	4	-0.1872	0.1334	-0.3112	0
	Quota in tonnes	4	77 493	23 347	61 368	110 868
Romania	Δsugarquota	3	-0.0137	0.0237	-0.0410	0
	Quota in tonnes	3	106 181	2 584	104 689	109 164

Slovakia	Δsugarquota	4	-0.1457	0.1725	-0.3382	0
	Quota in tonnes	4	137 995	48 895	103 670	207 387
Slovenia	Δsugarquota	1	0	-	0	0
	Quota in tonnes	1	52 973	-	52 973	52 973
Spain	Δsugarquota	4	-0.1526	0.1203	-0.2892	-0.0185
	Quota in tonnes	4	730 018	198 667	498 480	903 843
Sweden	Δsugarquota	4	-0.0675	0.0795	-0.1542	0
	Quota in tonnes	4	300 582	29 004	275 464	325 700
United Kingdom	Δsugarquota	4	-0.0362	0.0725	-0.1449	0
	Quota in tonnes	4	1 056 127	95 263	973 627	1 138 627

A.3 Summary statistics: Control variables

The averages of the variable for temperature as well as the basis for the factory closedown dummy variable are reported below.

	Temp (mean degrees C)	**Number of years a factory closedown**
Austria	16.25	1
Belgium	15.45	1
Bulgaria	19.38	1
Czech Republic	16.45	2
Denmark	13.94	1
Finland	12.94	1
France	19.13	2
Germany	16.94	4
Greece	19.34	1
Hungary	18.95	2
Ireland	13.47	1
Italy	21.28	2
Latvia	13.40	1
Lithuania	14.43	1
Netherlands	14.90	1
Poland	15.19	4
Portugal	21.29	1
Romania	19.38	2
Slovakia	18.66	2
Slovenia	17.78	0
Spain	22.39	3
Sweden	13.05	1
United Kingdom	13.04	1

B.1 The basis of the country grouping

This table reports how the countries in the sample were grouped according to historical data on production. The basis for the grouping was the process used by Frandsen *et al.* 2003, however their study only included EU15 countries. The new countries with sugar beet production were allocated in the groups according to their similarities with the Frandsen groups. The basis for the grouping was historical levels of non-quota production, average yields and production volume volatility.

	DATA			FRANDSEN	THIS STUDY	
	Total quota	**Total production**	**Non-quota prod.**	**Group****	**Group alloc. *****	**Final group**
Austria	387326	458137	70811	4		**4**
Belgium	819812	991666	171854	3		**3**
Bulgaria*	4752	4288	-464		1	**1**
Czech Republic	454862	553960	99098		3	**3**
Danmark	420746	471518	50772	3		**3**
Finland	146087	148583	2496	1		**1**
France	3768991	4515176	746185	4		**4**
Germany	3416896	4305959	889063	4		**4**
Greece	317502	259301	-58201	1		**1**
Hungary	401684	487725	86041		3	**3**
Ireland	199260	223745	24485	2		**2**
Italy	1557445	1158163	-399282	1		**1**
Latvia	66505	67111	606		1	**1**
Lithuania	103010	132857	29847		2	**2**
Netherlands	864560	1036762	172202	2		**2**
Poland	1671926	2001412	329486		3	**3**
Portugal	146087	148583	2496	1		**1**
Romania*	109164	184352	75188		2	**2**
Slovakia	207432	233005	25573		2	**2**
Slovenia	52973	37994	-14979		1	**1**
Spain	996961	1078176	81215	3		**3**
Sweden	368262	371632	3370	2		**2**
United Kingdom	1138627	1390000	251373	4		**4**

*(Production values from CEFS 2010 for year 2006 and quota from EU 2007)

**Group in the study by Frandsen *et al.* 2003.

***Based on data and compared to the grouping of Frandsen *et al.* 2003.

C.1 Description of data collection

Variable	Description	Source
Δbeet	Total volume of sugar beet production in each country for the years 2005-2009. Correspondence with Eurostat office showed some values faulty.	Eurostat Agricultural Database Table apro_cpp_crop
	Missing data from countries Greece, Italy and UK was collected from this source.	CEFS Sugar Statistics 2009 Table 2. Paid beet production
Δsugarquota	Total sugar production quotas to each country except Bulgaria and Romania when the reform started in 2006.	Council Regulation (EC) No 318/2006 of 20 February 2006
	Total sugar production quotas allocated to Bulgaria and Romania when they were included in the reform.	Commission Regulation (EC) No 247/2007 of 8 March 2007
	Amount of quota renounciation per country per year.	Annex to Press Release IP/09/366 "Quantities withdrawn from the market under the Restructuring Scheme 2006-2009".
Temperature	Average temperature per year per country collected from this database. No country average time-series exist free of charge, why data had to be manually taken from one weather station in a representative location for sugar beet production in each country. Some countries did not have data from any weather stations, why weather stations in neighbouring countries were used.	Project Millenium resource with European weather statistics. Table "Mean of daily mean temperature (TG) with unit 0.01 Temperature".
	The map was used to see which weather station in the country should be used as representative of the beet production temperature. Please, contact the authors for a full table describing from where temperature was collected.	Corporate Social Responsibility and social dialogue in the European Sugar Industry p. 16. http://www.eurosugar.org/pdf/bro_en.pdf
Factory closedown	Data on number of factories in each country. The dummy variable took on value 1 if this number decreased from one year to the next. The number of factories in a country never increased.	CEFS Sugar Statistics 2009 Table 13. Number of factories operating in each production year
Country groups	Contries grouped according to historical levels of production costs. For details of this grouping, see Appendix B.1.	Same source as Deltabeet.

D.1 Hausman test and check for need of robust standard errors

Results from the Hausman test, concluding that year fixed effects should be used rather than random effects since the P-value is 0.13 per cent which is acceptable at all generally acceptable levels of significance, implying that fixed effects is to be preferred.

	Coefficients		
	(b)	(B)	(b-B)
	fix	ran	Difference
qgroup1	.8838038	.9706712	-.0868675
qgroup2	.7872445	.9465996	-.1593551
qgroup3	.6787832	.8252853	-.1465021
qgroup4	-.5584354	-.0646926	-.4937428

b = consistent under Ho and H a; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg
Test Ho: difference in coefficients not systematic

chi2(4) = 17.87
Prob>chi2 = 0.0013

The regression of the extended model with year and country group effects. Note that the t-statistic is significant (above approximately the absolute value of 2) for the same variables in both regression, implying that robust standard errors would not bring more significance to the results.

	Δbeet	
	t-statistic (without robust std. err.)	t-statistic (with robust std. err.)
group1Δquota	(7.35)	(12.25)
group2Δquota	(4.45)	(9.82)
group3Δquota	(2.90)	(3.43)
group4Δquota	(-0.91)	(-1.00)
δ2006	(-4.63)	(-5.23)
δ2007	(-2.89)	(-2.80)
δ2008	(-3.79)	(-2.73)
β0	(3.16)	(2.80)