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Political effectiveness of agricultural policies – An empirical analysis

Kyösti Arovuori

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ACADEMIC DISSERTATION
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Abstract: The objective of this study is to analyse the effectiveness of agricultural policies, given the general economic and structural conditions under which the policies operate. The effectiveness of policies is measured in terms of their impacts on the stated policy objectives. In this study, an empirical analysis of the effects of implemented policies and policy reforms on the stated policy objectives of the Common Agricultural Policy of the European Union is conducted. The analysis is carried out at the EU15 level and the time period analysed ranges from 1975 to 2007. The analysis suggests that structural economic development has to some extent outpaced the effects of agricultural policies. Other factors have developed at a significantly faster pace compared to agricultural policies. Overall agricultural policies were not able to respond to the changing economic structures prior to the reforms in the 1990s and 2000s. For the future policy analysis, precise target levels need to be set in order to assess whether the stated policy objectives have been actually achieved or not.
Keywords: *Policy objectives, policy instruments, common agricultural policy*

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Tiivistelmä: Tutkimuksen tavoitteena on analysoida maatalouspolitiikan vaikuttavuutta erilaisten rakenteellisten ja taloudellisten olosuhteiden vallitessa. Vaikuttavuutta mitataan harjoitetun politiikan vaikutuksilla sille asetettuihin tavoitteisiin. Työssä tehdään ekonometrinen analyysi, jossa tarkastellaan EU:n yhteisen maatalouspolitiikan ja siinä toteutettujen uudistusten vaikutusta politiikalle asetettujen tavoitteiden kehittymiseen. Analyysi toteutetaan EU15 tasolla ja tutkimus kattaa vuodet 1975–2007. Tulokset osoittavat, että talouden ja rakenteiden muutoksella on ollut maatalouspolitiikkaa voimakkaampi vaikutus politiikan tavoitteiden kehittymiseen. Tutkimuksen mukaan maatalouspolitiikka ei pystynyt vastaamaan talouden ja rakenteiden kehitykseen ennen vuosien 1992 ja 1999 uudistuksia. Koska politiikan tavoitteille ei ole asetettu tarkkoja tavoitetasoja, analyysin perusteella ei voida sanoa, ovatko politiikan tavoitteet toteutuneet.
Avainsanat: *Politiikan tavoitteet, politiikan keinot, yhteinen maatalouspolitiikka.*

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The completion of a dissertation is like a bunch of U2 songs. You go along mysterious ways to realize that you still haven't found what you are looking for and finally get stuck in a moment you can't get out of. At the moment of surrender you find there is all that you can't leave behind, and you just have to walk on and hope that god will send his angels to help you towards the pride of that one work you are about to complete. In many senses, the names of these songs tell the story behind this dissertation and the story of life during the process.

The spark for academia and research was lit in the inspiring lectures on agricultural policy of my supervisor, then Professor, currently Rector, Jukka Kola. He also hired me for my first academic job and thus opened the way forward. Thanks for all the trust, encouragement and friendship.

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Oitti, June 2015

Kyösti Arovuori

TIIVISTELMÄ

Väitöskirjatyössä analysoidaan Euroopan unionin yhteisen maatalouspolitiikan vaikuttavuutta suhteessa politiikalle asetettuihin tavoitteisiin. Työn taustana on, että kirjallisuudessa maatalouspolitiikan keinojen ja tavoitteiden välisiä yhteyksiä on tutkittu empiirisesti vähän. Näissä empiirisissä sovelluksissa on pääsääntöisesti keskitytty ainoastaan tavoitteeseen maatalousväestön tulotason turvaamisesta ja sitä kautta politiikan tulonsiirtotehokkuuden analysointiin.

Politiikan vaikuttavuus on tässä työssä määritetty politiikan kyvyksi vastata sille asetettuihin tavoitteisiin, kun huomioidaan yhteiskunnan taloudellinen ja rakenteellinen kehitys. Empiirisessä analyysissä tarkastellaan EU:n yhteisen maatalouspolitiikan ja siinä toteutettujen uudistusten kykyä vastata politiikan virallisiin tavoitteisiin. Analyysi tehdään EU15-tasolla. Tutkimuksen aikaväli on 1975–2007. Analyysissä hyödynnetään useista eri tilastotietokannoista rakennettua paneeliaineistoa, jonka rakenne noudattaa EU:n kehitystä vuoden 1975 yhdeksän jäsenmaan yhteisöstä vuoden 1995 laajentumisen jälkeiseen 15 jäsenmaan yhteisöön.

Työn empiirisessä osassa rakennetaan ekonometrinen malli, jossa politiikan tavoitemuuttujien kehitystä selitetään politiikan keinomuuttujilla sekä talouden ja rakenteen kehitystä kuvaavilla kontrollimuuttujilla. Ekonometrinen analyysi tukee kuvailevan analyysin tuloksia siitä, että politiikan tavoitemuuttujat ovat kehittyneet pääsääntöisesti tavoitteiden mukaisesti. Maatalouden tuottavuus on noussut, markkinat ovat olleet vakaat, omavaraisuusaste on saavutettu ja ylläpidetty, ja kuluttajien kohtaamat elintarvikkeiden reaalihinnat ovat laskeneet. Maatalouden suhteellinen tulotaso on ajanjakson aikana kuitenkin laskenut.

Politiikan tavoitemuuttujien kehitys on samansuuntainen kaikissa mukana olevissa maissa. Ekonometrisen analyysin perusteella politiikan vaikuttavuudessa on maakohtaisia, tilastollisesti merkittäviä, eroja tuottavuuskehityksen, tulokehityksen sekä maakohtaisten omavaraisuusasteiden kehityksen osalta. Elintarvikkeiden kuluttajahintojen kehitykseen ja markkinoiden vakauteen politiikka on vaikuttanut samansuuntaisesti maakohtaisista eroista huolimatta. Tulosten perusteella voidaan todeta, että

yhteisen politiikan vaikuttavuus on sidoksissa maakohtaiseen taloudelliseen ja rakenteelliseen kehitykseen. Tämä on tärkeää huomioida politiikan suunnittelussa ja toimeenpanossa.

Harjoitettu maatalouspolitiikka vaikuttaa suoraan resurssien käyttöön ja niiden jakautumiseen yhteiskunnan eri sektoreiden välillä. Maatalouden tuottavuuden kasvun seurauksen työvoimaa on siirtynyt tasaisesti maatalouden ulkopuolisille sektoreille. Tämä muiden sektoreiden kohtaama työvoiman tarjonnan kasvu on edesauttanut yleisen talouden nopeaa kasvua tutkimusjakson aikana. Talouden nopea kasvu on myös vahvistanut maataloustuotteiden kokonaiskysyntää. Maataloussektorin tehokkuus onkin todennäköisesti heikompi maissa, joiden yleinen talouskasvu on ollut hidasta. Myös maatalouden suhteellinen osuus koko taloudesta on tällöin yleensä korkeampi.

Maatalouspolitiikan vaikutuksen seurauksena maatalous käyttää enemmän tuotantoresursseja talouden optimaaliseen tilanteeseen verrattuna. Useimmiten näitä resursseja voitaisiin hyödyntää yhteiskunnan kannalta tehokkaammin muilla sektoreilla. Politiikan vaikutuksen seurauksena maatalouden tuottavuuskehitys on ollut hitaampaa verrattuna tilanteeseen ilman politiikan ohjausta. Työvoimaa on pysynyt sektorilla enemmän kuin ilman politiikkaa. Samalla tämä on heikentänyt maatalouden tulokehitystä, koska sektorin koko on suurempi.

Maatalouspolitiikan uudistukset ovat parantaneet politiikan vaikuttavuutta. Politiikkamuutos tuotantoon sidotusta hintatuesta tuotannosta irrotettuihin hehtaarikohtaisiin suoriin tukiin on johtanut siihen, että maatalouden tuotantoresursseja, etenkin työvoimaa, on siirtynyt maatalouden ulkopuolisille toimialoille. Toisaalta maatalouspolitiikan uudistukset ovat lisänneet hintavaihtelua ja sitä kautta vähentäneet markkinoiden vakautta. Hintavaihtelut ovat suoraa seurausta siitä, että hallinnollisesti asetetusta hintatasosta on siirretty markkinoilla tapahtuvaan hinnanmuodostukseen.

Tutkimuksen tulosten perusteella maatalouspolitiikan vaikutukset politiikan tavoitteisiin ovat monivaikutteiset. Harjoitettu politiikka on osaltaan vaikuttanut asetettujen tavoitteiden vastaisesti. Vaikka maatalouspolitiikka on edistänyt maatalouden tuottavuuden kehitystä, se on samalla imenyt sektorille sellaisia tuotantoresursseja, jotka olisivat yhteiskunnan kannalta tehokkaammin hyödynnettävissä muilla sektoreilla. Lisäksi tavoitemuuttujien kehitys antaa viitteitä siitä, että maataloudelle on kansallisesti asetettu tavoitteita, jotka ovat ristiriidassa EU:n yhteisten tavoitteiden kanssa.

EU:n sisäiset erot talouden ja maatalouden rakenteissa ovat kasvaneet laajentumisen seurauksena. Tämän tutkimuksen tulokset osoittavat, että maakohtaiset erot ovat tilastollisesti merkitseviä politiikan tavoitemuuttujien kehityksessä. Vaikka maatalouspolitiikan uudistukset ovat parantaneet politiikan vaikuttavuutta, EU:n laajentuminen on nostanut tulevaisuuden maatalouspolitiikan keskeisimmäksi haasteeksi erilaisiin rakenteisiin soveltuvien politiikkakeinojen löytämisen.

Työssä tehdyn analyysin perusteella ei voida arvioida, ovatko EU:n yhteisen maatalouspolitiikan tavoitteet toteutuneet. Tämä johtuu siitä, että tavoitteille ei ole määritetty mitattavissa olevia tavoitetasoja. Empiirisen politiikka-analyysin parempi hyödyntäminen vaatii tuekseen politiikan tavoitetasojen aikaisempaa selkeämpää määrittelyä sekä tavoitteille asetettavien mittarien määrittämistä. Sekä tavoitetasot että tavoitteiden seuraamiseen valittavat mittarit pitää määrittää jo politiikan suunnittelu-vaiheessa.

SUMMARY

This dissertation analyses the effectiveness of the Common Agricultural Policy of the European Union. The motivation of this study arises from the fact that there is a lack of empirical research on the effects of policy instruments on the stated policy objectives. In addition, most of the analysis in the literature has focused on the policy objective to secure farmers' incomes and, thus, on the efficiency of income redistribution.

The policy effectiveness is defined as the ability of agricultural policy to respond to the stated policy objectives, given the general economic and structural conditions under which the policies operate. In this study, an empirical analysis of the effects of implemented policies and policy reforms on the stated policy objectives in the Common Agricultural Policy of the European Union is conducted. The analysis is carried out at the EU15 level and the time period analysed ranges from 1975 to 2007.

In the empirical part, an econometric model utilising panel data for the EU15 countries is built. In the model, the development of the defined policy target variables is explained with policy variables and a set of economic and structural control variables. The results show that policy target variables have, in general, developed in the desired direction. The productivity of agriculture has increased, markets have been stable, self-sufficiency ratios have been achieved and the real term food prices have declined. However, farmers' incomes have mostly declined.

Although the general development of the target variables is similar in all the countries included in the analysis, there is significant heterogeneity on the country level. While common policies have contributed, with a common impact, to market stabilisation and food price development, the impacts have been more diversified for productivity development and net entrepreneurial income. It can be stated that the impact of agricultural policies is directly linked to structural and economic conditions in a particular country. This needs to be taken into account in policy planning and implementation.

The implemented agricultural policies impact on resource allocation. Increase in productivity and decrease in the use of agricultural labour input

has contributed to more rapid general economic growth. Workforce made available from agriculture has shifted relatively smoothly to other sectors. The general economic growth has also boosted the demand for agricultural products. In countries with slower general economic growth, the structure of the agriculture sector is likely to be less efficient and the relative role of the agriculture sector in the overall economy is likely to be greater.

Thus, due to the policy impact, more resources are being absorbed into the sector compared to a situation without policies. Often these resources would be used more efficiently in other sectors. Based on this logic, agricultural policies have kept more resources in the agriculture sector compared to a situation without policies, which has reduced the pace of productivity growth in terms of labour use. In addition, it has had a negative indirect impact on farmers' incomes in the sense that the agriculture sector may be significantly larger than it would be without the implemented agricultural policies.

The implemented agricultural policy reforms have improved the policy effectiveness in general. The main contribution of the implemented reforms has been to the use of resources in agriculture. A policy shift from coupled price support to direct payments has released resources from agriculture to be utilised in other sectors. On the other hand, policy reforms have led to increasing price variation. This is a self-explanatory impact in the sense that administrative price setting was reduced and later on abolished in the policy reforms.

According to this study, the impact of agricultural policy on the policy objectives is multifunctional. The implemented policy instruments may also have worked in the opposite direction compared to the targets set. While agricultural policies have clearly contributed to increasing agricultural productivity, they have also absorbed resources into the sector which could have been utilised more efficiently in other sectors.

Moreover, the development of the target variables analysed indicates that national governments may have set different or additional targets for agricultural policies. However, the policies as such have evolved in the same direction in all countries.

The country-level heterogeneity of economic and agricultural structures has increased especially due to the recent enlargements of the EU from EU15 to EU28. The analysis in this study shows that country-level heterogeneity has a significant impact on the development of policy target variables. Although the implemented policy reforms have made a contribution towards the

desired direction and improved the effectiveness of the policies, it is a major challenge for future agricultural policies to effectively tackle the different structures.

Based on the analysis, the ability of policies to achieve their stated objectives cannot be directly judged. This is due to the fact that no exact target levels have been set for the policy objectives. To improve the applicability of empirical policy analysis in the actual policy evaluation, policy-makers should put more emphasis on the comparable and clear measurement of the stated policy objectives. For appropriate policy analysis, exact target levels need to be set. In addition, appropriate measurement of all policy objectives needs to be defined already at the planning stage of a policy.

POLITICAL EFFECTIVENESS OF AGRICULTURAL POLICIES –
AN EMPIRICAL ANALYSIS

Kyösti Arovuori

Dissertation

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1. INTRODUCTION

1.1. Background

Agricultural policies have a long history, especially in the developed countries. Many governments have seen agriculture as a sector which needs to be governed due to economic and political reasons. In economics, these reasons translate into income redistribution, market failures, public goods and externalities, and politics[1]. Government intervention and, thus, decisions by the policy-makers are not without constraints. Constraints for the policy-makers' decisions derive from political realities and prevailing political systems. These realities include economic factors, preferences of interest groups and other political supporters with different levels of lobbying power, and international commitments.

In 1957, twelve years after the end of the World War II, the principles for the Common Agricultural Policy (CAP) of the European Union (EU)[2] were set out in the Treaty of Rome. The CAP was established 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; thus to ensure a fair standard of living for the agricultural community, in particular by increasing the individual earnings of persons engaged in agriculture; to stabilise markets; to assure the availability of supplies; and to ensure that supplies reach consumers at reasonable prices (European Economic Community 1957).

The objectives of the CAP have remained unchanged since its establishment. The policy instruments used to achieve the policy objectives have, however, changed markedly over time. In addition, both agriculture and the EU have drastically changed from the time the Treaty of Rome was adopted. Productivity growth in agriculture has been fast and the number of people engaged in agriculture has decreased. Agricultural and food trade has

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[1] Sumner et al. (2010) provide an excellent overview on the evolution of research questions in agricultural policy economics.

[2] For simplicity, the notation European Union (EU) is used throughout the text despite the fact that until 1992 the official notation was European Community (EC).

become more open. The EU itself has grown from a homogeneous economic community of six to an economic and political union of 28 Member States. In spite of this development, the CAP is still the only sectoral policy within the EU that is commonly financed from the EU budget and implemented under common guidelines and principles in all of the current 28 Member States. The development of the EU budget and the share of the CAP expenditure are presented in Figure 1.

There are a good number of comprehensive textbooks on the development of the Common Agricultural Policy and its role in the EU. Some of the recent ones include Davidova and Hill (2012) and Oskam et al. (2010). Ritson and Harvey (1997) offer an extensive discussion of the overall development of the CAP since its foundation till the MacSharry reform in 1992 and of the features underlining the preparation of the Agenda 2000 reform. In addition, Burrel and Oskam (2000) discuss the challenges of the CAP in terms of the eastern enlargement of the European Union. In this study, the overall development of the CAP is touched upon only briefly[3]. However, to lay the foundation for the empirical part of the study, this sub-

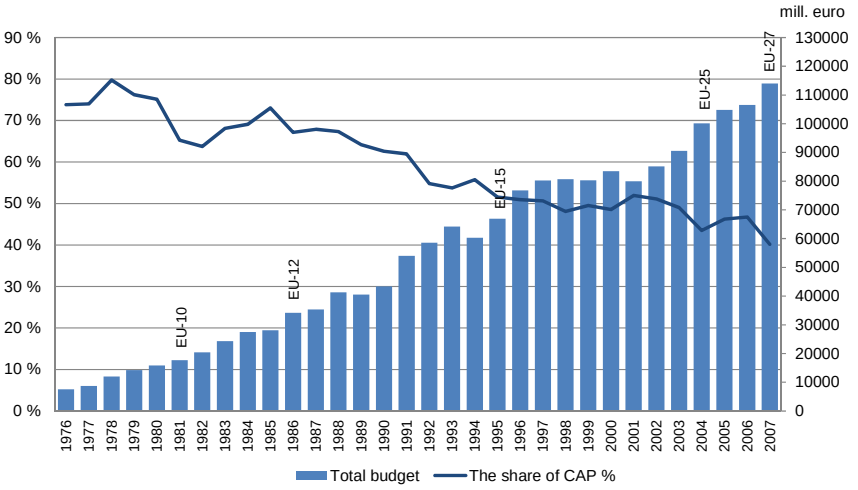

Figure 1. *Development of the EU final executed budget and the share of the CAP (Source: European Commission 2011)*[4]

[3] The development of the CAP is summarised in Appendix 1.

[4] EU6 (1957-): Belgium, Germany, France, Denmark, The Netherlands and Luxembourg; EU9 (1973-): EU6, Denmark, Ireland and UK; EU10 (1981-): EU9, Greece; EU12 (1986-): EU10, Portugal, Spain; EU15(1995-): EU12, Austria, Finland and Sweden; EU25 (2004-): EU15, Cyprus, Czech Republic, Estonia, Hungary, Lithuania, Latvia, Malta, Poland, Slovenia, Slovakia; EU27(2007-): EU25, Bulgaria, Romania; (EU28 (2013-): EU27, Croatia).

chapter presents a short discussion of the general development of the CAP and the fundamentals behind the policy reforms.

The CAP was gradually phased in during the transitional period from 1958 to 1968. The focus was on creating common agricultural markets with a common market and price policy. The Community's agricultural market and price policy rested on three principles: market unity, community preference, and financial solidarity. No emphasis was put on structural or farm development policy. According to Silvis and Lapperre (2010, 169), this was understandable since without common market regimes and price policies it would not been possible to create one large market for agricultural products and thus to exploit the economic gains deriving from free competition and the law of one price. According to Swinnen (2008, 3), the CAP has been under fire since its creation. Moreover, it has long been considered as a policy impossible to reform substantially, especially because of staunch opposition to reform from powerful farm and agribusiness lobbies[5]. In addition, the CAP has been protected by the successful defence of France and its allies in the European politics.

The core element of the CAP has been price support, secured with a high level of market protection (Table 1). As noted by Ackrill et al. (2008) and Silvis and Lapperre (2010), the use of price and market instruments led to major overproduction in the common market. The internal market was cleared with intervention storage and export subsidies. This increased the budgetary expenditure of the CAP and was a significant cause for major distortions on the world agricultural markets.

The starting points for the more fundamental reforms were the internal imbalance within the CAP and the negative multiplier impact of policies, especially on third countries. The pressures for reform arose from the common budget and commitments to cut tariffs and overall support levels under the GATT Uruguay round in 1986–1994. However, according to Swinnen (2008, 3), the continuing production growth was initially seen as a more severe threat in terms of expanding the budget costs than price support as such. This argument seems justified, given that controlling milk production

[5] See e.g. Niemi and Kola (2005), Pokrivcak et al. (2006) and Jensen et al. (2009) on the discussion of the resistance to fundamental CAP reforms. See Harvey (2004) for a broader explanation of the lack of radical policy reforms in agriculture.

was the focus of the first substantive CAP reform in 1984[6]. However, production quotas were not an option for controlling the growth of spending in crop production.

Table 1. *Price and market regimes for agricultural products (Source: El-Agraa 2001, 245, own modifications)*

	Target price	Guide price	Norm price	Basic price	Intervention price	Withdrawal price	Minimum price	Production aid	Deficiency payment	Threshold price	Sluice-gate price	Reference price	Variable levy	Supplementary levy	Customs duty	Export refund
Common wheat	X				X					X			X			X
Durum wheat	X				X			X		X			X			X
Barley	X				X					X			X			X
Rye	X				X					X			X			X
Maize	X				X					X			X			X
Rice	X				X					X			X			X
Sugar, white	X				X					X			X			X
Oilseeds	X	X			X		X	X								
Dried fodder								X	X							
Butter					X					X			X			X
Skimmed milk powder					X					X			X			X
Cheese					X					X			X			X
Beef					X								X		X	X
Pig meat				X	X						X			X		X
Poultry meat											X			X		X
Fresh fruit and vegetables				X		X						X			X	X
Olive oil	X				X			X	X	X				X		X
Wine		X			X							X			X	X
Tobacco			X		X					X					X	X

[6] Ackrill et al. (2008, 399) point out that production quotas for milk were also politically feasible. Production quotas reconciled contradictory positions of the Member States, given that some countries opposed reductions in price support and others sought to contain budget costs. However, no country strongly opposed the production quotas.

According to Ackrill et al. (2008), budgetary pressures were the pivotal and final push for fundamental policy reform. However, this was also fuelled by the changed political preferences and changes in the relative importance of different policy objectives. Environmental aspects, animal welfare and food safety started to receive more attention, while less attention started to be given to self-sufficiency and farm income oriented policy objectives.

The MacSharry reform in 1992 brought direct area and animal-related payments to the centre of the policy. For cereals, direct payments were introduced as compensation payments for reductions in administrative prices. In addition to these payments, compulsory set-aside was imposed concerning the whole arable crops sector. Animal-related direct payments were introduced as payments per head of livestock. The total amount of these payments was limited to predetermined maximum eligible livestock numbers. Since then, direct payments have been the dominant policy instrument in the CAP (Jongeneel and Brand 2010, 191). Prior to the MacSharry reform, direct payments were already applied under the less-favoured area scheme (LFA). LFA payments were introduced in 1974. The aim of the payments was to compensate for higher production cost due to less favourable production conditions within the EU.

As part of the MacSharry reform, the implementation of the environmental support scheme started in 1992. The voluntary environmental support scheme introduced conditional direct payments targeted to compensate for the costs and income losses incurred from the implementation of a particular environmentally- oriented production practice or measure. In the Agenda 2000, the administrative prices were further reduced and farmers received a partial compensation for this. The development of the CAP budget expenditure and the share of decoupled payments as a percentage of the total value of production in the EU are presented in Figure 2.

In the Fischler reform[7] in 2003, direct payments were transferred to the single farm payment scheme and finally decoupled from the current production. The levels of the single farm payments were based on historical payment entitlements that were decoupled from the level of current production. Modulation was also introduced (Swinnen 2008, 2). The aim of the modulation is to shift funds from agriculture to rural development by reducing transfers to farms that receive the highest amount of support. More

[7] Also called the Mid-Term Review (MTR).

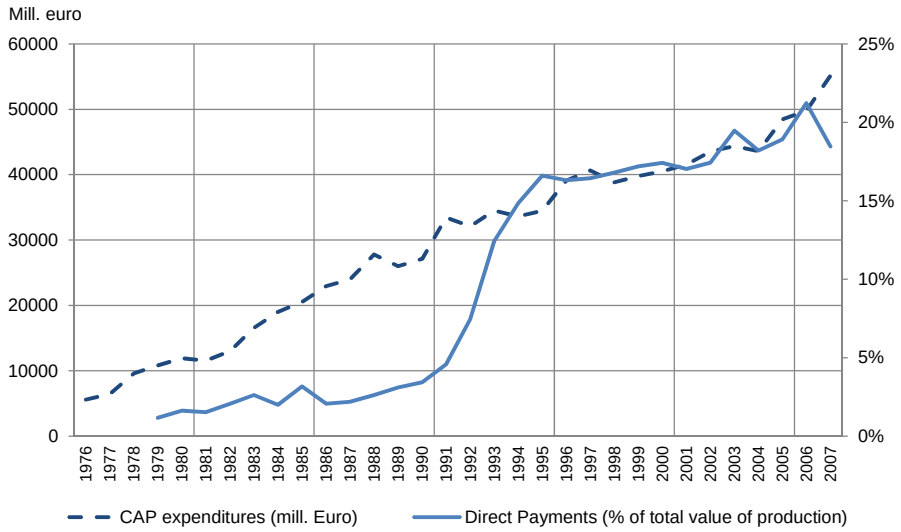

Figure 2. *CAP expenditure and the share of decoupled payments (Source: Anderson & Valenzuela 2008, European Commission 2011).*

emphasis was also placed on cross compliance introduced in Agenda 2000[8]. Since Agenda 2000 the Member States have been required to take measures to ensure that agricultural activities are compatible with environmental requirements. In 2003 broader cross-compliance requirements were set to ensure that the single farm payment is only paid to farmers who abide by a series of regulations relating to the environment, animal welfare, plant protection and food safety (Jongeneel and Brand 2010, 194).

1.2. Motivation

After 57 years since its foundation, it is easy to raise some fundamental questions concerning the CAP. How well has the CAP been able to contribute to the stated objectives set out in the Treaty of Rome, given the major structural changes in the EU and in the economy in general? Is the CAP effective in terms of its objectives? What is the contribution of the policy reforms to reaching the objectives?

[8] Elements of environmental cross compliance (application of appropriate environmental conditions to the management of compulsory set-aside) were introduced already in the MacSharry reform in 1992 (Jongeneel and Brand 2010, 194).

In order to seek answers to these questions, the objectives set in a political process need to be linked to policy analysis framework based on economic theory. The core of economic policy analysis rests on the fact that the implementation of policies influences the initial market equilibrium that would prevail under a competitive economy. The government intervention displaces the competitive equilibrium and impacts on welfare distribution within society. The changes in welfare distribution are due to changes in resource allocation that are caused by the changes in the relative prices of inputs and outputs. In the agriculture sector, there is a long tradition of market distortions and government imposed programmes that have an effect on welfare distribution.

According to OECD (2002, 10), the starting point for an examination of agricultural policy performance needs to be the consideration of its stated objectives. For a meaningful policy appraisal to be possible, these objectives need to be framed in terms that are sufficiently explicit in order that the effectiveness of alternative instruments can be measured and compared. It can be argued that the objectives of the CAP in general fulfil these criteria. However, the objectives lack the exactness that is necessary for the policy analysis.

1.3. Objectives

The objective of this study is to analyse the effectiveness of agricultural policies. In this study, policy effectiveness is defined as the ability of agricultural policy to respond to the stated policy objectives, given the general economic and structural conditions under which the policies operate. In order to do this, an empirical analysis on the effects of implemented policies and policy reforms on the stated policy objectives in the Common Agricultural Policy of the European Union is conducted.

In the empirical analysis, an econometric model utilising panel data for the EU15 countries is built. In the model, the development of the defined policy target variables is explained with policy variables and a set of economic and structural control variables. The target variables are selected to quantify the stated policy objectives of the CAP. The selected control variables aim to capture the general economic and structural development outside agriculture.

The policy variables aim to capture both the development of initial policy instruments already in force at the beginning of the research period

and the structural changes in the set of policy instruments due to the policy reforms implemented during the 1990s and early 2000s. The time period analysed ranges from 1975 to 2007.

Based on the empirical analysis, this study seeks to answer two inter-related research questions.

First**,** *what is the impact of agricultural policies and policy reforms on the development of policy target variables?*

Second, *what is the role of agricultural policies and policy reforms in the development of policy target variables compared to general economic and structural development*?

The scientific added value of this study arises from the fact that in the literature there is a lack of empirical policy analysis especially with this type of research setting. Although a framework for the analysis exists, most policy analyses in the literature have focused on the welfare effects of agricultural policies or on the efficiency of policies in terms of income redistribution. In addition, this study utilises different databases with extensive country-level data on agriculture and economic structures, among other things.

This study contributes to the discussion concerning the significance of the stated policy objectives in actual agricultural policy-making. According to Bullock et al. (1999, footnote p. 521), 'stated policy objectives are indicators of policy success while the end of each policy is to increase social welfare'. Thus, policies with a positive contribution to the development of the stated policy objectives also contribute to the overall social welfare. When the efficiency of a particular policy instrument increases, the welfare loss from the implementation of the policy instrument decreases[9].

Further, this study contributes to the discussion of the ability of the CAP to achieve its objectives. In addition, it analyses the ability of policies and policy reforms to take in account the structural changes in the overall economy. This study also aims to contribute to the on-going discussion about the role and relevance of agricultural policies in modern economies and especially in the EU.

[9] The difference between effectiveness and efficiency of policies is opportunity costs. Effectiveness measures only the impact of an instrument on an objective no matter how much it costs. Thus, in this study it is assumed that effective policies lead to higher welfare via the desired development of the stated policy objectives, given the societal costs from the implemented agricultural policies.

1.4. Structure of the thesis

The thesis is structured as follows. Chapter two presents the general framework for policy analysis and reviews the essential agricultural policy analysis literature. The method applied is presented in Chapter three. Chapter four introduces the data and data sources. The empirical policy analysis is presented in Chapter five. Chapter six presents the results and discusses the main findings. Finally, Chapter seven sets out the policy implications and discusses questions for future research.

2. FRAMEWORK FOR AGRICULTURAL POLICY ANALYSIS

In agricultural economics literature, normative analysis of agricultural policies or the welfare economics approach with the aim to rank, compare or assess policy outcomes is applied the most commonly, especially in empirical work (see Bullock and Salhofer 2003)[10]. The capacity of the government to affect welfare is constrained by resource scarcity, technology and economic behaviour of individuals. Policy analysis is limited by the researchers' ability to identify and model the capacity of the government to affect welfare (Bullock et al. 1999, 513). In this study, it is argued that the framework for welfare economic policy analysis by Bullock et al. (1999) coincides with the traditional theory of economic policy (Tinbergen 1952, 1967; Theil 1965), given that the stated agricultural policy objectives are incorporated into an economic model using social welfare functions.

Traditionally, the theory of economic policy considers social welfare as a function of economic indicators such as the rate of economic growth, rate of employment and external trade balance, among others. However, such targets are not ends as such but only indicators of policy success. The end of a policy is to influence the welfare of individuals (Bullock et al. 1999, 521). Moreover, all policies are aimed to increase the overall welfare in society. Thus, it can be argued that the framework for normative policy analysis forms the basis for empirical policy analysis conducted in this study, given that the stated policy objectives are regarded as means for welfare maximising policies.

To rank or asses policies, there is a need for value judgements to be compared. The most important value judgements in welfare economic policy analysis are that (1) the welfare status of society must be judged solely by the members of society and (2) society is better off if any member in society is made better off without making anyone else worse of (see Bullock 1999, 513;

[10] For extensive reviews of normative and positive policy analysis literature see Josling (1974), Swinnen and van der Zee (1993), Bullock et al. (1999), Alston and James (2002), de Gorter and Swinnen (2002), Rausser and Goodhue (2002), Bullock and Salhofer (2003), and Swinnen (2010).

Just et al. 2004, 3). The first judgement is a definition for welfarism. It says that the only thing that matters in ranking different policy outcomes is their impact on the individual in society. The latter is the well-known Pareto principle.

The first two sub-chapters present a general framework for agricultural policy analysis and link the more common welfare economics approach to the theory of economic policy, usually referred to as the target-instrument approach. In addition, the role of surplus transformation curves, Pareto criterion and social welfare functions in policy analysis is emphasised. The third sub-chapter presents a literature review. The literature review covers the main developments and evolution of policy analysis since late 1950s. In addition, emphasis is put on the different forms of policy analysis and especially on the empirical applications.

2.1. General framework

In general, agricultural policy analysis involves two steps. First, a researcher has to identify government's policy objectives and to define the set of target variables for the desired analysis. Second, a researcher has to specify instrument variables to be analysed. The instrument variables are constrained by technical and political realities, but at the same time need to be under the control of a policy-maker (or the government).

The technical and political constraints include general economic factors, limits in budget expenditure, and decision-makers' and interest groups' preferences, among other things. Normally these constraints are treated as exogenous variables that may be non-controllable for a decision-maker. After the specification of the variables, a researcher can construct a formal model to describe the relationship between policy objectives and instruments and impose the necessary technical, economic and political constraints. (Tinbergen 1967; Josling 1974; Gardner 1987a; Hughes-Hallet 1989; Bullock et al. 1999; Bullock and Salhofer 2003.)

Following Bullock et al. (1999), a framework for economic policy analysis can be presented as follows. Government has m number of policy instruments x by which to influence policy outcome. The policy outcome is measured as a function of welfare of all n individuals in society. Government's problem is to maximise this function using a certain number of the instruments available.

Formally, a vector

$$X = (x_1, x_2, x_3, \dots, x_n) \quad (1)$$

describes all policy instruments available for the government. A specific government policy X is described by the values of available policy instruments, such as

$$X^A = (x_1^A, x_2^A, x_3^A, \dots, x_m^A),\ X^B = (x_1^B, x_2^B, x_3^B, \dots, x_m^B) \quad (2)$$

where A and B describe a particular level of each instrument x under two policies X.

Each government policy has an effect on the policy outcome U. Policy outcome U is a vector of the welfare of all n individuals in society, described as

$$U = (u_1, u_2, u_3, \dots, u_n). \quad (3)$$

To simplify the analysis, individuals in society are often aggregated to groups with similar interests or preferences. In agricultural economic analysis these groups are often defined as producers, consumers, taxpayers and input-suppliers, or sub-groups such as dairy producers, crop producers and meat producers.

Different policies imply different welfare levels for the groups and, hence, different policy outcomes. From policy X^A the welfare level U^A is

$$U^A = (u_1^A, u_2^A, u_3^A, \dots, u_n^A). \quad (4)$$

According to Bullock et al. (1999, 514), 'even though government has various policy instruments to derive various policy outcomes, what government can do in affecting welfare is limited by the realities of economic markets'. In policy implementation, governments face constraints that are both political and economic. The size and direction of a policy change depends on the prevailing market conditions, such as scarcity of resources and interdependencies within the economy, among other things.

In an economic model market realities impose limits that are implicit in the assumed economic models and in the model parameters. Typical examples are the functional forms for demand and supply as well as demand

and supply elasticities (Bullock et al. 1999). To relate policies, policy outcomes and welfare measurements for economic analysis, market realities must be incorporated into the analysis via an economic model. To present this formal model, let

$$B = (b_1, b_2, b_3, \dots, b_n) \tag{5}$$

be a vector of *n* model parameters, let

$$F(\cdot) = \left(f_1(\cdot), f_2(\cdot), f_3(\cdot), \dots, f_y(\cdot)\right) \tag{6}$$

be a vector of *y* functional relationships describing the economic system and let

$$G(\cdot) = \left(g_1(\cdot), g_2(\cdot), g_3(\cdot), \dots, g_n(\cdot)\right) \tag{7}$$

be a vector of welfare measures[11]. Now each group's welfare can be presented as a function of government policy, market conditions, functional relations of the economic system and welfare measures used as

$$\begin{aligned} U = (u_1, u_2, u_3, \dots, u_n) = \\ \left(g_1\big(f(x,b)\big), g_2\big(f(x,b)\big), g_3\big(f(x,b)\big), \dots, g_n\big(f(x,b)\big)\right) \\ = \left(h_1(x,b), h_2(x,b), h_3(x,b), \dots, h_n(x,b)\right) = h(x,b), \end{aligned} \tag{8}$$

where the right-hand side *h(x,b)* presents the welfare effect as a function of policy instruments *x* and market parameters *b (*Bullock et al. 1999).

Government can choose only from a limited set of policies. Thus, not all the values for *x* are technically and politically feasible. Political feasibility also depends on the prevailing political system and politicians' and their supporters' preferences. Technical feasibility is related to economic and technical constraints such as limited budget expenditure, implementation costs of policies and administrative realities.

[11] In agricultural economics literature Marshallian surplus measures, e.g. consumer and producer surpluses, are usually applied instead of the more exact Hicksian (equivalent variation, compensating variation) surplus measures. See Alston and Larson (1993) for a discussion.

Pareto criterion

According to the Pareto criterion, change from policy A to policy B is recommended if and only if at least one person in society is better off after the policy change and no one is made worse off. If the welfare of a person cannot be improved without making even just one person worse off, society is Pareto optimal. Following Bullock et al. (1999, 519), the Pareto criterion can be presented formally as follows. For every policy instrument level $x^A, x^B \in X$,

$$x^A \succ x^B \Leftarrow h_i(x^A, b) \geq h_i(x^B, b), i = 1,2, \dots, n, \tag{9}$$

policy x^* is Pareto efficient if any other technically feasible policy is less efficient than x^* in terms of the Pareto criterion. In other words, x^* is Pareto efficient if $x^* \in X$ and there is no other $x' \in X$ that would satisfy condition

$$h_i(x', b) \geq h_i(x^*, b), i = 1,2, \dots, n \tag{10}$$

when at least for one policy it holds that

$$h_i(x', b) \geq h_i(x^*, b), i = 1,2, \dots, n. \tag{11}$$

The Pareto criterion is a weak criterion for value judgement. This weakness accounts for its wide acceptance as a tool for establishing a social preference ordering of policies. However, it is not possible to rank two or more different Pareto efficient policies based on the Pareto criterion only. Moreover, the Pareto criterion does not say anything about distributive equity, such as income disparities and unequal distribution of welfare in society (see e.g. Just et al. 2004, 15-38).

Kaldor and Hicks present a compensation criterion[12] for welfare judgement. According to the Kaldor-Hicks compensation criterion, policy change from policy A to policy B is recommended, if those who gain from policy change can compensate for losses to those who lose. Formally, *x'* is potentially Pareto preferred to *x**, if there is some reallocation of *x''*[13],

$$h_i(x'', b) >_i h_i(x', b), i = 1,2, \dots, n, \tag{12}$$

such that *x''* is preferred to *x'* for all agents *i* (Varian 1992, 405).

[12] or potential Pareto improvement

[13] $\sum_{i=1}^{n} x_i'' = \sum_{i=1}^{n} x_i'$

The compensation criterion can be used to rank policies in terms of potential income redistribution. However, it does not state that the actual payment needs to be made (Just et al. 2004, 15-38). According to Varian (1992, 405), the compensation criterion is concerned solely with the allocative efficiency, and the question of proper income distribution can best be handled by alternative means.

Coate (2000, 438) suggests that the policy analyst should not investigate whether the social value of the utility gains exceeds the social value of the losses or whether the gainers might in principle compensate those who lose. Rather, a researcher should investigate alternative policy changes that could be made with similar distributional consequences. A policy change would be judged efficient if an alternative policy change which is better for all does not exist.

Surplus transformation curves

Policy-induced changes in welfare distribution are not without costs. In his seminal work, Gardner (1983) formalised surplus transformation curves that can be used to depict the welfare effects of policy instruments. Gardner provided a systemised framework for Josling's (1974) observation that, by continuously changing the level of the instrument of a simple policy, a curve could be mapped in social groups' welfare space to provide a broad picture of government's constrains when using a single policy instrument. Alston and Hurd (1990), Bullock (1992b, 1994, 1996), Salhofer (1996) and Bullock and Salhofer (1998) show that STCs are envelopes to the Pareto frontier. Thus, optimal combinations of different policy instruments draw a locus of Pareto efficient points. In other words, combining available policy instruments optimally, actual Pareto frontiers can be derived from a set of technically feasible policy instruments.

The slope of the surplus transformation curve measures the marginal transfer efficiency of policies. Bullock (1994, 1996) shows how surplus transformation curves relate to the Pareto frontier and, thus, assume that government can use policy instruments efficiently. According to Bullock (1994, 1996), Pareto efficient policies can be derived by solving an n constraint maximisation problem.

In notation, given market parameters b', x^* is Pareto efficient $X^* \in PE(b')$ if it simultaneously solves the n constrained maximisation problem

$$\underset{x \in X}{Max}\{h_i(x,b'): h_j(x,b') \geq h_j(x^*,b')\ \forall\ i,j\}, \quad i = 1,\dots,n, j = 1,\dots n, i \neq j, \tag{13}$$

which states that welfare is maximised if and only if there is no other policy x that would lead to higher welfare of group i without making group j worse off.

According to Gardner (1983, 232), this type of analysis can be used in both positive and normative policy analysis. 'The positive application of STCs is to explore whether policy variations over time can be explained in terms of efficiency in income redistribution'. The normative application is 'to rank prospective programs for redistributing income.' In the literature, the latter is often applied (see e.g. Alston and James 2002).

Social welfare function

While the Pareto criterion allows the judgement of the efficiency of a policy, it does not consider distributive equity. All points at the Pareto frontier are efficient and, hence, Pareto incompatible with each other. To be able to rank Pareto incompatible points within the set of feasible policy outcomes, a researcher has to apply value judgements about distributive equity (Bullock and Salhofer 2003, 235). Social preference orderings can be obtained by imposing the criteria for distributive equity as constrains into a social welfare function (SWF) or by directly incorporating these criteria into the functional form of the social welfare function (Bullock et al. 1999, 521).

A complete ranking of all feasible welfare outcomes is provided by the Bergson-Samuelson social welfare function. According to Bullock et al. (1999, 522), the most common functional form of a Bergson-Samuelson SWF and, hence, the most common value judgement criterion used to derive a complete ranking of policy outcomes is the utilitarian[14] social welfare function.

A Bergson-Samuelson SWF assigns numerical values to policy outcomes. According to Bullock et al. (1999, 521), 'Since the arguments of a social welfare function are social groups' welfare levels u, clearly SWFs are welfaristic constructs'. By using a SWF a researcher can obtain a complete social preference ordering of X, since W assigns a number to every technically feasible policy outcome. A policy x^A which results in a higher (equal, lower) SWF level W is socially superior (equal, inferior) to policy x^B with a lower (equal, higher) SWF level. Under the social welfare function criterion, a policy x^* is said to be socially optimal if it solves *max W(h(x,b))* or equivalently *max*

[14] or Benthamite social welfare function

W(u). Provided that society is assumed to benefit if the welfare of any social group increases without decreasing the welfare of any other social group[15], if $x^{\star}$maximises the SWF, $x^{\star}$ is Pareto efficient (Bullock et al. 1999, 522).

Following Bullock et al. (1999, 522), the utilitarian social welfare function can be presented as follows

$$W = W(u_1, u_2, \dots, u_n) = u_1 + u_2 + \cdots + u_n = h_1(x, b) + h_2(x, b) + \dots + h_n(x, b) \tag{14}$$

The value judgement criterion implied by the utilitarian social welfare function is

$$x^A > x^B \; if \; W\big(h(x^A, b)\big) > W\big(h(x^B, b)\big), \; with \; W\big(h(x, b)\big) = h_1(x, b) + h_2(x, b) + \dots + h_n(x, b) \tag{15}$$

Policy x^A is preferred to policy x^B if x^A gives higher social welfare or, in other words, its welfare outcome lies on a higher social indifference curve. These social indifference curves are contours of the social welfare function. The optimal policy lies on the highest obtainable social indifference curve.

The utilitarian value judgement criterion completes the social preferences ordering of policies. However, ranking policy options by summing welfare levels is based on the assumption that increasing the welfare of a wealthy person by one unit is of equal social value as increasing the welfare of a poor person by one unit.

According to Bullock and Salhofer (2003, 236), the use of a utilitarian social welfare function in agricultural policy analysis has often been criticised. One of the main objectives of agricultural policies is to redistribute welfare to farmers. This objective has to be taken into account in policy analysis. Bullock and Salhofer (2003, 236) categorise three different formulations of policy objective functions that aim to consider redistributive equity, given the policy objective of farmers' income level. These categories are: i) a utilitarian SWF with a predetermined welfare level for farmers or non-farmers, ii) a utilitarian SWF with a predetermined welfare ratio between farmers and non-farmers, and iii) a weighted linear SWF.

[15] the SWF is assumed as increasing in *u*

For case i), policy *A* is preferred to *B* if it leads to a higher social welfare level, given the same predetermined level for one (farmers) of the two social groups (farmers and non-farmers). In this approach, one can either maximise the welfare of non-farmers given some predetermined welfare level of farmers or minimise the cost to non-farmers given some predetermined transfer to farmers. For case ii), policy *A* is preferred to *B* if it leads to higher social welfare, given some predetermined welfare level ratio between farmers and non-farmers. For case iii), policy *A* is preferred to *B* if it leads to a higher social welfare level, given that more weight is put on the welfare of one (usually farmers) of the two groups.

2.2. Theory of economic policy

The theory of economic policy holds as the normative premise that government can pursue an optimal economic policy by operating a set of instruments and by fine-tuning the instrument levels in order to reach a priori well-defined targets (van der Zee 1997, 12). Target-instrument approach allows the comparison of different policies based on their ability to achieve these particular objectives. According to Hughes-Hallet (1989, 189), the theory of economic policy obligates policy-makers to make an efficient and consistent use of their policy instruments.

The welfare economic policy analysis defines optimality in terms of the Pareto criteria and ranks policies based on their ability to maximise the social welfare function and, thus, individual welfare. According to Bullock et al. (1999, footnote p. 521), 'stated policy objectives are indicators of policy success while the end of each policy is to increase social welfare'. Thus, achieving stated policy objectives leads to higher social welfare. It can be argued that the initial objective of the analysis coincides in both the target-instrument and welfare economic approaches.

Following a notation similar to that used previously in this chapter, Tinbergen's (1952, 1967) target-instrument approach can be formalised as follows. Let

$$Y = (y_1, y_2, y_3, \dots, y_n) \tag{16}$$

be a vector of well-defined policy objective variables. Let

(17) $$X = (x_1, x_2, x_3, \dots, x_n)$$

be a vector of policy instruments and

(18) $$Z = (z_1, z_2, z_3, \dots, z_n)$$

a vector of exogenous variables. Now, the economy is presented as

(19) $$Y = AX + BZ$$

where A and B are reduced form matrices of coefficients. If the number of target variables equals the number of instrument variables, it is possible to express *X* in terms of *Y* such that

(20) $$X = A^{-1}[Y^* - BZ]$$

where Y^* can be interpreted as the vector of optimal target levels. According to Hughes-Hallet (1989, 195), 'it is important to distinguish the simple necessary condition that there must be at least as many instruments and targets from the more complicated necessary and sufficient condition that those instruments must also be linearly independent. The reason is obvious: the instruments may be sufficient in number but unable to generate separate effects'. When the number of instruments is smaller than the number of targets, the targets cannot be met simultaneously. When different sets of instruments are available to attain the same target levels, the Tinbergen approach offers no selection criteria (van der Zee 1997, 12; Hughes-Hallet 1989).

The same model was later extended to also cover flexible targets. Instead of maximising *ex ante* chosen target variables, the focus was on the maximisation of social utility or welfare function *U*, which depends on target *y* as well as instrument variables *x* (Tinbergen 1967; Theil 1965). This welfare function is presented as

(21) $$U(X, Y) = U(y_1, \dots, y_n; x_1, \dots, x_n)$$

Given the restrictions imposed by the modelled relationships in economy, the policy-makers' preferences with respect to the levels of targets *y* and

instruments x can now be explicitly analysed. Thus, taking the first order condition with respect to policy instrument x gives the partial effect

$$\frac{\partial U(y,x)}{\partial x_i},\ i=1,...,m \tag{22}$$

and for the total effect of the optimal change of a policy instrument, we get

$$\sum_{k=1}^{n}\frac{\partial U}{\partial y_{k-1}}\frac{\partial y_k}{\partial x_i}+\frac{\partial U}{\partial x_i}. \tag{23}$$

The first term of the equation presents the overall change in social welfare that occurs when a marginal change in a policy instrument impacts on a particular target variable y_k and the marginal change in target variable y_k impacts on the other y_{k-1} target variables.

As stated by Gardner (1989, 1166), the relevant aspect of the function for most policy questions is its partial derivatives with respect to different policy objectives, such as individual's income. Evaluating policies means in practice assessing a change in policy, and an optimal policy is arrived at when any change reduces U. The partial derivatives can be thought of as weights. If a change in an instrument has an impact of the same magnitude on all the objectives, then all the objectives are weighted equally and no trade-offs are present.

The theory of economic policy requires that the set of policy instruments includes only variables that are under the direct control of the policy-maker. For example, one should specify the tariff instead of tariff revenue, and the discount rate instead of interest rate (van der Zee 1997, 12).

Given the frameworks presented above, Tinbergen's target-instrument approach is linked to the normative policy analysis framework via the utilisation of social welfare functions. By definition, government's objective is to maximise overall welfare. Stated agricultural policy objectives are the means to achieve the highest possible welfare level. Under the given economic and structural conditions, government implements policy instruments to achieve the policy objectives. Thus, a social welfare function can now be presented where the overall utility is a function of the stated policy objectives, policy instrument and market parameters. The overall utility, e.g. the numerical value of the social welfare function, changes marginally when the level of the policy instrument is changed marginally.

2.3. Literature review

The aim of this sub-chapter is to review the evolution of formal literature on agricultural policy analysis. The review is categorised based on the development of welfare economic analysis and surplus transformation, the more recent theoretical settings complementing the traditional policy analysis with different aspects from political economy, and the empirical applications. The emphasis is on the ability of policies to respond to the objectives set. In most of the literature, the policy objectives are categorised under income objectives and policy efficiency is measured in terms of the social costs of agricultural programmes[16].

Welfare economic analysis and surplus transformation

The formal literature on agricultural policy analysis rests heavily on seminal works by Nerlove (1958), Wallace (1962), Floyd (1965) and Josling (1969). Nerlove and Wallace were the first to analyse and to formally compare the impacts of the different agricultural policy measures on the overall welfare in society. Wallace compared three different policy measures, i.e. marketing quota, target price and deficiency payment (or a subsidy), and input restrictions in terms of their social costs. Social costs were measured as geometric areas in the supply-demand space, similar to those known as Harberger's triangles[17]. These geometric areas equate social costs to a loss in consumer and producer surpluses when prices and quantities change due to a policy change. Based on a graphical analysis, Wallace showed that the relative efficiency to achieve the desired price level using a production quota or price support depends on the size of the demand and supply elasticity. Thus, the effects of different policy instruments are heavily dependent on market parameters and conditions as well as on the correct measurement and estimation of the parameters.

The framework was extended by Floyd (1965), who constructed a Hicksian-based multi-market equilibrium displacement model to analyse the effects of different policy measures. The structure of this one output-two input model includes final demand, two-factor supply equations, a production function with two factors of production, and an equation for market clearing. Factor demands in factor markets are derived from the

[16] See Appendix 3 for summary.
[17] See Harberger (1971).

demand for agricultural products[18]. Floyd considered three price support programs: price support without output or input control, price support with acreage control and price support with marketing quotas. Floyd's well-known result was that price support measures with and without input controls tend to benefit different groups involved very differently and may have disadvantageous effects on input markets. The main beneficiaries are those engaged in land markets, while the final effects depend on the own-price elasticity in production and own-price elasticity of inputs as well as elasticity of substitution between inputs[19].

Wallace and Floyd show formally that different price support measures may include leakages that lead to inefficient policies. Wallace measured inefficiency in terms of social cost and Floyd in terms of distributive leakages between output and input markets, showing that the actual effects on farmers' income level may be ambiguous. Both of them concluded that the final outcome depends on elasticity and other market parameters.

Josling's (1969) measurement of inefficiency was a step further. Josling examined the relative efficiency of three alternative price policies, when government's objective was to secure farmer's incomes and displace imports. Policy efficiency was measured as per unit costs with respect to both policy objectives. Based on the analysis, Josling argues that 'any objective which can be interpreted in terms of the economic variables of a formal model can be subject to similar analysis.'

Josling (1974) was also first to introduce a graphical framework to analyse policy efficiency in terms of different policy objectives. Josling's graphical presentation laid the foundation for surplus transformation curves (STCs), later popularised by Gardner (1983, 1987a). The graphical presentation of surplus transformation curves allows the comparison of several single policy instruments in a single graph. Thus, given some desired level of farmers' income it is possible to find the most efficient measures to achieve that level with the least societal costs. According to Alston and James (2002, 1695), 'these graphical presentations allow us to compare policy consequences, to prescribe more efficient policies and to understand policy choices.'

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[18] Gardner (1975) used a similar model to measure changes in marketing margins between farmers and retailers, when products are assumed homogeneous. James and Alston (2002) extended the model to a heterogeneous product to analyse the effects of taxation in the Australian wine sector.

[19] Gardner (1987a, 86-116) found similar results after extending the model to include production controls, acreage controls and several input markets.

Gardner (1987b) and Bullock (1992a) used a similar approach in analysing agricultural policies in the U.S. and in the European Union, respectively. The framework was first extended to cover several policy instruments by Alston and Hurd (1990). They show that transfer efficiency is improved when two policy instruments are combined, given that the instruments are not mutually exclusive. When a quota is set equal to the competitive quantity and combined with a subsidy, transfers from consumers to producers can be made without distortions in production and consumption. That is, the quota would prevent supply response to the subsidy.

Kola (1991, 1993) applied a similar analysis for measuring the efficiency of different production control instruments in Finland, and Gisser (1993) analysed the efficiency of a combination of a target price and acreage control in terms of their efficiency in income redistribution. Isosaari (1993) applied the framework to analyse the effects of different policy instruments on welfare distribution in the Finnish sugar production sector under imperfect competition. In the STC analysis, a model with three interest groups and one policy instrument was built to rank different policy instruments based on their efficiency. Efficiency was measured in terms of deadweight losses.

Salhofer (1996, 1997) extended the analysis to cover all the policy instruments in use on the Austrian bread grain market. Besides agriculture, the analysis also covers agricultural input industries and food processing industry. His analysis shows that the applied policy is not Pareto efficient. This framework was generalised by Bullock (1996) and Bullock and Salhofer (1998), who provide the theoretical framework for the analysis of the efficiency of sub-optimal combinations of policies in terms of their social costs.

The empirical results on the transfer efficiency of different policy instruments found in the literature are well summarised in OECD (2002). According to OECD (2002, 13-15), there are two sources of transfer loss that limit the effectiveness of agricultural policy instruments. The first is economic costs, which result from induced inefficiencies in the use of productive resources, distortions in consumption patterns, and the effect of taxation on economic incentives. The second source of loss is distributive leakages, whereby some of the benefits accrue to groups other than the intended beneficiaries. When these losses are added up and compared between the instruments, we can see clearly that no support policy linked to agricultural activity succeeds in delivering more than half of the monetary transfers from consumers and taxpayers as additional income to farm households. In the

case of market price support and deficiency payments, the share is one fourth or less, for input subsidies it is less than one-fifth. These results indicate that price support-based agricultural policies fail to contribute efficiently to the stated objective of securing farmers' incomes.

More recent empirical applications in welfare analysis are Niemi (2005) and Ackrill et al. (2008). In Niemi (2005), the welfare effects of a policy shock are analysed using a comparative static partial equilibrium analysis. The policy shock analysed is the accession of Finland to the EU and the adoption of the CAP. The direct static welfare effects are analysed for eight agricultural commodities in the Finnish agricultural markets. The results suggest that the opening of Finnish agricultural markets for competition upon the EU accession have incurred large annual welfare losses to farmers, while consumers have gained. The taxpayers have also gained as a result of the decrease in direct subsidies and export restitutions paid from the national budget. All in all, however, the EU accession led to an increase in the overall welfare of the agriculture sector in Finland. These results indicate that in Finland the CAP has contributed negatively to the target of securing farmers' incomes[20] compared to the previous national policies, while the policy target of reasonable consumer prices has developed in the desired direction.

Ackrill et al. (2008) analyse the welfare effects of the major CAP reforms. In addition, their study links the reforms to a wider institutional context, i.e. to the international trade obligations, EU budget concerns and the enlargements. Based on a graphical analysis, they show that the CAP was not able to respond to the rapidly increasing productivity and the increased political heterogeneity due to the enlargements of the EU. Moreover, the nature of the CAP as a source of budget revenue in the first decades of the CAP transforms into a policy that is a significant source of welfare losses prior to the fundamental reforms, starting from the MacSharry reform in 1992.

The studies reviewed above draw a picture of the development of literature on welfare economic policy analysis. In general, policies are analysed in terms of changes in the overall welfare distribution and income transfer efficiency. The main assumption as regards the policy targets is that policies are implemented to attain the desired welfare level to farmers with the least economic costs. The costs are measured in terms of deadweight losses. In the end, the policies are ranked based on their efficiency to distribute income from consumers and taxpayers to producers.

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[20] As noted by Harvey (2004, 271-272), one should bear in mind that reduction in producer surplus does not necessarily indicate reduction in farmers' income.

Political preference functions

The relative political power or social welfare weights of political interest groups are measured using political preference functions (PPF). They were first introduced by Rausser and Freebairn (1974). PPF is assumed to incorporate both the political preferences and the influence activities of political actors and groups involved. The PPF models assume that the interest group pressure forces the government to consider a set of criteria that roughly corresponds to the desires of the various interest groups. Thus, these criteria are arguments in the government's PPF.

According to Gardner (1989, 1165), PPF studies assume that policies influence the level of the political preference function only by influencing people's incomes. This is done to evade the problems relating to utility measurement. However, the level of PPF which is an indicator of political objectives depends upon the way in which people's incomes enter it. Bullock (1994) argues that PPFs assume government policies to be Pareto efficient. PPF studies measure marginal rates of substitution along a modelled Pareto frontier. If government policies are inefficient in terms of the Pareto criterion, the observed relative weights may not give a meaningful explanation for policy implementation. Other studies using the PPF approach are Burton (1985), Oehmke and Yao (1990), and Rausser and Foster (1990).

Theoretical studies on the policy objectives and instruments

Interesting theoretical studies closely related to the research questions set out in this study are Becker (1983), Oskam (1988), Swinnen (1994), Hueth (2000), Guyomard et al. (2004), Nedergaard (2006) and Howlett (2009). Although all the studies have a different setting, the aim is to increase the understanding of the policy design and the effects of policy instruments on particular policy objectives.

Becker (1983) analyses the level of income distribution as an outcome of a political process that builds on competition among pressure groups for political favour. According to Becker, an increase in deadweight costs discourages pressure by subsidised groups and encourages pressure by taxpayers. Thus, governments correct market failures in favour of the politically powerful. Active groups produce pressure to raise their political influence, where all influences are jointly determined by the pressures produced by all groups. The political budget equation between the total amount raised in taxes and the total amount available for subsidies implies that the sum of all influences is zero, which has a significant effect on the

competition among pressure groups. It is shown that the political equilibrium depends on the efficiency of each group in producing pressure, the effect of additional pressure on their influence, the number of persons in different groups and the deadweight costs of taxes and subsidies. Moreover, Becker argues that policies which raise efficiency are likely to win out in the competition for influence because they produce gains rather than deadweight costs. Thus, the groups benefited have the intrinsic advantage compared to the groups harmed.

Oskam (1988) introduces a decision-based economic theory that derives the underlying policy objective function from observed decision-making. Thus, the constructed objective function is based directly on the revealed preference of the policy-makers. The objective function is derived from choice behaviour that is also constrained with limits in budget expenditure and technology available. According to Oskam (1988, 34), the main advantage of this approach is that there is no preliminary requirement about the unit of measurement of the objective function and the type of variables entering it. The only restriction is that they should be the objective variables of the decision-maker. In addition, the form of the objective function can be derived both at the individual level and at more aggregate level. One clear advantage of this approach is that empirical results can be used in different fields of research, especially in political economy research.

Oskam and Witzke (1990) applied the decision-based economic theory to the analysis of US wheat policy decisions. In order to construct a linear objective function for US wheat markets, they selected five policy objectives and defined twelve policy instruments implemented on the US wheat markets. The policy objectives are producer surplus, consumer surplus, budgetary expenditure, volume of exports and volume of production. Budgetary expenditure is used to normalise the preference function, and its weight is set to equal one. Their analysis shows that the derived policy objective function clearly weights producer welfare over consumer welfare. In addition, the volume of production does not appear to be an important policy objective, while the volume of exports is. Moreover, the weights are consistent over all policy decisions included in the model.

Swinnen (1994) analyses the political economy of agricultural protection in a general equilibrium framework. The underlying argument is that rational politicians offer protectionist policies in return for political support from their constituency. Individuals in the economy have different factor endowments and politicians exploit these differences in establishing redistributive policies when maximizing political support. The model predicts

that politicians' optimizing behaviour will lead to an increase in agricultural protection. The analysis indicates that the observed correlation between agricultural protection and economic development is not due to a single factor. Structural changes in the economy influence the political equilibrium through their effect on pre-policy endowment incomes, the impact of the policy on individual welfare, and the efficiency of the policy in transferring income. These changes have an impact on political support for the policy and, consequently, on the political equilibrium. According to the model, politicians increase agricultural subsidies as real incomes in agriculture fall relative to the rest of the society. The model predicts that the equilibrium subsidy will increase as the share of agriculture in total output decreases, as capital intensity in and outside agriculture increases, and as supply elasticities increase. The impact of the decrease in the share of food in total consumption expenditure on the equilibrium protection levels depends on the distribution of income taxes and tariff revenues.

Hueth (2000) applies the mechanism-design approach to examine the structure of optimal policies under three alternative government objectives. The objectives analysed are a minimum level of net income for all farmers, transfer of income from consumers and taxpayers to the farm sector, and an augmented income-transfer objective where the government seeks to also support the nonmarket benefits from the production of relatively high-cost farms. The nonmarket benefits are associated with the concept of family farm, which despite the higher than average production costs creates particular social and cultural added value within the US agriculture sector. The analysis suggests that the existence of nonmarket values may create a distortion in policies in favour of production from relatively high-cost farms. The implication is that the government perceives a connection between the existence of relatively high-cost farm operations and the preservation of the sustainability of rural communities. If many relatively high-cost farmers are perceived to be more conducive to the survival of rural areas than a few low-cost farms and if the government wishes to support rural communities, it would prefer that more of the production comes from high-cost farms. In a closed economy where domestic demand is less than perfectly elastic such a production distortion may no longer be optimal under the policy objectives considered.

Guyomard et al. (2004) analyse and classify four agricultural income support programmes according to their ability to achieve three domestic policy goals. The four income support programmes set out an output subsidy, land subsidy, and a decoupled payment both with and without mandatory

production. The policy goals are to support farmers' incomes, to maintain a maximum number of farmers and to reduce the negative externalities arising from non-land input use. The analysis is conducted using a partial-equilibrium model of the farm sector with land price endogeneity and free exit and entry. Based on the analysis, two main conclusions are drawn. First, no income support programme uniformly dominates over the others for the three policy targets. Second, for each policy target, the ordering of the four income support programmes depends on the conditions that cannot be predicted by the theory alone. The ranking depends on the elasticity values with respect to land uses. A more general conclusion in the paper is that the three policy goals considered cannot be achieved using a single policy instrument. In addition, there are trade-offs among policy targets. According to their policy recommendation, policy-makers should follow the principle of targeting policies to their specific objectives by letting the market forces freely determine the level of production, consumption and trade. At the same time, the income support objective should be addressed by a decoupled income transfer without mandatory production and other policy goals through specific targeted measures.

Nedergaard (2006) introduces a deductive theoretical model to analyse the CAP. His main argument is that the characteristics of the CAP cannot be explained without government failures of the political systems as an independent variable. In the model, market failure covers certain characteristics of the supply and demand of agricultural goods as well as some peculiar characteristics of agricultural production. Market failures are associated separately and in aggregate to the supply and demand side, as well as to farmers, consumers and politicians and bureaucrats. However, his study does not reveal how market failures at each stage of the policy process actually impact on the policy objectives of the implemented policies.

Howlett (2009) disaggregates policy goals and means into a vertical process where public policy choices and the level of policy targets and instruments are defined at three different stages. For the policy instruments, these stages are general preferences, operational tools and specific calibrations. For the policy objectives, these stages are general abstract policy aims, operational policy objectives and specific policy targets. His main argument is that all stages need to be analysed separately while keeping in mind the strong interlinks within the policy process.

Empirical studies in political economy of agriculture

According to Pokrivak et al. (2006), the majority of empirical studies on the political economy of the CAP use either reduced form models that relate indicators of policy distortions to a set of political indicator variables, or more descriptive methods to analyse purely the historical development of the CAP. Examples of the first category are Olper (1998) and of the latter Olper (2008) and Jensen et al. (2009). Swinnen (2008) covers studies relating to the different aspects of the political economy of the Fischler reform in 2003.

Olper (1998) analyses the determinants of CAP protection across the EU countries and over time from a political economy perspective. The analysis is aimed to shed light on whether or not the traditional hypothesis advanced in the theoretical and empirical literature is consistent with the CAP policy game, given that the decision-making is strongly influenced by the political and economic interests of the Member States. The analysis covers both the time-series and cross-country dimensions. The results show that agricultural protection increases when market conditions are against the farming industry and in countries with a comparative disadvantage in agriculture. Intra-EU trade is an important determinant of protection levels. Also, the number of farms strongly conditions the protection patterns across countries, showing that small countries and small agriculture sectors are the most likely to gain CAP transfers. A high budget share for food consumption appears to reduce protection. In addition, the estimation results indicate that CAP policy-makers are sensitive to income indicators when assessing how much they are supporting farmers.

Olper (2008) analyses the constraints and causes of the 2003 Fischler reform in a more qualitative setting. His main argument is that the reforms were accomplished because of two reasons. The first was the ability of the then Agriculture Commissioner to take advantage of the very complex political environment, in which budget pressures and enlargement mattered. Second, the imposed reform package had relatively low redistributive effects, which means that it had only marginal effects on the pre-reform political economy equilibrium.

Jensen et al. (2009) apply a rational choice theory to analyse whether the CAP positions of the EU Member States are related to structures in their agriculture sectors. Their overall hypothesis is that intensiveness of agricultural production corresponds to the willingness to reform the CAP, given the structural fundamentals in each member country. Thus, the likelihood of a fundamental policy reform is related to the level of

intensification of agriculture within the EU. The study concludes that future development of the CAP, i.e. the level of future CAP reforms, highly depends on the political positions of the new Member States.

In addition to the studies analysing purely the political economy of the CAP, there are several more recent empirical applications of the different aspects of the political economy of agricultural policies that are relevant for this study, especially in terms of the econometric procedures applied. These studies include Thies and Porsche (2007), Masters and Garcia (2010), Olper and Raimondi (2010), Bates and Block (2010), Dutt and Mitra (2010) and Gawande and Hoekman (2010). All these studies analyse well-known political economy theories with different panel data estimation settings and, thus, provide significant added value to the empirical research of agricultural policies.

Thies and Porsche (2007) analysed the political economy of agricultural producer support in the OECD countries. In the analysis, they use the average producer nominal protection coefficient as a dependent variable and a set of economic and political variables as independent variables. These variables include agricultural employment and the share of agriculture in GDP, among others, as well as shock indicators for economic recession and fiscal crisis. Other variables are the terms of trade, labour productivity ratio and the factor endowment ratio. The political variables are drawn from the Database of Political Institutions (Beck et al. 2001). These include variables for veto players, federalism, constituency and party fragmentation. In addition, dummy variables for the EU and post-Uruguay round were included. The statistical models were estimated using the panel-corrected standard errors estimation technique. The results of the study show that all political institutional variables play a very important role in determining the level of agricultural producer support, while the impact of structural economic variables is not as uniformly significant. The political variables have relatively robust effects across the four models, but cyclical downturns in terms of recession or fiscal crisis do not seem to enable agricultural producers to achieve greater protection.

Masters and Garcia (2010) analysed the political economy hypothesis on the form of agricultural distortions using the data from Anderson and Valenzuela (2008). The policy impacts are measured for seventy-two products, chosen to account for over 70 per cent of agricultural value added in each country, resulting in a total of over 25 000 distinct estimates from particular products, countries and years. They use nominal rate of protection

(NRA) as the dependent variable. Independent variables include border prices, crop area, checks and balances, entry of new farmers, monetary depth, policy transfer costs and urban population, among others. Their analysis confirms three well-known stylised facts in political economy. It is shown that a consistent anti-trade bias exists in all countries, the development paradox of anti-farm bias in poorer countries and pro-farm bias at higher incomes exists, and there is a resource abundance effect toward higher taxation of agriculture in more land-abundant countries. The study concludes that, while there is robust support for some theories and not for others, none of their regressions account for more than half of the variance across countries and over time. To explain the remainder would require deeper analyses of the institutional context of policies, in particular countries and commodities.

Olper and Raimondi (2010) conduct an empirical analysis with the aim to better understand the interaction between institutions and agricultural policy distortions. They estimate the average effect of constitutions on policy outcomes using difference-in-differences approach. In the analysis, NRA is used as a dependent and different constitutional variables as independent variables. The constitutional effects on the protection levels are measured by calculating the difference in average protection before and after the transition in the treated countries and comparing it to the changes in protection levels in control countries. Their study showed that transition towards democracy has significant effects on agricultural protection levels, but the effects are heterogeneous across different forms of democracy. On the other hand, the results do not indicate that significant differences exist across alternative forms of government.

Bates and Block (2010) explore the political economy of agricultural trade protection in sub-Saharan Africa. They argue that policies towards agriculture are often by-product of other political concerns, which is why analysts should take into account the broader political setting when addressing agricultural policies. In addition, while the analysis should still continue to focus on normative and welfare issues, close attention should be paid to the incentives faced by the policy-makers. Dutt and Mitra (2010) use a similar approach to explain the cross-country variation in agricultural protection and within-country evolution of this protection over time.

2.4. Discussion

The main conclusion to be drawn from the reviewed literature is that, although constantly discussed in the literature, the relations of agricultural policy instruments and stated objectives are rarely analysed – that is, with the exception of the income objectives. The income objective is, however, usually analysed using indirect measurement, mainly producer surplus. Moreover, it is argued, that despite the several stated objectives generally observed in the government documents, the initial objective of agricultural policies has been to transfer incomes from consumers to farmers (Gardner 1983; Hueth 2000).

It can be concluded that the theoretical restrictions imposed in the theory of economic policy need to be relaxed for the desired empirical analysis in this study. This is because of several reasons. First, independent variables cannot be selected purely on a theoretical basis. Examples and insight can be drawn from both the empirical and theoretical literature, but not a clear justification for the model variables as such.

Second, the policy objective set for the analysis has, in general, been the farmers' income level measured using producer surplus. The policies are ranked either in terms of their ability to increase producer surpluses or in terms of social costs incurred. Thus, there exists no direct reference to the construction of a social welfare function for empirical application that would include several stated objectives.

Third, the stated policy objectives lack actual target levels. In the welfare economic analysis, the target can be set as Pareto optimal or zero deadweight cost. The stated policy objectives are qualitative as such and need to be specifically quantified. However, while not directly measured in quantitative terms, no exact target levels have been defined. Thus, the social welfare function constructed will only approximate the overall welfare levels via the stated objectives.

Fourth, empirical applications both in the normative and positive analysis of agricultural policies have been carried out to analyse the efficiency of policies in terms of social costs and deadweight losses (normative), or the economic, structural and political factors which have impacted on policy formation or on the level of agricultural protection (positive). The question remains what is the effect of implemented policies on the stated objectives, given the economic and structural conditions under which the policies are implemented. This study aims to contribute to this discussion.

3. METHOD

The ultimate goal of economic analysis is to measure the impacts of different economic phenomena on selected variables. The variables are selected based on the research question in hand. In an economic analysis the question is whether a change in one variable causes a change in another variable.

In an econometric model, a causal relationship between two or more variables is established while holding the other factors constant. For the analysis, the set of control variables x that are explicitly held fixed when studying the effect of z on the expected value of y is selected. The reason for controlling these variables is the assumption that z is correlated with other factors that influence y.

Deciding on the list of proper controls is not always straightforward. Using different controls can lead to different conclusions about the causal relationship between y and z. Thus, a researcher needs to decide which factors are to be held fixed in the analysis (Woolridge 2010, 3-7). In the empirical analysis, these decisions are usually based on the underlying economic theory and research literature, among other things.

The vector of control variables $X=(x_1, x_2,\ldots,x_n)$ is assumed to capture the economic and structural development under which the vector of policy variables $Z=(z_1, z_2,\ldots,z_n)$ impacts on the selected policy target variable y. In a simple functional presentation the relation between the target variable y and policy variable z_i can be written in the form

$$y = f(X, z_i) \quad (24)$$

in which we are able to analyse how y changes when z_i is marginally changed given the development of the vector of control variables X. However, according to Woolridge (2010, 15), in a stochastic setting we cannot assume that $y = f(X, z_i)$ for some known function and observable variables (X,z_i) because there are always unobserved factors affecting y. Thus, including an error term ε with a conditional mean zero to get

[21] Implies the same causal relationship as (19) in the previous section.

(25) $$y = f(X, z_i, \varepsilon)$$

where an error term is expected to capture the unobserved impact in the estimated model. In a linear econometric specification this implies

(26) $$y = X\beta + z_i\alpha + \varepsilon,$$

where β and α are the estimated coefficients and ε is the error term.

In this study, econometric panel data analysis is applied to conduct the empirical part of the study, where the economic phenomenon studied is agricultural policy and its impact on the selected variables is analysed. In the analysis the effects of a vector of policy variables $Z=(z_1, z_2,\ldots,z_n)$ on a particular policy target variable y is examined holding the vector of control variables $X=(x_1, x_2,\ldots,x_n)$ fixed over time and for individuals. In an applied panel data setting, all variables are observed for a number of selected individual countries i in a given time t, while the level and pace of development of the variables differs between countries over time. Both between-country and over-time differences are incorporated into the analysis. The linear econometric specification for the panel data analysis is

(27) $$y_{it} = X'_{it}\beta + z_i\alpha + \varepsilon_{it}.$$

In the next section, the chosen panel data estimation procedures are described. The first sub-chapter introduces briefly the general structure of the panel data estimation procedures. The second sub-chapter describes the test procedures utilised in the analysis. In the third sub-chapter, the model specification and its justification based on the theory of economic policy is introduced. The first two sub-chapters are based on Greene (2011), Baltagi (2008) and Hsiao (2003).

3.1. Panel data analysis

The panel data set will consist of n sets of observations on individuals to be denoted $i=1,\ldots,n$. If each individual in the data set is observed the same number of times, usually denoted as T, the data set is a balanced panel. An unbalanced panel data set is one in which individuals may be observed different numbers of times. This can be denoted as T_i. A fixed panel is one in

which the same set of individuals is observed for the duration of the study (Greene 2011).

The fundamental advantage of a panel data set over a cross-section data is that it will allow a researcher great flexibility in modelling differences in behaviour across individuals (Greene 2011, 345). According to Baltagi (2008, 6-9), panel data allows the researcher to control individual heterogeneity, is more informative in terms of greater variability, and is more efficient especially in terms of more degrees of freedom.

The basic framework for panel data analysis is a regression model of the form (Greene 2011, 346):

$$(28) \qquad y_{it} = X'_{it}\beta + z'_i\alpha + \varepsilon_{it} = X'_{it}\beta + c_i + \varepsilon_{it}.$$

There are K regressors in X_{it}, not including the constant term. The heterogeneity or individual effect is $z_i\alpha$, where z_i contains a constant term and a set of individual or group specific variables.

The model in equation (28) is a classical regression model. If z_i is observed for all individuals, then the entire model can be treated as an ordinary linear model and fit by least squares. Complications arise when c_i is unobserved, as is the case in most applications.

The main objective of the analysis will be a consistent and efficient estimation of the partial effects

$$(29) \qquad \beta = \partial E[y_{it}|x_{it}]/\partial x_{it}.$$

Whether this is possible depends on the assumptions about the unobserved effects. The first assumption is the strict exogeneity of the independent variables

$$(30) \qquad E[\varepsilon_{it}|x_{i1}, x_{i2}, \dots,] = 0.$$

That is, the current disturbance term is uncorrelated with the independent variables in every period, past, present and future. The crucial aspect of the model concerns the heterogeneity, i.e. whether or not the omitted effects, c_i in the general model, are correlated with the included variables (whether a fixed or random effects approach is more appropriate).

A particularly convenient assumption would be mean independence

$$E[c_i|x_{i1}, x_{i2}, \dots,] = \alpha. \quad (31)$$

If the missing variables are uncorrelated with the included variables, then they may be included in the disturbance of the model. This is a particularly strong assumption that underlies the random effects model.

The alternative would be a more general formulation

$$E[c_i|x_{i1}, x_{i2}, \dots,] = h(x_{i1}, x_{i2}, \dots,) = h(X_i). \quad (32)$$

However, it is also a more complicated one since it may require yet further assumptions about the nature of the function (Greene 2011, 346).

In the data with multiple countries the observed variables may include, for example, GDP and population demographics. The unobserved variables can be country-specific characteristics such as different levels of heterogeneity in the preferences and skills of the population. Both observed and unobserved variables are taken to be constant over time.

According to Greene (2011, 371), the fixed effects model allows the unobserved individual effects to be correlated with the included variables. Then the differences between units are modelled strictly as parametric shifts of the regression function.

The random effects approach specifies that the error term is a group-specific random element. It is similar to ε_{it}, except that for each group there is a single draw that enters the regression identically in each period. The crucial distinction between fixed and random effects is whether the unobserved individual effect embodies the elements that are correlated with the regressors in the model, not whether these effects are stochastic or not.

For example, an inter-country comparison may well include the full set of countries for which it is reasonable to assume that the model is constant. If the individual effects are strictly uncorrelated with the regressors, it might be appropriate to model the individual specific constant term as randomly distributed across cross-sectional units. This view would be appropriate if the sampled cross-sectional units are believed to be drawn from a large population. The payoff to this form is that it greatly reduces the number of parameters to be estimated. The cost is the possibility of inconsistent estimates, if the assumptions turn out to be inappropriate (Greene 2011, 371).

Fixed effects model

A fixed effects model arises from the assumption that the omitted effects, c_i in the general model,

$$y_{it} = X'_{it}\beta + c_i + \varepsilon_{it} \tag{33}$$

are correlated with the included variables. In a general form the correlation is presented as

$$E[c_i|X_i] = h(X_i). \tag{34}$$

Because the conditional mean is the same in every period, the model can be written as

$$\begin{aligned} y_{it} &= x'_{it}\beta + h(X_i) + \varepsilon_{it} + [c_i - h(X_i)] \\ &= x'_{it}\beta + \alpha_i + \varepsilon_{it} + [c_i - h(X_i)] \end{aligned} \tag{35}$$

By construction, the bracketed term is uncorrelated with X_i, so the term may be absorbed in the disturbance, and the model be written as

$$y_{it} = x'_{it}\beta + \alpha_i + \varepsilon_{it} \tag{36}$$

A further assumption is that $Var[c_i|X_i]$ is constant. With this assumption, the specification becomes a classical linear regression model.

Equation (36) is the formulation that signifies the fixed effects model. It is not the case that any variable is fixed in this context and random elsewhere. The fixed effects formulation implies that differences across groups can be captured in differences in the constant term. Each α_i is treated as an unknown parameter to be estimated (Greene 2011, 359).

According to Greene (2011, 360), a major shortcoming of the fixed effects approach is that any time-invariant variables in x_{it} will mimic the individual specific constant term, and thus the time-invariant variables cannot be estimated. This lack of identification is the price of the robustness of the specification on the unmeasured correlation between the common effect and exogenous variables.

Following the notation by Greene (2011, 360), the least squares estimation of the fixed effects model is presented next.

Let y_i and X_i be the T observations for the ith unit, $\boldsymbol{i}$ be a $Tx1$ column of ones, and ε_{it} be the associated $T\ x\ 1$ vector of disturbances. Then

$$y_i = X_i\beta + \boldsymbol{i}\alpha_i + \varepsilon_{it}. \tag{37}$$

Collecting these terms gives

$$\begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix} = \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_n \end{bmatrix} \beta + \begin{bmatrix} i & 0 & \dots & 0 \\ 0 & i & \dots & 0 \\ \vdots & & \vdots & \\ 0 & 0 & \dots & i \end{bmatrix} \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \vdots \\ \alpha_n \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{bmatrix} \tag{38}$$

or

$$y_i = [X\ d_1\ d_2\ , \dots, d_n] \begin{bmatrix} \beta_i \\ \alpha_i \end{bmatrix} + \varepsilon, \tag{39}$$

where d is a dummy variable indicating the ith unit. Now, denote the $nT\ x\ n$ matrix by $D=[d_1,d_2,\dots,d_n]$. Then, assembling all nT rows gives

$$y = X\beta_i + \boldsymbol{D\alpha_i} + \varepsilon_i \tag{40}$$

This model is usually referred to as the least squares dummy variable (LSDV) model, because the observed values of the variable for coefficient α_i takes the form of dummy variables. However, the computational procedure for estimating the slope parameters in this model does not require that the dummy variables for the individual effects are actually included in the matrix of explanatory variables (Hsiao 2003, 32).

The model is a classical regression model. If n is small enough, the model can be estimated by ordinary least squares with K regressors in X, and n columns in D, as a multiple regression with $K+n$ parameters. If n were thousands, the size of the computation would be reduced by using results for a partitioned regression (Greene 2011, 360) or by obtaining a specific least squares dummy variable estimator (Baltagi 2008, 14) [22].

[22] In our case with 15 countries, 33 years and around 400 observations for each dependent variable, n is considered small. For further discussion of the specifications when n is large, see Greene (2011, 361) and Baltagi (2008, 14-15).

Random effects model

Following Greene (2011, 371), consider a reformulation of the model presented in equation (28)

$$y_{it} = \alpha + x'_{it}\beta + (\alpha + u_i) + \varepsilon_{it} \tag{41}$$

where there are *K* regressors including a constant. Now, the single constant is the mean of the unobserved heterogeneity, $E[z_i'\alpha]$. The component $u_i = \{z_i'\alpha - E[z_i'\alpha]\}$ is the random heterogeneity specific to the *i*th observation and is constant through time. Thus, u_i can be viewed as the collection of factors $z_i'\alpha$ not in the regression but specific to a country.

Assuming strict exogeneity of the independent variables

$$\begin{aligned} &E[\varepsilon_{it}|X] = E[u|X] = 0 \\ &E[\varepsilon_{it}^2|X] = \sigma_\varepsilon^2 \\ &E[u_i^2|X] = \sigma_u^2 \\ &E\left[\varepsilon_{it}u_j|X\right] = 0 \\ &E\left[\varepsilon_{it}\varepsilon_{js}|X\right] = 0 \; if \; t \neq s \; or \; i \neq j \\ &E\left[u_i u_j|X\right] = 0 \; if \; i \neq j \end{aligned} \tag{42}$$

the formulation of the model can be viewed in blocks of *T* observations for group *i*, y_i, X_i, u_i**i** and ε_i. For these *T* observations, let $n_{it} = \varepsilon_{it} + u_i$ and $n_i = \left[n_{i1,} n_{i2}, \dots, n_{iT}\right]$.

In view of this form of n_{it}, there is a model often called an error components model. For this model

$$\begin{aligned} &E[n_{it}^2|X] = \sigma_\varepsilon^2 + \sigma_u^2 \\ &E[n_{it}n_{is}|X] = \sigma_u^2, t \neq s \\ &E[n_{it}n_{is}|X] = 0 \; for \; all \; t \; and \; s \; if \; i \neq j. \end{aligned} \tag{43}$$

The feasible generalized least squares estimation of the error component model proceeds as follows. The model defined in equation (41), namely

$$y_{it} = \alpha + x'_{it}\beta + (\alpha + u_i) + \varepsilon_{it},$$

is a generalised regression model, given the strict exogeneity assumptions defined in (42). The disturbances are autocorrelated in a way that observations are correlated across time within a group, but not across groups.

In particular, the parameters of the random effects model can be estimated consistently, but not efficiently, by ordinary least squares (Greene 2011, 372)[23].

According to Baltagi (2008, 14), Greene (2011, 379) and Hsiao (2003, 49), there are no clear selection criteria for an appropriate model. According to Baltagi, the fixed effects model is an appropriate specification if the focus is on a specific set of N countries and the inference is restricted to the behaviour of this set of countries. Inference in this case is conditional on the particular N countries that are observed. According to Hsiao, whether to treat the effects as fixed or random makes no difference when T is large. This is because both the LSDV estimator and the generalized least-squares estimator become the same estimator. When T is finite and N is large, the question becomes more difficult.

According to Greene, from a purely practical standpoint the dummy variable approach is costly in terms of the degrees of freedom lost. On the other hand, the fixed effects approach has one considerable virtue: there is little justification for treating the individual effects as uncorrelated with the other regressors, as is assumed in the random effects model. The random effects treatment may suffer from inconsistency due to this correlation between the included variables and the random effect.

Hsiao points out that the issue is not whether or not α_i in equation (36) can be viewed as random draws from a common population or whether the conditional distribution of α_i given x_i can be viewed as identical across i. In the linear regression framework, treating α_i as fixed leads to the identical estimator of β whether α_i is correlated with x_i or is from a heterogeneous population. For ease of reference, it is concluded that when α_i is correlated with x_i in equation (36), the fixed effects model is more appropriate. On the other hand, when α_i is uncorrelated with x_i, the random effects model becomes appropriate.

[23] See Greene (2011, 372-376) for the discussion of the other consistent estimators and estimation procedures.

3.2. Testing the panel data estimates

According to Baltagi (2008), it is not self-evident which of the two estimation procedures, fixed or random effects, should be used. In this study, both approaches are utilised. The appropriateness of the model is assessed based on the following statistical test procedures.

The decision-making tree is as follows:

1. Ordinary least squares estimation results are used to assess the convergence of the selected model and to reveal the structure of heterogeneity via the estimated distribution of the error component.
2. F-test statistics are utilised to reveal whether the inclusion of individual aspects in the model increases the explanatory power of the model.
3. The Lagrange multiplier test is utilised to assess whether the effects model is appropriate for the analysis.
4. The Hausman test is utilised to assess whether fixed or random effects model is more appropriate for the analysis.
5. Chow test is utilised to analyse whether a policy reform creates a structural break in the data.

Next, the underlying assumptions and the interpretation of the test statistics are discussed briefly.

Heterogeneity

The structure of heterogeneity is estimated from ordinary least squares. First the distribution of the error component is estimated using ordinary least squares, and then these estimates are used in generalized least squares estimation (Greene 2011, 285).

Differences across groups

When interested in differences across groups, the hypothesis that the constant terms are all equal can be tested with the F-test. Under the null hypothesis of equality, the efficient estimator is pooled least squares. The F-ratio used for this test is

$$F(n-1, nT-n-K) = \frac{(R^2_{LSDV} - R^2_{Restricted})/(n-1)}{(1-R^2_{LSDV})/(nT-n-K)}, \tag{44}$$

where LSDV indicates the dummy variable model and Restricted indicates the pooled or restricted model with only a single overall constant term.

Significant (high) F-test values favour an individual specific effect, i.e. the fit of the model increases when the individual aspects are added.

Lagrange multiplier test

The efficiency of the OLS residuals can be analysed using Lagrange multiplier test statistics. Given the null hypothesis that there are no group effects in the effects model, i.e. $H_0: \sigma_u^2 = 0, H_1: \sigma_u^2 \neq 0$,the test statistics are defined as

$$LM = \frac{nT}{2(T-1)}\left[\frac{\sum_i(\sum_t e_{it})^2}{\sum_i\sum_t e_{it}^2} - 1\right]^2. \quad (45)$$

Under the null hypothesis, the limiting distribution of LM is chi-squared with one degree of freedom[24] (Greene 2011, 376-377).

Large values of LM favour the effects model over the classical model with no common effects. Rejection of the null hypothesis is likely in the presence of fixed effects, i.e. group effects exist. The variance of dependent variables is not equal to all individuals. The classical regression model with a single constant term is appropriate for the data, so the null hypothesis is rejected in favour of the RE model.

However, when the true model is actually the fixed effects model, OLS (classical regression model) yields biased and inconsistent estimates of the regression parameters. This is an omission variables bias due to the fact that OLS deletes the individual dummies when in fact they are relevant (Baltagi 2008, 15). Under the random effects model, the OLS estimates are still unbiased and consistent, but no longer efficient (Baltagi 2008, 19).

Hausman test

The specification test devised by Hausman (1978) is used to test for orthogonality of the common effects and the regressors. The test is based on the idea that under the hypothesis of no correlation, both LSDV and GLS are consistent but OLS is inefficient. However, under the alternative hypothesis with correlation, OLS is consistent but GLS is not. Therefore, under the null hypothesis, the two estimates should not differ systematically, and a test can be based on the difference.

[24] Interpretation of the chi-squared statistics: the classical regression model with a single constant term is appropriate for the data = null hypothesis rejected in favour of the effects model (variance is not equal to all individuals).

The other essential ingredient for the test is the covariance matrix of the difference vector, $\left[b-\hat{\beta}\right]$, where b is an inefficient LSDV and $\hat{\beta}$ is efficient GLS estimate (Greene 2011, 379):

$$Var\left[b-\hat{\beta}\right]=Var[b]+Var\left[\hat{\beta}\right]-Cov\left[b,\hat{\beta}\right]-Cov\left[\hat{\beta},b\right]. \tag{46}$$

Hausman's essential result is that the covariance of an efficient estimator with its difference from an inefficient estimator is zero, which implies that

$$Cov\left[b,\hat{\beta}\right]=Var\left[\hat{\beta}\right]. \tag{47}$$

The required covariance matrix for the test is

$$Var\left[b-\hat{\beta}\right]=Var[b]-Var\left[\hat{\beta}\right]=\Psi, \tag{48}$$

and the chi-squared test is based on the Wald criterion

$$W=X^2[K-1]=\left[b-\hat{\beta}\right]'\Psi\left[b-\hat{\beta}\right]. \tag{49}$$

For Ψ, the estimated covariance matrices of the slope estimator in LSDV model and the estimated covariance matrix in the random effects model are used, excluding the constant term. Under the null hypothesis, W has a limiting chi-squared distribution with *K-1* degrees of freedom. According to (Baltagi 2008, 65-68), the Hausman test is a useful device for determining the preferred specification of the common effects model, despite the shortcomings in its construction.

Chow test

To test the hypothesis that some or all of the regression coefficients are different in two or more subsets of the data the Chow test is applied. To conduct the test, first the regression using a full data set is estimated to compute the restricted sum of squares residual. A second regression is estimated using the subset of data to compute the unrestricted sum of squares residual, and so on. The Chow test is then carried out with F statistic,

$$F[K,n_1+n_2-2K]=\frac{\left(SSE_{restricted}-(SSE_1+SSE_2)\right)/K}{(SSE_1+SSE_2)/(n_1+n_2-2K)} \tag{50}$$

where SSE_j is the sum of squared residuals from the indicated regression and K is the number of coefficients in the model (Greene 2011, 130-135)[25].

In this study, the LM, F-test Hausman and test statistics are utilised in the empirical analysis section. Given the highly empirical nature of this study, the discussions on possible stylish facts in econometrics and in test procedures are left to methodologically oriented studies. However, the importance of relevant estimation and test procedures is well understood.

In addition, the possible problems arising from the nature of data in terms of heteroskedasticity and serial correlation are not discussed[26]. However, according to Hsiao (2003, 55-56), heteroskedasticity can arise because the variances of α_i or u_{it} or both vary with i in an error-component setup. This is especially the case when panel studies involve cross-sectional units of varying size. Given the structure of the data, there is a possibility for inconsistent estimators in the analysis.

3.3. Basic equation to be estimated

In this study, the traditional theory of economic policy (Tinbergen 1952, 1967; Theil 1965) is incorporated under the framework of welfare economic policy analysis by Bullock et al. (1999). As noted earlier, the theory of economic policy considers social welfare as a function of economic indicators. In this study, the stated policy objectives are regarded as means for welfare maximizing policies and, thus, as arguments in the social welfare functions.

The setting of the analysis is based on the traditional version of Tinbergen's theory of economic policy, which starts out by classifying the variables of an econometric model into four groups: (a) policy target variables; (b) policy instruments; (c) data or non-controllable variables; and (d) non-target or irrelevant variables (Hughes-Hallet 1989, 195). In this study, the classification is modified to include policy target variables, exogenous variables not controllable by the policy-makers, and policy variables.

The estimation procedures are selected to utilise the structure of the compiled data set as efficiently as possible. For empirical analysis, the stated agricultural policy objectives are incorporated into an econometric model as

[25] The testing procedure for Chow test assumes that the point of the structural break is known. In our case, we test whether a policy reform imposes a structural break for all five estimated models.

[26] See e.g. Baltagi (2008, 87-113) and Hsiao (2003, 55-60) for discussion.

dependent variables. Thus, the desired social welfare function is expressed in terms of particular policy target variables. The grounds of the analysis rest in Tinbergen's theory of economic policy, and it draws on recent empirical applications in the agricultural economics literature.

While the functional form and model variables for the analysis in this study cannot be drawn directly from a theoretical basis, the analysis starts with a single equation linear model in the form of

$$Y = \alpha + \beta_1 x_{1t} + \beta_2 x_{2t} + \ldots + \beta_K x_{Kt} + u_{kt}, \tag{51}$$

or,

$$Y = \alpha_0 + \sum_j \beta_j X_{jit} + u_{it} \tag{52}$$

[27]

where y is a policy target variable, x_i the vector of j explanatory variables, β_j the coefficients to be estimated, α_0 a constant, and u a random error term. The subscripts i and t denote the countries and periods of time, respectively, to which the variables refer.

The relationships between target variables and policy instruments are estimated using two alternative specifications. First, the equation is estimated using the fixed effects approach in which the country dummies are included. Second, it is assumed that country-specific differences are fully accounted for by the regressors X_{jit}. This specification is estimated using the random effects approach.

The development of the target variables at the individual country level may depend on a multitude of country-specific factors, only some of which may be captured by the included variables. If any of these omitted variables are correlated with included explanatory variables, the fixed effects coefficients will be biased.

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[27] Tinbergen's conventional econometric model was specified as $Y_t = \sum_{j=1}^{n} \pi_{1j} Y_{t-j} + \sum_{j=0}^{k} \pi_{2j} x_{t-j} + e_t$, where Y_t are endogenous variables, x_t are policy instruments, and e_t are non-controllable random variables. Y_t itself contain a subset of m policy targets y_t. The remaining elements of Y_t are non-targets, and e_t would be composed of variables exogenous to both the policy makers and the model, including the model disturbance term (Hughes-Hallet 1989, 195). The main difference to the specification used in this study is that multiple targets are not analysed simultaneously. Thus, the first term of Tinbergen's equation is excluded.

4. DATA

The data for the analysis in this study are obtained from several large databases. These include the European Commission, Eurostat, Food and Agriculture Organisation (FAO), International Labour Organisation (ILO), Organisation for Economic Co-operation and Development (OECD), and World Bank as well as the Database of Agricultural Distortions (Anderson and Valenzuela 2008) and the Database of Political Institutions (Beck et al. 2001)[28].

From the original data sources, a panel for EU15 countries is compiled following the enlargement of the European Union during the research period from 1975 to 2007. The structure of the panel is presented in Table 2. Due to the chosen approach to follow the development of the EU, the structure of the panel is heterogeneous. From 1975 to 1994 the panel is unbalanced, since the number of countries evolves throughout the period. From 1995 onwards the panel is balanced.

The data obtained from the European Commission come from two different statistical publications. The first source is the annual Agriculture in the European Union – Statistical and economic information. The report covers aspects such as the economic situation in agriculture, agricultural structures, trade, markets, financial aspects and rural development (European Commission 2009, 2010). The second source is the Financial programming and budget (European Commission 2011). This includes statistics on the revenue and expenditure of the EU budget as well as the financial frameworks for the following financial periods.

[28] A full list of variables in the data and their sources are presented in Appendix 2.

Table 2. *The structure of the panel data*

	1975-	1981-	1986-	1995-2007
EU9	Belgium, Denmark, France, Germany, Italy, Ireland, Luxembourg, The Netherlands, UK			
EU10		Greece		
EU12			Portugal, Spain	
EU15				Austria, Finland, Sweden
	unbalanced panel			**balanced panel**

From the Eurostat, the database of Economic Accounts for Agriculture (EAA) is used. The purpose of the database is to analyse the production process of the agricultural industry and the primary income generated by this production. The EEA accounts are detailed data on the value of output, intermediate consumption, subsidies and taxes, consumption of fixed capital, rents, interests and capital formation. The values are both in current and constant prices. The EAA database also includes statistics on Agricultural Labour Input and Unit Values (Eurostat 2012).

FAOSTAT is an international database on global food and agricultural statistics operated by the Food and Agriculture Organization of the United Nations. FAOSTAT includes very extensive global and country-level statistics on agricultural production, consumption, prices, trade and nutrition, etc (FAOSTAT 2011). In this study, country-level trade data on food exports and imports are utilised to calculate the food trade balance in the form of export-import ratio.

LABORSTA is an international database on labour statistics operated by the Department of Statistics of the International Labour Organisation (ILO). The LABORSTA database covers statistics on employment, hours of work, wages, labour costs and consumer prices, etc. (LABORSTA 2011). In this study, the food price indices for each EU15 country are utilised.

The Organisation for Co-operation and Development (OECD) provides extensive statistics on a variety of economic issues. This study uses data from the Economic Outlook statistics on the general gross financial liabilities of the EU15 countries (OECD 2011).

World dataBank is an extensive source of different international databases maintained by the World Bank. Among other things, the World dataBank includes statistics on World Development Indicators, Gender Statistics, Global Economic Monitor for Commodities and Millennium Development Goals (World Bank 2011). The data utilised in this study are population statistics, net indirect taxes and agriculture value added per worker.

Database of Agricultural Distortions is a core database produced by the World Bank's research project on Distortions to Agricultural Incentives. The database includes data on Nominal Rates of Assistance (NRA) to producers, together with a set of Consumer Tax Equivalents (CTE) for farm products and a set of Relative Rates of Assistance to farmers in 75 focus countries (Anderson and Valenzuela 2008).

The Database of Political Institutions (DPI) is a large cross-country database that originally covered 177 countries over the years 1975-1995 and included 108 variables, giving details about elections, electoral rules, type of political system, party composition of the opposition and government coalitions, and extent of military influence on government. In addition, the DPI also contains a number of new variables compiled from the raw data, including original measures of checks and balances and stability (Beck et al. 2001). The DPI is constantly updated and some of the variables may have been replaced over time.

In the dataset that has been compiled some concerns exist. Given the whole research period, the main caveat is the lack of complete time series for some countries in the original data sources. There is a lack of data for Germany in almost all databases applied. This is due to the fact that the Federal Republic of Germany and German Democratic Republic were reunited in 1990, and the statistics on these two parts of Germany have not been compiled into a single time series. In addition, time series also lack for the Federal Republic of Germany prior to 1990. Full data series were difficult to obtain for Greece, Belgium and Luxembourg. Incomplete time series for the variables included in the final analysis are mentioned in the relevant sections. It should be noted that some of the variables in the data were excluded from the analysis purely due to incomplete data. Examples of these variables include the gross value added on agriculture and R&D expenditure.

5. EMPIRICAL POLICY ANALYSIS

The empirical analysis is conducted as follows. After the introduction of the selected target variables and their development, the econometric specification of the model is presented. The third sub-chapter describes the development of the control and policy variables included in the model. In the last sub-chapter, a comparative static analysis of the independent variables is carried out for all target variables[29].

5.1. Policy target variables

Selected dependent variables are chosen as relevant approximations of the stated policy objectives. The stated policy objectives of the CAP are: to increase agricultural productivity, to ensure a fair standard of living, to stabilise markets, to assure the availability of supplies, and to ensure that consumers reach supplies at reasonable prices.

In this study, increase in agricultural productivity is measured via value added in agriculture per worker; a fair standard of living is approximated via real term net entrepreneurial income in agriculture, deflated with the consumer price index; market stability is measured using the standard deviation over a five-year annual moving average in wheat prices; availability of supplies is measured in terms of aggregate self-sufficiency ratio for wheat and milk; and, finally, reasonable consumer price level is determined with the food price index deflated with the GDP deflator. The selected target variables are presented in Table 3.

All selected variables are indirect and, to some extent, subjective indicators in the sense that the stated policy objectives of the CAP are highly qualitative. The other major concern in analysing the effectiveness of policies relates to the fact that no exact target levels have been set for the policy objectives. For example, the policy objective is set as 'to ensure a fair standard of living to farmers', but the income level at which the objective is achieved is

[29] Country-level descriptive statistics for all model variables are presented in Appendix 4.

Table 3. *Summary of independent variables*

Variable	**Specification**	**Source**
Y1 Agricultural value added per worker (constant 2000 US$)	Is adopted as the target variable for the development of agricultural productivity. Agricultural value added per worker measures the output of the agriculture sector less the value of intermediate inputs. Given the proportion per worker, it reflects the rational use of labour emphasised in the stated policy objective. Data are in constant 2000 USD.	World Bank
Y2 Net entrepreneurial income index deflated with consumer price index (2005=100)	Is adopted as the target variable for a fair standard of living. Entrepreneurial income corresponds to the operating surplus (total returns-total costs): plus property income minus interest on debts payable by the farm and rents payable on land and other non-produced tangible assets rented by the farm. For the analysis proportioned to the general consumer price development. Directly comparable between countries and the data relatively well available. The main caveat is that net entrepreneurial income does not proportion farmers' incomes either to the general standard of living in the EU countries or to the income development in sectors other than agriculture.	Eurostat, LABORSTA
Y3 Standard deviation of wheat prices	Is used as the target variable for market stability. The producer price for wheat is used as the base due to the overall importance of wheat in the EU15 crop production. In order to reduce the effect of annual price variation due to production fluctuations caused, for example, by exceptional weather conditions, the standard deviation is calculated as the five-year moving average. Alternative specifications used in the estimations were wheat prices (euro/tn), annual standard deviation, annual variance, and variance of the five-year moving average.	European Commission, own modifications
Y4 Self-sufficiency ratio (wheat and milk aggregated)	Is used to measure the availability of supplies. The self-sufficiency ratio is a very common measure both in the academic literature and in government programmes. Calculated as a percentage share of domestic production of total domestic consumption. Self-sufficiency is aggregated as on average of wheat and milk to cover both main production sectors covered by intervention programmes in the EU15.	Database of Agricultural Distortions
Y5 Food price index (2005=100) deflated with GDP deflator (2000=100)	Is used as the target variable for reasonable consumer prices. Deflated using GDP deflator. Deflator proportions food price development to general economic development. The main caveat relates to the fact that the development of food price indices is not proportioned either to general price development or the development of purchasing power. Thus, based on the food price indices it cannot be directly argued whether the food price development has been reasonable or not.	LABORSTA, World Bank

not specified. For the analysis, this means lack of exactness. Our analysis reveals the direction and magnitude to which agricultural policies and policy reforms contribute, but cannot reveal the exact level of the coefficient for effectiveness.

Due to the lack of exact target levels, the basis for the analysis rests on the development of the selected target variables. Next, the development of the target variables is described at the individual country level and the justification of the variable selection is discussed briefly.

To increase agricultural productivity[30]

The objective of the CAP is to increase agricultural productivity via technological progress and rational use of inputs, especially labour. Thus, value added per worker in agriculture is a justified approximation for the policy objective. Moreover, comparable country-level data for EU15 are relatively well available compared to other productivity measures. The country-level development is shown in Figure 3.

The agricultural value added per worker has increased rapidly in all countries during the research period, with Portugal as an exception. Variation between the countries has increased towards the end to the period, indicating different agricultural structures and their developments within the countries. The agricultural value added per worker has approximately tripled in most countries, except in Portugal, where the increase has been very small.

[30] For this variable, data were available only starting from 1980. For Greece the data were unavailable.

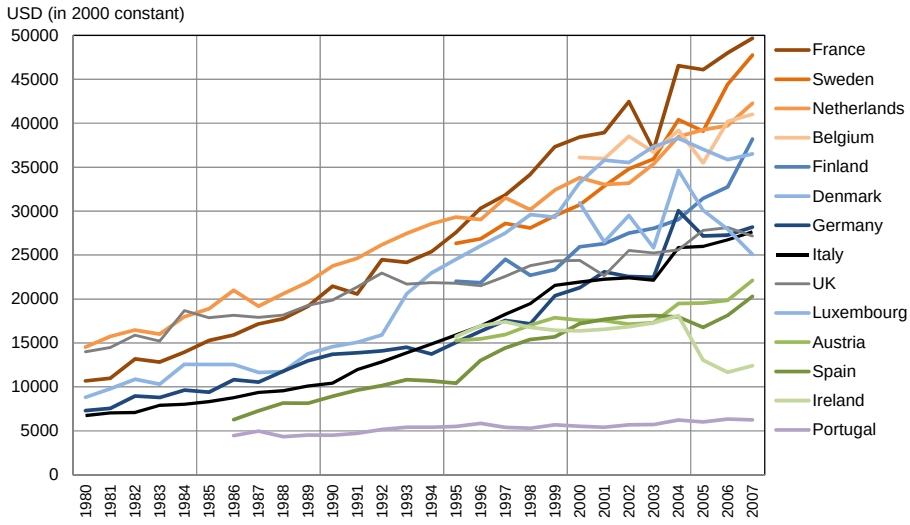

Figure 3. *Agricultural value added per worker in EU15 countries (Source: World Bank)*

In general, the observed development is due to both the increased value of production and declining use of labour input in agriculture. The annual development has been relatively stable in all countries, with the exception of peaks and subsequent surges especially in France, Italy and Ireland in 2003 and 2004. The between-country variation is considerable, ranging in real terms from a little above 5000 USD in Portugal to nearly 50000 USD in France in 2007. For the EU9 in 1980, the range was from around 6000 USD in Italy to 15000 USD in Germany.

The heterogeneity of agricultural structures and differences in the ability of agriculture sectors in the EU Member States to create added value is clearly visible in the graph. It seems evident that implementing a common policy with significant policy impact is difficult. On the other hand, the productivity of agriculture in terms of agricultural value added per worker has developed in the desired direction in all countries.

To ensure a fair standard of living

An index of net entrepreneurial income is used to measure the development of farmers' incomes and thus, to approximate the development of a fair standard of living. The indices for individual countries are presented in Figure 4. The main benefit of using net entrepreneurial income to measure the development of farmers' incomes is that statistics are directly comparable in all EU15 countries. In addition, farmers' individual incomes are particularly

emphasized in the policy objective. In order to proportion the farmers' income development to the general standard of living and to the development of purchasing power, the index was deflated with the country-level consumer price index.

However, using income development as the target variable does not allow to analyse whether farmers achieve a certain pre-determined level of income or whether the income level is fair or not. Instead, our analysis focuses on the impacts of agricultural policies on the development of farmers' income regardless of whether the incomes have increased or decreased.

In general, the development of net entrepreneurial income has been heterogeneous in the EU countries[31]. The variation in the magnitude of annual changes is large, but the direction of these changes is quite similar in all countries. In addition, the between-country variation decreases towards the end of the research period. Variation in net entrepreneurial income is the greatest in Denmark, the Netherlands, Italy and the UK. However, on average, these countries also have the highest average income levels during the research period. The steadiest development is seen in France. All three countries with the highest variation have relatively large agriculture sectors and they are known to be in favour of more liberalized agriculture. In addition, agricultural trade is significant in all these countries. France, instead, is very well known for its large domestic agriculture sector and positive attitudes towards protection in the agricultural markets.

It can be concluded that the profitability of agriculture varies significantly between countries. Moreover, there is no clear trend in the development of net entrepreneurial income at the EU15 level. Thus, a general policy impact cannot be determined based on the graphical analysis.

[31] For Denmark, France, and the UK first observations are from 1978, for Belgium and Italy 1980, for Luxembourg 1985, for the Netherlands 1986, Spain and Ireland 1990, Germany 1992, Greece 1993.

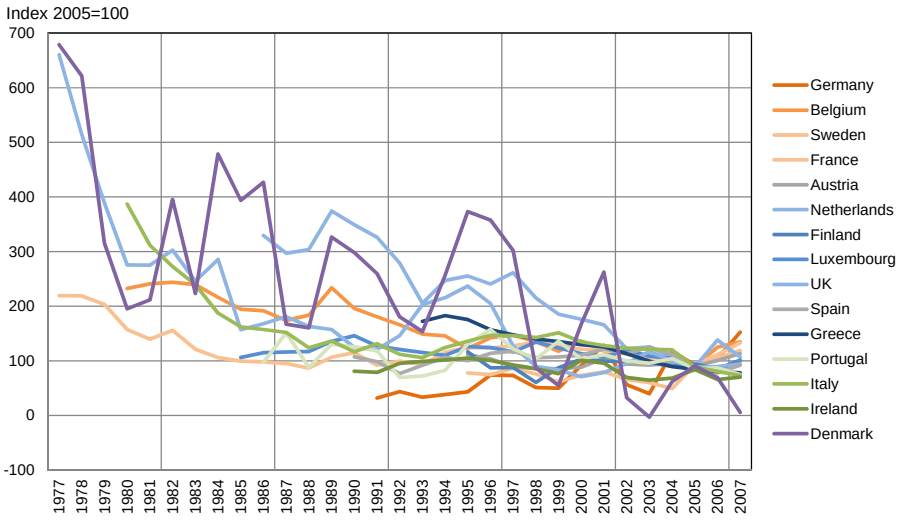

Figure 4. *Net entrepreneurial income[32] in the EU15 countries (Source: Eurostat, LABORSTA)*

To stabilise markets

Market stability is measured in terms of the annual standard deviation of wheat producer prices over a five-year moving average[33]. The calculated standard deviations are presented in Figure 5. Wheat prices are used as the base due to the overall importance of wheat in the EU15 crop production. In addition, the policy changes are expected to be the most clearly present on the wheat markets, given that the CAP reforms were first implemented in the common market organisation for cereals. In order to reduce the effects of annual price variation due to production fluctuations caused, for example, by exceptional weather conditions, the annual price changes are proportioned to the five-year moving average.

In general, the annual standard deviation in producer prices is relatively small, with the exception of Austria and Finland in the early years after the accession to the EU. The deviation was great when the national price regimes were replaced by the price regimes under the CAP. The nature of the administrative price setting at the EU level is clearly seen in the graph. The magnitude and direction of changes in the annual variation are the same in

[32] Deflated with consumer price index 2005=100 (Source: LABORSTA)

[33] $MA = \frac{(p_n + p_{n-1} + \ldots + p_{n-4})}{n}$, and $Y_i = \left((MA_{n-m} - \frac{P_{m-n}}{n} + \frac{p_m}{n}) - p\right)$, where n = 1, … ,5, and i = 1975, … ,2007, and p = annual wheat producer prices (eur/tn).

almost all countries, with few exceptions only. Larger than average standard deviations are observed in Portugal, the UK and Greece, but the between-country variation diminishes towards the end of the research period.

The accession of individual countries to the EU has increased the annual variation in producer prices. However, in Sweden the transition to the common price regime was smoother compared to Finland and Austria. In Sweden the role of policies in agriculture prior to the EU accession was less dominant or even non-existent compared to Finland and Austria. However, the data suggest that the EU enlargement has not as such led to increased price variability within the EU.

The increasing producer prices towards the end of the research period are also clearly seen in the graph via the positive standard deviation. Increase in the deviation indicates that policy reforms have given room to market signals in the producer price formation and, thus, responded to the demand for more market orientation. According to the data, agricultural producer prices have been relatively stable during the period analysed. Thus, policies have worked in favour of the objective set.

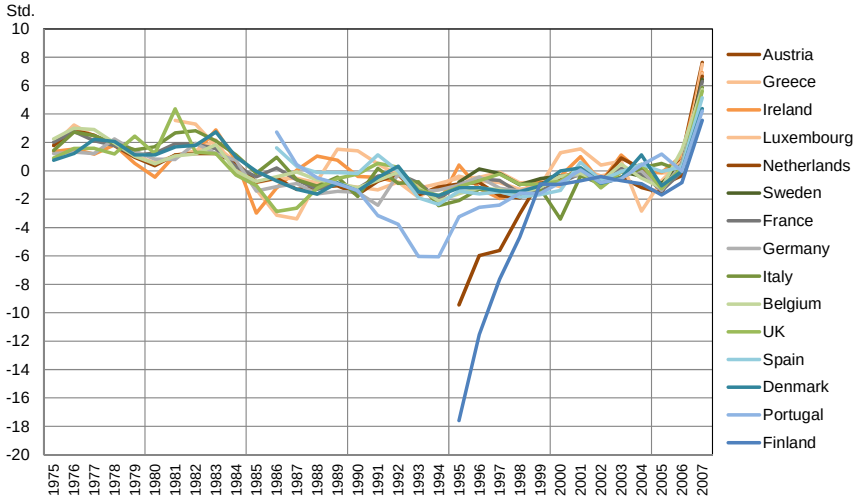

Figure 5. *Standard deviation in wheat prices in the EU15 countries (source: Eurostat, European Commission, own calculations)*

To assure the availability of supplies

The availability of supplies is often measured with the self-sufficiency ratio. Self-sufficiency ratio is calculated as a percentage share of domestic production of total domestic consumption. For the EU Common Agricultural Policy, the self-sufficiency target is set for different products separately. To validate the analysis, a country-level self-sufficiency ratio aggregate of milk and wheat is used to approximate the stated policy objective of assuring the availability of supplies. The self-sufficiency ratios in the EU15 countries are presented in Figure 6[34].

The data indicate that the annual variation in self-sufficiency is mainly due to the variation in total production levels. Given that rapid annual changes are more likely in crop production, the variability is due to variation in the yield levels and total crop production areas. Thus, weather conditions and temporary changes in production due to changes in relative crop prices can be assumed to have a more direct effect on the actual self-sufficiency level. Changes in milk production are more trend-like, with possible lags compared to changes in the prices, costs or demand. Changes in policies are not likely to contribute on an annual basis but, instead, impacts are observed over longer term.

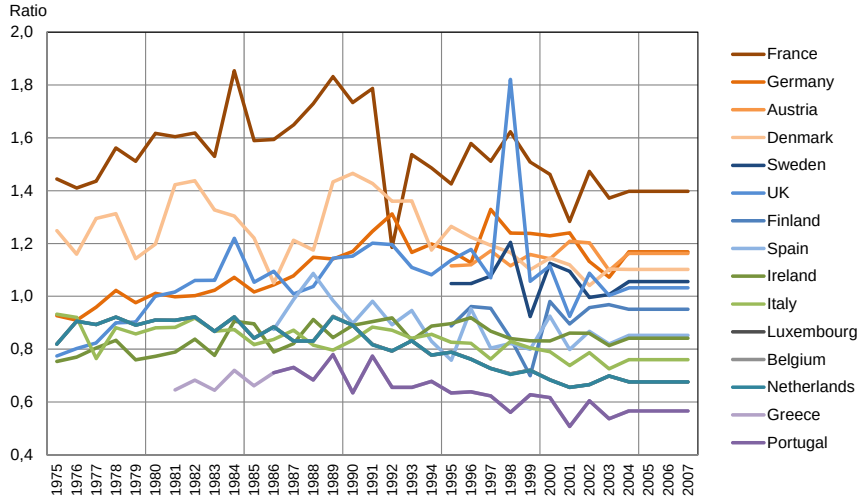

Figure 6. *Aggregated self-sufficiency ratio for wheat and milk in the EU15 countries (Source: Anderson and Valenzuela 2008, own calculations)*[35]

[34] The original data lack the self-sufficiency ratios for Belgium, Luxembourg and Greece. For Belgium and Luxembourg, data from the Netherlands and for Greece data from Portugal are used.

[35] Self-sufficiency levels are set to the 2004 levels from 2004 to 2007 in the original data.

According to the data, countries with a self-sufficiency ratio above one in the early 1980s tend to have it above one until the end of the research period. Similarly, countries that produced less than the domestic consumption in the early 1980s tend to do so in 2007 as well. Our data suggest that a trend towards lower self-sufficiency ratios started during the late 1980s and early 1990s in all countries. In addition, the implementation of the CAP reforms in 1992 and 2000 are clearly seen in the data. Self-sufficiency levels declined in general after 1992 and again after 2000, although less clearly in some of the EU15 countries.

The differences in the country-level self-sufficiency ratios indicate that all countries have not set the target on 100 per cent self-sufficiency. Thus, at the individual country level, agricultural policies have not secured self-sufficiency. However, on the EU internal markets the total production has exceeded total consumption during the whole research period.

To ensure that supplies reach consumers at reasonable prices

The fifth objective of the CAP is to ensure reasonable consumer prices of food. This objective is measured by the real-term food prices and using general food price indices deflated with the GDP deflator. The indices for the EU15 countries are presented in Figure 7. The use of food price indices is justified on two grounds. First, indices are directly comparable between countries. Second, the indices are weighted to take into account the differences in national consumption baskets. The main caveat relates to the fact that on the basis of food price indices it cannot be argued whether food price levels are reasonable or whether food price development is reasonable.

Until the most recent years of the research period, food prices have evolved with decreasing real-term trend in all EU15 countries. The pace of the decrease has been quite similar during the whole period. However, the between-country comparison of food prices shows that price levels have been relatively heterogeneous in the EU9. In addition, this heterogeneity prevailed until the late 1990s, after which the price levels got closer to each other in all countries. Overall, the heterogeneity of price levels has decreased towards the end of the research period. While the food prices have in general decreased, the graph shows sharp consumer price reductions in the Netherlands and Germany in 1995. These price changes are due to domestic policy changes.

The effects of policies cannot be directly shown from the graphical analysis. It can be argued that prices would have decreased at a slower pace without the policy reforms in 1992 and 2000. However, the reduction in the

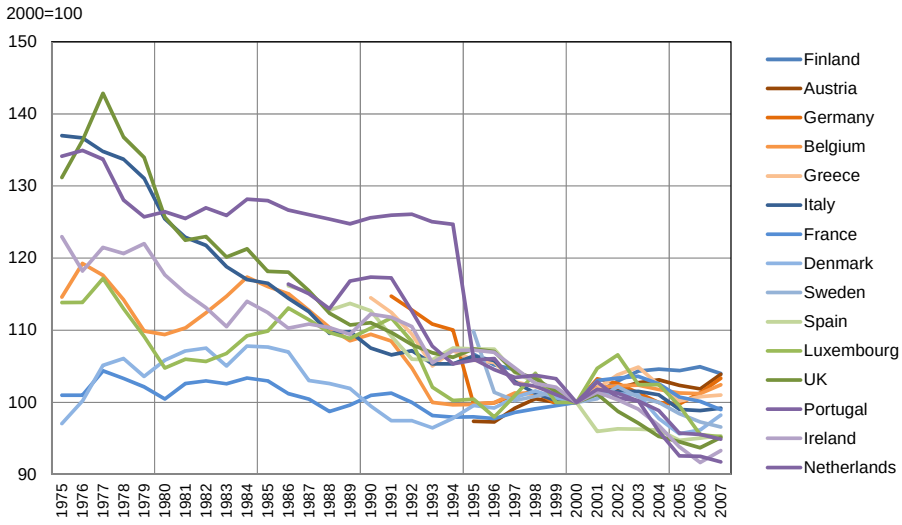

Figure 7. *GDP deflated food consumer price index in the EU15 countries (Source: LABORSTA, World Bank).*

administrative producer prices does not seem to have remarkable direct impact on the consumer price levels in 1992 and 2000.

5.2. Econometric specification

For all five target variables, the estimated empirical models are similar specifications with seven independent variables. Due to the lack of direct theoretical basis, the initial selection of model variables is based on the reviewed literature and deduction. The final selection was made based on the overall statistical significance of the variables.

The independent variables were selected based on deduction and statistical efficiency in the final estimations. The utilised variables were selected to fulfil the requirements for a structural and economic variable that has an exogenous role in agricultural policies. In the final model, the control variables included were net food exports in the form of export-import ratio, GDP per capita, net indirect taxes as a share of GDP, and rural population. The contents of the variables and data sources are described briefly in Table 4. In the final model, independent variables are included as logarithmic transformations, with the exception of the variable for export-import ratio and dummy variables for policy reform.

One of the main requirements of the target-instrument approach is prompt specification of the policy instruments. In a multi-country analysis the inclusion of individual policy instruments as such to the analysis is extremely difficult due to the lack of data. In this study, instead of specific policy instrument variables, the aggregate impact of agricultural policies is measured using nominal rate of assistance (NRA). Thus, one of the main restrictions set in the theory of economic policy was knowingly relaxed in the analysis. Moreover, to emphasize the structural changes in the CAP, dummy variables for MacSharry reform and Agenda 2000 were included in the model.

The estimated model speciation is:

$$Y_i = \alpha + \beta_1 eximr + \beta_2 logGDPperCapita + \beta_3 logNetTaxr + \beta_4 logRurPop + \beta_5 logNRA + \beta_6 DMacSharry + \beta_7 DAgenda2000 + \varepsilon, \; where \; i = 1 - 5 \tag{53}$$

Although the estimated models are similar for each dependent variable, the size of the estimated coefficients cannot be directly compared between the models. In order to emphasize the role of the independent policy variables, two sets of models are estimated: first a model with all control and policy variables included and, second, models with control variables only. Thus, the power of policy variables is analysed in two stages. In the first stage, policy variables are analysed in terms of individual statistical significance, magnitude and direction. In the second stage, policy variables are analysed based on the overall statistical power by which they improve the model[36].

[36] Masters and Garcia (2010, 218) test the significance of each policy variable z by entering them stepwise to the model, while keeping the control variables x constant. Thus, their aim was to ask whether introducing z reduces the estimated value of β, or raises the equation's estimated R-squared without changing the estimated value of β, or perhaps adds no additional significance at all.

Table 4. Summary of independent variables

Control variables	Specification	Source
Export-import ratio (Food trade balance)	Net food exports (export-import ratio > 1) indicate that a country is competitive in agricultural markets and agriculture has a significant role in the economy. Agriculture gains income from a broader market. Net food imports (export-import ratio < 1) indicate that a country has the ability to buy food from the markets and agriculture has a less significant role in the economy. Net food imports increase competition in the domestic markets. The role of policies with respect to policy objectives may differ depending on whether a country is a net food importer or exporter.	FAOSTAT
GDP per capita (constant 2000 USD)	In general, the source of GDP growth in the EU has been in sectors other than agriculture. General economic growth leads to more efficient use of resources and an increase in the added value. It also increases the other employment opportunities for people engaged in agriculture, and thus has a push effect on structural change in agriculture. Technological development is the main source of economic growth.	World Bank
Net indirect taxes ratio (as a share of GDP, constant 2000 €)	Structural variable. Net taxes on products (net indirect taxes) are the sum of product taxes less subsidies. When proportioned to GDP allows controlling the magnitude of taxation relative to general economic development. A change in the share of net indirect taxes of GDP captures both the effect of policy-oriented changes on taxation levels and the relative changes in overall economic activity, especially in production.	World Bank
Rural population	Structural variable. The number and development of rural population approximates the dynamics of rural areas, the structure of a country and the relative importance of rural economy in the overall economy.	World Bank
Policy variables		
Nominal rate of assistance (%-ratio)	Aggregated variable for all price distorting agricultural policy instruments. Higher (lower) NRA indicates higher (lower) distortions. Includes all national support measures. If policies are effective, variables should have significant impact on all objectives.	Database of Agricultural Distortions
Dummy for MacSharry reform 1992	Captures the policy reform shock and shift towards less market distorting agricultural policies. Price support policies were abolished and farmers received full compensation for price reductions through direct hectare-based payments.	
Dummy for Agenda 2000 reform	Captures the policy reform shock and shift towards less market distorting agricultural policies. Price support policies were abolished and farmers received partial compensation for price reductions through direct hectare-based payments.	

5.3. Development of the control variables

Export-import ratio measures the proportions of all food[37] exports and all food imports at the country level. Higher than one ratio means a country is a net exporter and a ratio less than one that a country is a net importer. For the EU15[38], only five countries are net exporters of food during the research period (Figure 8). The highest export-import ratios have been in Denmark and Ireland. Other countries with higher than one export-import ratio include France, the Netherlands and Spain. With the exception of Germany and Spain, all countries have been in the same category during the whole research period. In Germany, the export-import ratio turned below one during the mid-1980s. Spain has been able to increase its export-import ratio quite steadily from the late-1980s. The lowest export-import ratios are observed in Portugal, UK and Sweden.

In constant terms, the GDP per capita has increased steadily during the period analysed (Figure 9). The gap between the EU15 countries in terms of the GDP per capita levels has increased towards the year 2007. The level is the highest and the fastest growth has occurred in Luxembourg. However, given the special nature of its economy, the reasons behind the more rapid growth are self-explanatory.

Besides Luxembourg, the countries with the highest GDP per capita levels in 2007 were Ireland, Denmark, Sweden and the UK. The lowest are observed in Portugal, Greece, Spain and Italy. The GDP growth has been steady, although in the late 1990s and early 2000s there was a general decline in the levels. However, towards the end of the period the growth was rapid in the whole EU15 area.

A higher level of net indirect taxes in proportion to GDP indicates an economy with higher tax returns from domestic production, higher general taxation, or both, with respect to the total size of the economy. The share of indirect taxes in GDP has been the highest in the welfare states of the northern EU countries, i.e. Denmark, Sweden and Finland. In the biggest economy of the EU15, Germany, the share has decreased during the research period and was below 10 per cent at the end of the period (Figure 10). The

[37] Besides agricultural products, includes processed food as well. Food exports are used instead of agricultural exports to also approximate the importance of total food industry.

[38] No data available for Belgium and Luxembourg.

overall between-country differences range from 10 per cent in Germany to 17 per cent in Denmark.

The importance of the rural economy is approximated with the rural population. The biggest rural population is in the countries with the largest total economies and population, i.e. Germany, France, Italy and Spain (Figure 11). Although migration and structural change have been rapid in all countries, the relative positions of the countries in the between-country comparison have remained the same, with the exception of the Netherlands.

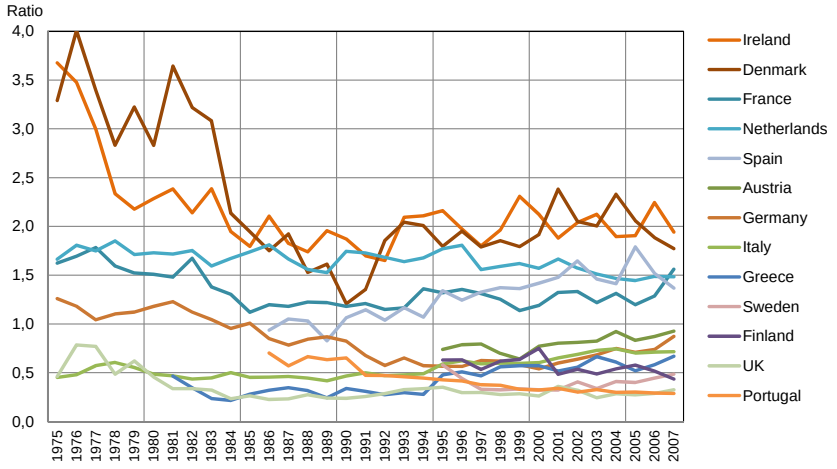

Figure 8. *Food export-import ratio (Source: FAOSTAT)*

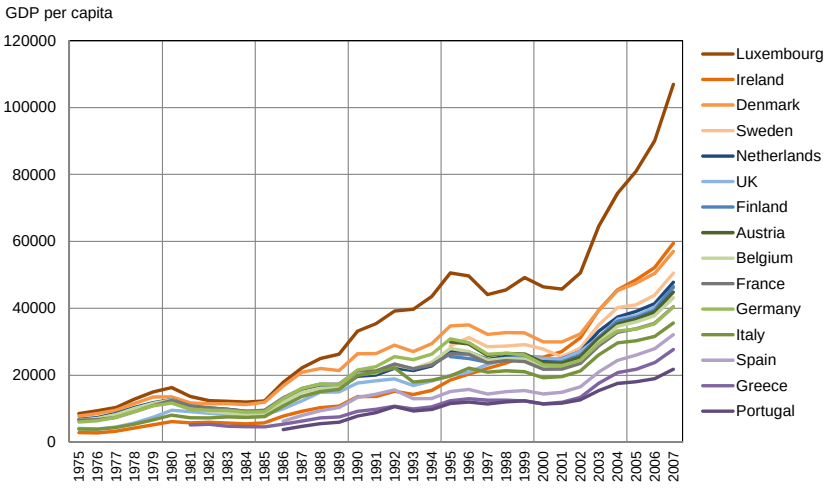

Figure 9. *Development of GDP per capita (constant 2000 USD) (Source: World Bank)*

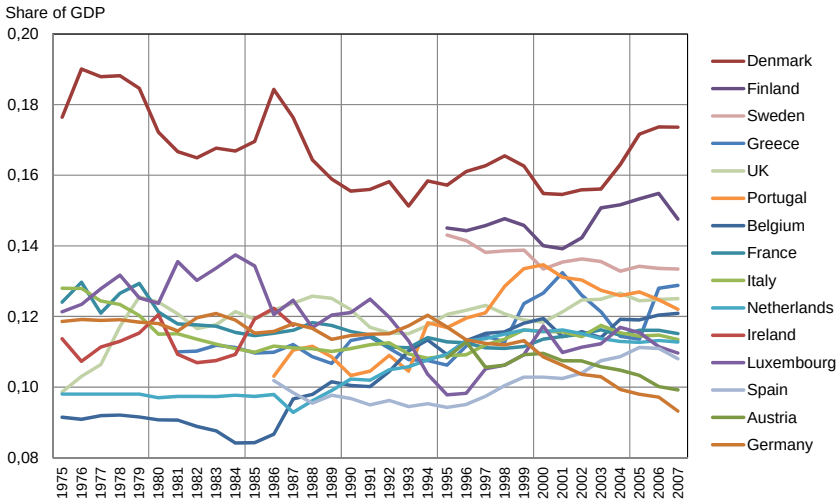

Figure 10. *Development of net indirect taxes as a share of GDP (constant 2000) (Source: World Bank)*

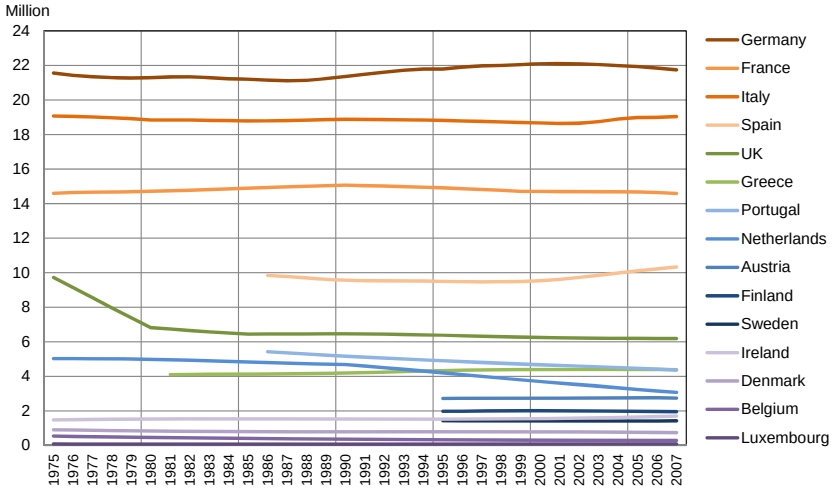

Figure 11. *Rural population (mill.) (Source: World Bank)*

5.4. Development of the policy instrument variable

Nominal rate of assistance aggregates all policy instruments which distort agricultural markets. It mainly describes the government-imposed distortions that create a gap between the domestic prices and what they would be under free markets. Included are any product specific input subsidies. In this study, a weighted average NRA is used. The weighted average NRA for all the products covered is derived using the value of production at undistorted prices as product weights, which are expressed as a percentage of the distorted price.

According to Anderson et al. (2010, 31), 'the NRA for each farm product is 'computed as the percentage by which government policies have raised gross returns to farmers above what they would be without the government intervention' and defined as (Anderson et al. 2010, 30-31)

$$\text{NRA} \equiv \frac{P_d - P_f}{P_f}, \tag{54}$$

where P_d is the observed domestic price in local currency for a given product, country and year, and P_f is the estimated domestic price that would hold in the absence of commodity market or exchange rate interventions. By definition, NRA is zero in a competitive free-trade regime and positive where producers are subsidised by taxpayers or consumers.

The nominal rate of assistance (NRA) has developed in the same direction in all the EU countries (Figure 12). Until the mid-1980s, the NRAs were going upwards and since then the trend has been downwards. National policies as well as producer price levels explain the difference in the actual level of NRAs between countries. The differences between country-level NRAs have decreased towards the end of the research period. This development indicates that the policy reforms and EU enlargements have led to more harmonized policies in terms of NRA within the EU15. Some national policies are still implemented[39], but their relative role in market distortions has declined. More importantly, individual EU countries do not pose any direct border protection measures that would increase the difference between farm gate and world market prices.

[39] For example, Finland paid approximately 60 per cent of all agricultural expenditure from its national budget in 2007 (Niemi and Ahlstedt 2008, 51-53). Only a small share of these payments were paid as coupled agricultural payments and, thus, included in NRA as distortive agricultural policies.

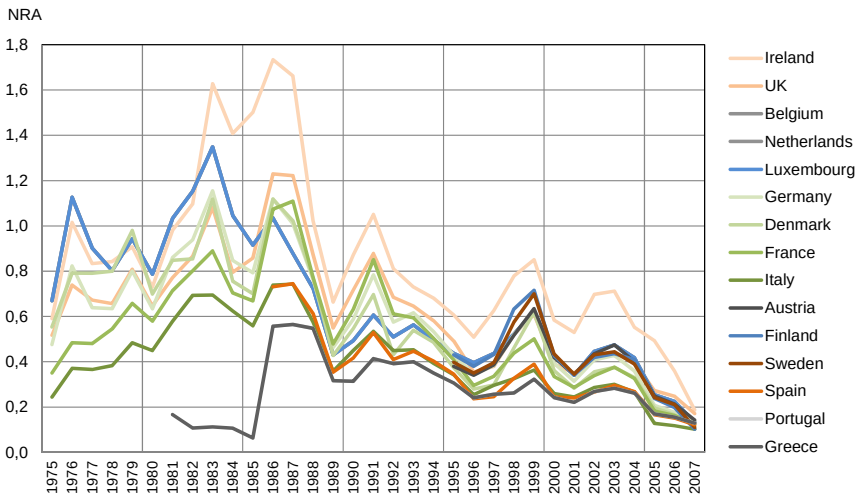

Figure 12. *Country-level NRAs 1975-2007 (Source: Anderson & Valenzuela 2008)*

Producer prices are not harmonized within the EU. While all the countries face the same undistorted world market price, the levels of NRA differ due to the differences in national producer prices. There have been considerable differences in the producer price levels between countries. These differences are often explained with differences in production costs, transportation costs, unbalanced national supply-demand ratio, and lack of export demand. Thus, the development of the EU policies dominates NRAs in each country. The annual magnitude of changes is to a large extent similar between countries. The interpretation is that national policies have been more stagnant and less relevant compared to the overall development of the CAP.

Besides domestic market protection under national and EU-level policies, NRA is also affected by the changes in the world market prices. These price changes may be due to changes in the supply-demand ratio or heavy use of trade policy measures such as export subsidies and deficiency payments.

During the time period analysed, agricultural product prices have peaked significantly three times, thus reducing the country-level NRAs. These peaks occurred in 1980, 1997 and 2007. Correspondingly, NRAs were high in 1986 and 2001, when international agricultural product prices slumped (Figure 13). In addition, the implementation of the CAP reforms in 1992 and 2000 led to

decreases in NRA[40]. Moreover, world agricultural product prices were and still are influenced by policies. The changes in the EU-level policies affect the world agricultural prices.

This means that NRA is under the policymakers' control, although not directly. Thus, it needs to be stated that, by construction, NRA violates the assumption of the theory of economic policy that the model should include only variables that are under the direct control of policymakers.

While the NRA covers only price distorting agricultural policies, additional variables are needed to incorporate the shift from distortive price and market support instruments towards less price distorting direct payments. The dummy variables for MacSharry and Agenda 2000 reforms are incorporated in the analysis to capture the major policy shifts from price support towards direct and, finally, decoupled payments. Besides a shift in policy structure, these variables aim to capture the initial shock from the policy reform.

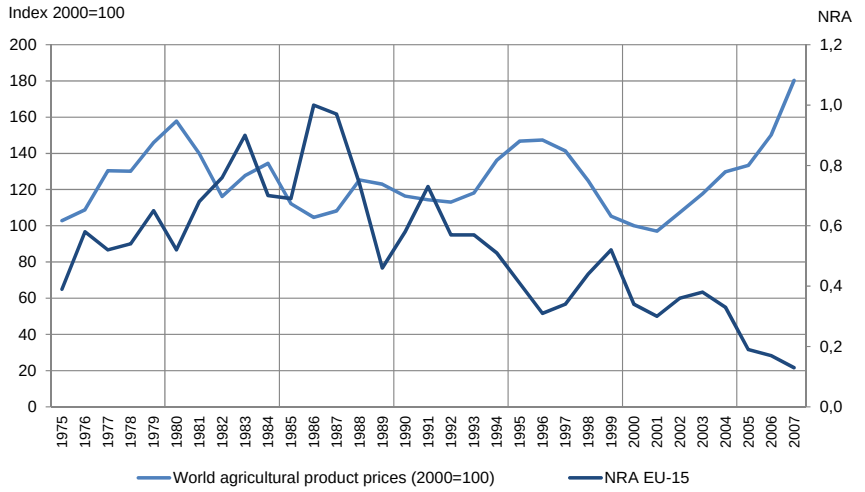

Figure 13. *NRA and world agricultural product price index (Source: Anderson & Valenzuela 2008, World Bank).*

[40] This is also seen in the OECD (2002, 11), which reports a significant reduction in the share of market price support and payments based on output and input use in the producer support estimates (PSE) from the late 1980s to early 2000s.

5.5. Alternative variables

Prior to the final model specifications, several different control and policy variables with pre-assumed impacts on the policy objectives were tested. Control variables excluded from the final model were the EU agricultural expenditure, share of food in all consumer expenditure, urban population, and general gross financial liabilities of governments as a per cent of GDP. Policy variables excluded from the final analysis were a variable for milk quota regime and share of decoupled payments in the total value of agricultural production.

The share of food in all consumer expenditure aimed to capture the decline in the overall importance of agriculture in consumption expenditure. The urban population variable was replaced with the rural population, which in general is just a negative of urban population. In addition, for the relative measurement rural population was proportioned to urban population and total population, but both specifications were excluded from the final model due to statistical insignificance. General gross financial liabilities of governments aimed to capture the change in the political feasibility of financing agricultural policies by the governments. Politicians are less able to transfer budget funds to sectoral policies when the governments' financial liabilities increase. In the final model, the net indirect taxation as a share of GDP is assumed to capture the same effect with a reverse sign.

Decoupled assistance to farmers is separated from the NRA. By definition, decoupled payments distort resource allocation significantly less compared to coupled payments. The share of decoupled payments is aimed as a proxy of the increase in the use of less market distorting agricultural policies. As the share of decoupled payments of all agricultural payments increases, policies are expected to become less market distorting. In addition, the budget expenditure is assumed to become more predictable due to decoupling. Decoupled assistance is measured as a per cent of the aggregated total value of production at the EU level (Anderson and Valenzuela 2008). Thus, it describes the policy evolution towards less distorting policy instruments within the EU as a whole. In the final models, the dummy variables for policy reforms in 1992 and 2000 capture this impact with higher statistical efficiency.

The policy variable for the milk quota regime was not statistically significant for any of the models. The likely explanation is that, at the aggregated level, changes in the common market organisation for milk do not

capture the same magnitude of the overall policy process compared to the common market organisation for crop production[41].

In addition, to restrict the analysis to a normative policy analysis only, all purely political variables available were dropped out of the model. Examples of these variables include the number of votes in the government, number of parties with agricultural or rural agenda in the national parliaments, and the number of veto players (number of parties) in the government. The justification to exclude these variables relies on the assumption that the implemented policies are a result of a political process. All political variables mentioned may have impact on which policies are implemented and at which level. However, they do not directly impact on the development of the stated policy objectives.

5.6. Comparative statics of policies and targets

Due to the strong empirical nature of the analysis, the expected effects of the independent variables cannot be directly drawn from the theory. However, some basic assumptions based on intuition and existing literature can be made. Comparative statics of all independent variables and policy objectives are presented in Table 5.

Net food exports are assumed to have a positive impact on agricultural productivity due to the pull effect from the increasing demand. In addition, exports are a source of additional income in the agriculture sector and thus contribute positively to the fair standard of living. Growing trade stabilises markets in the sense that any shortfalls or surpluses can be handled with exports and imports to smoothen the price impacts. The impact of net food exports depends on whether the country has a self-sufficiency ratio above or below one. If the ratio is below one, net food exports reduce the availability of supplies on the domestic markets while, if above one, markets are cleared with exports. Higher net food exports may lead to higher food prices. This is due to the fact that food exports reduce the supply on the domestic markets (see e.g. Acrill et al. 2008, Oskam and van Witteloostuijn 2010, Silvis and Lapperre 2010).

GDP per capita growth indicates higher productivity and higher value added in production. Thus, growth in the general GDP levels is expected to have a positive impact on agricultural productivity. Income development in

[41] See Acrill et al. 2008 for discussion.

other sectors has outpaced the development of agricultural incomes. Increasing demand due to economic growth may lead to more unstable markets in terms of price fluctuations and growing demand, which may lead to higher food prices. On the other hand, GDP growth and increased productivity are expected to contribute positively to the availability of supplies (see e.g. Oskam and van Witteloostuijn 2010).

Net indirect taxes and rural population are structural variables with expected indirect impacts. Net indirect taxes approximate the level of economy and/or the level of government. Higher indirect taxation is expected to contribute positively to productivity growth in agriculture and negatively to the fair standard of living. Increase in net indirect taxes is likely to approximate increased economic activity. On the other hand, indirect taxes may indicate tax changes with negative impact on incomes. Rural population approximates the size and dynamics of rural economy in a country. Larger rural economy is expected to indicate less productive agriculture sector and lower standard of living due to the higher number of people engaged in agriculture[42]. The development in the number of rural population approximates rural dynamics in terms of alternative employment and non-agriculture job creation (see e.g. Terluin et al. 2010). Moreover, the impact of rural population on market stabilisation and reasonable consumer prices is not predetermined.

The impacts of agricultural policy variables are drawn from the existing literature and intuition. While the overall expected impact of policies should be in favour of all policy objectives set, the actual realistic contribution may have the opposite impacts. Nominal rate of assistance is expected to contribute negatively to agricultural productivity due to the fact that agricultural policies have kept resources in the agriculture sector that would be more efficiently utilised in other sectors[43]. NRA is expected to have a positive impact on farmers' incomes and, due to the administratively set prices levels, a positive impact on market stabilisation. Moreover, NRA is expected to contribute positively to the availability of supplies due to higher levels of production and negatively on reasonable consumer prices in the sense that prices support policies have led to higher consumer prices,

[42] Accroding to Terluin et al. (2010, 315), even in the most rural regions of EU15, the services sector is by far the largest employer, while the share of both agriculture and industrial employment are decreasing.

[43] See e.g. Thomson et al. 2010 for discussion especially on the role and impacts of the structural policy measures included in the CAP.

compared to a situation without the implemented policy programmes (see e.g. Silvis and Lapperre 2010).

The policy impact of the MacSharry and Agenda 2000 reforms[44] on agricultural productivity, farmers' incomes and reasonable consumer prices is expected to be positive. The positive impact is due to the fact that a shift towards direct and decoupled payments has released resources from the agriculture sector and thus led to enhanced productivity in the sector. Moreover, direct payments form a safety net to producers in terms of base income that is not dependent on changes in market incomes. A negative contribution is expected as regards the availability of supplies and market stabilisation. Policy reforms have allowed markets to function based on market signals and thus have led to increasing price volatility. Decoupled support has lowered the production levels and, thus, self-sufficiency ratios (see e.g. Jongeneel and Brand 2010).

Table 5. *Comparative statics of model variables*

Policy objectives **Model variables and expected effects**	**Increase agricultural productivity**	**Ensure a fair standard of living**	**Stabilise markets**	**Assure the availability of supplies**	**Ensure that supplies reach consumers at reasonable prices**
Export-import ratio	+	+	+	+/-	-
GDP per capita	+	-	-	+	-/+
Net indirect taxes (as a share of GDP)	-	+	-	+	-
Rural population	-	-	+/-	+	+/-
Nominal rate of assistance (NRA)	-	+	+	+	-
MacSharry reform	+	+	-	-	+
Agenda 2000 reform	+	+	-	-	+

[44] Policy reforms have their own specific objectives. Most of the developments discussed here present the desired effects with respect to the stated objectives set in the Agenda 2000 reform (see e.g. European Commission 1999).

6. RESULTS

6.1. Econometric estimations

In this chapter, the econometric estimation results are reported for each target variable[45]. The implications of the results in terms of theoretical considerations, estimations procedures and policy impacts are discussed in the final sub-chapter.

The estimation results are analysed based on the test statistics provided in the NLOGIT4 estimation procedures[46]. First, ordinary least squares (OLS) estimates are provided to reveal the structure of heterogeneity via the estimated distribution of the error component. Second, the overall statistical efficiency of the model and the impacts of variable and group effects are assessed based on the least squares with group dummy variables (LSDV) estimation and the test statistics of the classical regression model with group effects. The statistical efficiency is assessed with R-squared, F-test and partial analysis of group and variable effects. Random effects models are estimated using the generalized least squares (GLS) estimation method. Third, the Lagrange multiplier test is used to analyse whether the effects model is appropriate for the analysis compared to the classical regression model, or whether group effects exist. Fourth, the Hausman test is used to assess whether differences across groups can be captured in differences in the constant term or, in other words, whether the fixed or random effects model should be applied in the analysis. Fifth, a Chow test is applied to test whether a policy reform forms a structural break in the estimated model.

The aim of the analysis is to reveal the impact of implemented agricultural policies on the policy target variables. These impacts are analysed based on the sign, magnitude and statistical significance of the estimated

[45] The development of all variables is discussed in Chapter 5. Descriptive statistics are presented in Appendix 4. Due to lack of data, the number of countries included in the final estimations is 12 for Y1 and 13 for all the others. Countries dropped out in the estimations are Greece (Y1), Belgium and Luxembourg (Y1-Y5). Given that these countries have a minor role in EU agriculture, losing these countries in the analysis does not impact on the applicability of the results.

[46] Additional estimation results are provided using STATA.

coefficients. In addition, the estimation results with control variables only are also presented. The comparison aims to reveal the impact of policy instrument variables on the overall statistical efficiency of the model and on the size and magnitude of the control variables included. The estimation results are presented in Tables 6 and 7.

For each model, ordinary least squares (OLS), least squares with group dummy variables (FE) and generalized least squares (RE) estimates are provided. In some models, there are variables that lack statistical significance. However, none of the variables is statistically insignificant throughout the estimated models. Given the justification of the variables, none of them were dropped out from the final models, in spite of the statistical insignificance.

Based on the utilised test statistics, the effects model is, in general, more efficient compared to the classical regression model only. The F-test suggests that in all models the model fit increases when individual aspects are added. The fixed effects model was statistically more efficient in three out of five estimated models with all variables included. Thus, country-level heterogeneity has a statistically significant impact on the model outcome for three target variables. For control variables only, the fixed effects model was appropriate in three out of five estimations.

6.1.1. Agricultural value added per worker

The first policy objective of the CAP, to increase agricultural productivity, is measured via agricultural value added per worker (World Bank 2013). The statistical power of LSDV estimates is very good with R-squared 0.88 (Y1 in Table 6) for the policy variables model and 0.82 for the control variables only (Y1 in Table 7). The Lagrange multiplier test favours the effects model over the classical model with no common effects. R-squared for the group effects only is 0.52, while independent variables only capture 0.51 of the total explanatory power of the model.

The F-test value indicates that the model fit increases when the individual aspects are added. Based on the Hausman test statistics, the null hypothesis that the individual effects are uncorrelated with the other regressors in the model cannot be rejected. The fixed effects model is statistically more efficient for the analysis. This indicates that country-level heterogeneity has a statistically significant impact on the model outcome. All

country-specific constants are statistically significant at a 99 per cent confidence level.

Six out of seven explanatory variables are statistically significant at an at least 95 per cent confidence level. The signs of the estimated coefficients are as expected. The coefficient for export-import ratio lacks statistical significance in the model.

GDP per capita and agricultural policy reforms have contributed positively to agricultural value added per worker. The coefficients for net indirect taxes, rural population and nominal rate of assistance all receive negative signs.

Overall economic growth has contributed towards increasing the value added per worker. Increasing productivity in agriculture, especially due to technological progress, has led to a significant increase in farm output. At the same time the number of farmers and agricultural employment has decreased.

The sign for the estimated coefficient for rural population suggests that, the higher the number of rural population, the slower the increase in agricultural value added per worker.

The negative sign of the coefficient for net indirect taxation indicates that increase in indirect taxes in proportion to GDP reduces the growth rate in agricultural value added. The variable implies negative indirect impacts on labour demand outside agriculture, especially if the increase in the share is due to decrease in GDP per capita or increase in indirect taxes.

The sign for nominal rate of assistance is negative. Agricultural policies have, in aggregate, kept the resources in the sector and, thus, reduced the pace of increase in the value added per worker. However, the implemented policy reforms have shifted the direction. Both policy reform dummies receive a positive sign with about the same magnitude.

In the model with control variables only, the Hausman test statistics indicate that the fixed effects model is statistically more efficient compared to the random effects model. Thus, country-level heterogeneity has a statistically significant impact on the model outcome. All independent variables and country-specific constants are statistically significant at a 99 per cent confidence level. The signs for the variables are similar in both models. The magnitude of the estimated coefficients differs slightly between the two estimated models. In the model with policy variables only, both the GDP per capita and rural population capture a more significant share of the explanatory power. Moreover, the negative impact of net indirect taxes is closer to the same relative magnitude compared to the model with policy

variables. The estimated coefficient for export-import ratio is now statistically significant with the expected positive sign.

The comparison of the models indicates that, in aggregate, agricultural policies have had major impacts on the development of agricultural value added per worker. The overall impact has been negative. Thus, the implemented policies have kept more resources, particularly labour, in the agriculture sector than would have remained without the policies. Moreover, agricultural policy reforms have led to increasing productivity in terms of reduced labour use. This result indicates that towards the end of the research period agricultural policies have contributed more effectively to the policy objective set and the implemented policy reforms have increased the effectiveness of the policy.

6.1.2. Net entrepreneurial income

The second objective of the CAP is stated as to ensure a fair standard of living for agricultural community. In our analysis, the fair standard of living is measured via the development of farmers' income. As a target variable for farmers' income, an index of net entrepreneurial income deflated with consumer price index is used (Eurostat 2011). The statistical power of LSDV estimates is good with R-squared 0.67 for the policy variables model (Y2 in Table 6) and 0.63 for the control variables only (Y2 in Table 7). The Lagrange multiplier test favours the effects model over the classical model with no common effects. R-squared for the group effects only is 0.35, while independent variables only capture 0.34 of the total explanatory power of the model.

The F-test value indicates that the model fit increases when the individual aspects are added. Based on the Hausman test statistics, the null hypothesis that the individual effects are uncorrelated with the other regressors in the model cannot be rejected. The fixed effects model is statistically more efficient for the analysis. This indicates that the country-level heterogeneity has a statistically significant impact on the model outcome. All country-specific constants are statistically significant at a 99 per cent confidence level.

Four out of seven estimated coefficients are statistically significant at an at least 95 per cent confidence level. Coefficients for export-import ratio and for both policy reforms are statistically insignificant. Increase in GDP per

capita contributes negatively to net entrepreneurial income, while rural population and net indirect taxes contribute positively to farmers' incomes. All policy variable coefficients have negative signs.

The sign of the coefficients contradicts the expectations in two ways. All policy variables receive a negative sign and rural population receives a positive sign. For policy variables, the signs and especially the relative magnitude of the coefficients indicate that general structural and economic factors have overruled agricultural policies and thus neutralised the impact of policy programmes on farmers' incomes.

The positive impact of the rural population on farmers' income indicates that income development in agriculture correlates with larger rural population. The reasoning may rest on the fact that the number of rural population is larger in countries with a larger overall rural economy and agriculture sector.

The results are partly explained with the structure of agriculture in the EU. Despite rapid structural development, the number of farms is still relatively large within the EU15. It can be argued that in the absence of agricultural policy the number of farms would be smaller and average farm size larger. However, the level of total production would be linked to the use of resources on the sector, namely land. With a smaller number of farmers the use of resources in agriculture could have been more efficient and, thus, have led to increasing incomes.

For the other variables, the signs are as expected. Rapid economic growth has led to faster income growth outside agriculture. Given the declining share of agriculture in GDP, the income growth in other sectors seems to have outpaced the income development in agriculture and, thus, turned the coefficient for GDP per capita into a negative one.

Based on the Hausman test statistics, the FE model is statistically more efficient also for the model with control variables only. Thus, the country-level heterogeneity has a statistically significant impact on the model outcome. In the model, three out of four control variables are statistically significant at a 90 per cent confidence level, at least. All country-specific constants are statistically significant at a 99 per cent confidence level. The signs and magnitudes of the coefficients are similar to the model with policy variables included. This supports the outcome of the model with policy variables included that general economic and structural development outpaces the impact of policy variables on the target variable.

Table 6. *Estimation results for models with policy variables*[47][48]

Target variable	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
Fixed effects (FE)/ Random effects (RE)	FE	FE	RE	FE	RE
Food trade balance (export-import ratio)	1.21 (1.18)	-0.18 (0.17)	1.10*** (0.26)	-0.04** (0.02)	-0.08*** (0.03)
GDP per capita (constant USD) log	2.62** (1.16)	-1.29*** (0.16)	-0.30 (0.33)	0.06*** (0.02)	-0.23*** (0.04)
Net indirect taxes (ratio, in proportion to GDP) log	-23.3*** (5.25)	1.60** (68.2)	1.34 (1.31)	-0.34*** (0.10)	-0.57*** (0.15)
Rural population log	-15.5*** (5.195)	4.84*** (0.81)	0.36 (0.24)	0.19* (0.10)	-0.12*** (0.03)
Nominal rate of assistance log	-3.79*** (.866)	-0.65*** (0.12)	-2.18*** (0.35)	0.01 (0.01)	-0.19*** (0.03)
Dummy for MacSharry reform 1992	4.66*** (.832)	-0.05 (0.13)	-2.18*** (0.30)	-0.07*** (0.02)	-0.15*** (0.04)
Dummy for Agenda 2000 reform	3.96*** (.680)	-0.16 (0.10)	1.47*** (0.30)	-0.06*** (0.01)	-0.05* (.029)
Constant			1.58 (5.03)		4.05*** (0.60)
Country-specific dummies					
Austria	156.4***	-54.2***		-2.82**	
Belgium	-	-		-	
Denmark	155.3***	-47.5***		-2.35**	
France	168.9***	-53.4***		-2.89**	
Finland	199.4***	-62.7***		-2.71**	
Germany	193.9***	-64.7***		-3.25**	
Greece	-	-57.6***		-3.39***	
Italy	147.1***	-51.3***		-2.96***	
Ireland	190.6***	-64.0***		-3.52**	
Luxembourg	-	-		-	
Netherlands	177.3***	-54.9***		-3.26**	
Portugal	159.8***	-58.6***		-3.40***	
Spain	173.2***	-61.0***		-3.32**	
Sweden	169.0***	-51.6***		-2.73**	
United Kingdom	183.1***	-58.4***		-3.08**	
OLS statistics					
Number of observations	252	254	307	307	291
R-squared	0.88	0.67	0.39	0.92	0.61
Adj. r-squared	0.87	0.65	0.35	0.92	0.59
F-test	97.05 (.000)	25.44 (.000)	9.64 (.000)	178.06 (.000)	22.67 (.000)
Chi-sq	539.21 (.000)	284.54 (.000)	151.49 (.000)	782.39 (.000)	276.89 (.000)

[47] All fixed effects models are OLS estimates with group dummy variables, all random effects models are GLS estimates.

[48] ***,**,* are statistically significant with 99, 95 and 90 per cent confidence levels, respectively, standard errors are in parentheses.

R-squared for the classical model					
Constant term only	0.00	0.00	0.00	0.00	0.00
Group effects only	0.52	0.35	0.08	0.89	0.28
X – variables only	0.51	0.41	0.28	0.43	0.48
X and group effects	0.88	0.67	0.39	0.92	0.61
Effects model vs. classical model					
Lagrange multiplier test	764.59 (.000)	149.35 (.000)	9.57 (.000)	2030.88 (.000)	77.21 (.000)
Fixed vs. random effects					
Hausman test	19.86 (.006)	52.04 (.000)	12.55 (.084)	16.84 (.018)	11.00 (.139)
Chow test for structural break (Agenda 2000)					
F (critical value 2.03)	32.930	20.756	26.393	12.853	13.127

6.1.3. Standard deviation in wheat producer prices

The third policy objective of market stabilisation is measured using an annual standard deviation around a five-year moving average of domestic wheat prices in each country[49] (Eurostat 2011, European Commission 2009, 2010). Increase in standard deviation indicates instability in producer prices. In terms of the policy objective set, less variation is preferred to more[50].

Of all the five estimated models, this is the one with the least explanatory power in terms of the selected target variable. The statistical power of LSDV estimates for the policy variables model is fair with R-squared 0.39 (Y3 in Table 6) and poor with R-squared 0.15 for the control variables only (Y3 in Table 7).

The F-test value indicates that the model fit increases when the individual aspects are added. Based on the Hausman test statistics, the null hypothesis that the individual effects are uncorrelated with the other regressors in the model can be rejected at a 99 per cent confidence level. The random effects model is statistically more efficient for the analysis, and the country-level heterogeneity can be reduced to a single constant. However, the estimated single constant is not statistically significant.

[49] $Y_i=\left((MA_{n-m}-\frac{P_{m-n}}{n}+\frac{p_m}{n})-p\right)$, where $n=1,\ldots,5$, and $i=1975,\ldots,2007$; and p= annual wheat producer prices (eur/tn).

[50] In 1995, Finland and Austria faced significant reductions in producer prices, when national price regimes were synchronized to common markets overnight. Due to the use of a five-year moving average, these price reductions impact on the size of the dependent variable until 1999 in these two countries.

Table 7. *Estimation results for models with control variables only*[51][52]

Target variable	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
Fixed effects (FE)/ Random effects (RE)	FE	FE	RE	FE	RE
Food trade balance (export-import ratio)	5.00*** (1.37)	-0.07 (0.17)	0.95*** (0.26)	-0.07*** (0.02)	-0.10*** (0.03)
GDP per capita (constant USD) log	12.5*** (0.73)	-0.83*** (0.10)	-0.17 (0.23)	-0.04*** (0.01)	-0.26*** (0.02)
Net indirect taxes (ratio, in proportion to GDP) log	-29.8*** (6.29)	1.26* (0.72)	1.99 (1.38)	-0.36*** (0.10)	-0.56*** (0.16)
Rural population log	-27.9*** (6.21)	4.90*** (0.82)	0.48** (.217)	0.27*** (0.10)	-0.11*** (0.03)
Constant			-2.65 (4.95)		4.18*** (0.57)
Country specific dummies					
Austria	232.0***	-60.2***		-3.19**	
Belgium	-	-		-	
Denmark	210.6***	-53.5***		-2.53**	
France	243.8***	-59.2***		-3.24**	
Finland	243.8***	-68.7***		-3.18**	
Germany	294.2***	-70.7***		-3.76**	
Greece	-	-62.9***		-3.86***	
Italy	294.6***	-57.6***		-3.23**	
Ireland	209.3***	-69.7***		-4.05***	
Luxembourg	-	-		-	
Netherlands	293.6***	-60.9***		-3.61***	
Portugal	253.0***	-63.9***		-3.89***	
Spain	266.9***	-66.7***		-3.80***	
Sweden	238.7***	-57.4***		-3.05**	
United Kingdom	271.7***	-64.3***		-3.52**	
OLS statistics					
Number of observations	252	254	307	307	291
R-squared	.82	.63	.15	.91	.53
Adj. r-squared	.81	.61	.10	.91	.50
F-test	73.57 (.000)	25.71 (.000)	3.17 (.219)	185.16 (.000)	19.36 (.000)
Chi-sq	437.54 (.000)	255.62 (.000)	49.55 (.000)	742.11 (.000)	220.08 (.000)
R-squared for the classical model					
Constant term only	.00	.00	.00	.00	.00
Group effects only	.52	.35	.08	.89	.28
X – variables only	.50	.34	.05	.26	.38

[51] Fixed effects models are OLS estimates with group dummy variables, random effects models are GLS estimates.

[52] ***,**,* are statistically significant with 99, 95 and 90 per cent confidence levels, respectively, standard errors are in parentheses.

X and group effects	.82	.63	.15	.91	.53
Effects model vs. classical model					
Lagrange multiplier test	698.11 (.000)	249.47 (.000)	1.51 (.219)	1699.26 (.000)	84.85 (.000)
Fixed vs. random effects					
Hausman test	26.66 (.000)	39.54 (.000)	7.11 (.130)	19.73 (.000)	7.77 (.100)

In the model, four out of seven coefficients are statistically significant with an at least 90 per cent confidence level. The signs of the coefficient are in line with the expectation, especially in terms of policy variables. In aggregate, agricultural policies have reduced the price variation. The impact of the MacSharry reform was similar, but Agenda 2000 led to less stabilised market prices. The results are in line with the predetermined policy impact, given that until Agenda 2000 the wheat prices were determined administratively based on the current situation on the internal markets. Despite the reductions in administrative prices in 1992 and the introduction of direct hectare-based support, the intervention scheme was still effective, providing target and floor prices for wheat and, thus, reducing price variation.

Higher export-import ratio has increased price variation. With more trade, price signals from the external markets transmit more effectively to domestic agricultural product prices.

Based on the relative magnitude of the coefficients, the estimated model emphasises the impact of policies over control variables in wheat price deviation. This is in line with the policy structure and intuition. However, the lack of overall statistical efficiency in the estimated model leaves open the impact of general economic and structural development on price determination.

For the model with control variables only, the F-test value indicates that the model fit increases when the individual aspects are added. However, the Lagrange multiplier test favours the classical model with no common effects over the effects model. Based on the Hausman test statistics, the null hypothesis that the individual effects are uncorrelated with the other regressors in the model can be rejected, and the country-level heterogeneity can be reduced to a single constant.

In the GLS estimations of the final model with control variables only, two out of five coefficients are statistically significant at an at least 90 per cent confidence level. The estimated coefficient for the constant, GDP and net indirect taxes lacks statistical significance. For the two other variables the

signs and magnitudes of the estimated coefficients are similar to those in the model with all variables. However, given the magnitude with which the policy variables improve the statistical power of the model, the results support the main finding that the selected control variables have significantly less explanatory power over wheat price variation.

6.1.4. Self-sufficiency

The fourth policy objective of the assurance of the availability of supplies is measured via the aggregated self-sufficiency ratio in wheat and milk. By definition, self-sufficiency is achieved when domestic production exceeds domestic consumption. In this study, self-sufficiency is measured using the country-level self-sufficiency ratio from Agricultural Distortions Database (Anderson & Valenzuela 2008).

The statistical power of LSDV estimates is very good with R-squared 0.92 for the policy variables model (Y4 in Table 6) and 0.91 for the control variables only (Y4 in Table 7). The Lagrange multiplier test favours the effects model over the classical model with no common effects. R-squared for the group effects only is 0.89, while independent variables only capture 0.43 of the total explanatory power of the model.

The F-test value indicates that the model fit increases when the individual aspects are added. Based on the Hausman test statistics, the null hypothesis that the individual effects are uncorrelated with the other regressors in the model cannot be rejected. Fixed effects model is statistically more efficient for the analysis. This indicates that the country-level heterogeneity has a statistically significant impact on the model outcome. All country-specific constants are statistically significant at a 99 per cent confidence level.

In the model, six out of seven independent variables are statistically significant at an at least 90 per cent confidence level. However, for the policy variables, the coefficient for the nominal rate of assistance is statistically insignificant. The signs of the statistically significant coefficients are as expected. Higher export-import ratio, net indirect taxes and both policy reforms have had a negative impact on the self-sufficiency ratio, while GDP per capita and rural population have contributed positively.

The negative sign of export-import ratio indicates that countries with net food exports prefer trade over domestic self-sufficiency. The analogy for net

indirect taxes is quite straightforward: the higher the proportion of net indirect taxes on GDP, the lower the net food exports. Net indirect taxes also apply to imported goods, and thus higher proportion of indirect taxes indicate that the rate of taxation is higher or the role of imports in the economy is in general greater, or both. The higher the food exports, the lower the taxes collected from food imports.

Larger rural population indicates that the role of the rural economy in the overall economy is greater. A larger rural population indicates, in general, higher dependency on agriculture. This is why self-sufficiency ratios have been above one in countries with larger rural economies. In addition, the positive contribution of the general economic growth in terms of GDP per capita has made it possible to maintain the desired self-sufficiency ratios.

The negative signs for the MacSharry and Agenda 2000 reforms indicate that the policy reforms led to lower production levels and, thus, to lower self-sufficiency ratios. This is similar to the expected impact, given that in the reforms agricultural policies shifted from price support instruments towards hectare-based direct payments. The reforms also included elements such as set-aside and other environmentally targeted instruments which had a direct impact on the level of production. In the milk sector, the quota regime became effective, and the reform introduced changes in animal payments as well.

The lack of statistical significance in the aggregated agricultural policy variable may be due to the bipolarized nature of the EU countries. The groups of countries with the self-sufficiency ratio less than one and those with the ratio more than one are relatively stable within the research period, and no major changes in these ratios occurred.

In the model with control variables only, all estimated coefficients are statistically significant at an at least 99 per cent confidence level. In addition, all country-specific constants are statistically significant at an at least 95 per cent confidence level. The signs and magnitudes of the coefficients are similar to those in the model with policy variables included, with the exception of GDP per capita. This result suggests that, during the research period, the self-sufficiency ratios have been a stable policy element which has developed in line with the general economic and structural development.

6.1.5. Food price development

The fifth policy objective of the CAP to ensure that supplies reach consumers at reasonable prices is measured using a food price index deflated with a country- level GDP deflator (LABORSTA 2011, World Bank 2011). Thus, the model analysis reveals how and with what magnitude agricultural policies have contributed to the real-term food price development, given the economic and structural development.

The statistical efficiency of LSDV estimates is good with R-squared 0.61 for the policy variables model (Y5 in Table 6) and 0.53 for the control variables only (Y5 in Table 7). The Lagrange multiplier test favours the effects model over the classical model with no common effects. R-squared for the group effects only is 0.28, while independent variables only capture 0.48 of the total explanatory power of the model.

The F-test value indicates that the model fit increases when the individual aspects are added. Based on the Hausman test statistics, the null hypothesis that the individual effects are uncorrelated with the other regressors in the model can be rejected. Thus, the random effects model is statistically more efficient for the analysis, and the country-level heterogeneity can be reduced to a single constant. In the GLS estimations of the final model, the estimated coefficient for the constant is statistically significant at a 99 per cent confidence level.

In addition to the constant, all independent variables are statistically significant at an at least 90 per cent confidence level. All coefficients receive negative signs, indicating the actual development where food prices in real terms have declined during the research period. In spite of policies based on price support, the aggregated contribution of policy variables has been towards lower prices.

All estimated coefficients are statistically significant at an at least 90 per cent confidence level also in the model with control variables only. The signs and magnitudes of the coefficients are similar in both models. Inclusion of policy variables increases the explanatory power of the analysis. The results indicate that without price support-based agricultural policies food prices would have declined even more rapidly. The impact of policies on price development must also be linked to the fact that the share of food in all consumer expenditure has significantly decreased during the time period analysed. Thus, the general economic and structural development, especially

in terms of general income development, has outpaced the indicated policy impact.

6.2. Alternative estimation

In order to validate the analysis, alternative estimation methods for the models with policy variables were applied. SUR (seemingly unrelated regression) estimates for all five target variables were estimated. This was done despite the fact that, when the set of independent variables is the same over all models, SUR is identical to OLS estimates and, thus, OLS yields efficient estimates

The explanatory power for the SUR estimates ranges from 0.26 for model Y3 to 0.54 for model Y5. The signs for the estimated coefficients are similar to the OLS/GLS estimates in 70 per cent of the cases over all five target variables. The statistical significance of the particular coefficients over all models is slightly better in the SUR estimates. Thus, given the different treatment of the data and country level heterogeneity[53], the SUR estimation methods support the validity of the analysis and the results presented above.

In order to reveal the possible inconsistencies of the OLS estimates due to the endogeneity of the independent variables, the instrumental variable[54] (IV) approach was utilised. The analysis aims to reveal whether the changes in the independent variable are associated not only with changes in the dependent variable but also with changes in the error term. The analysis reveals that for the dependent variables Y3 and Y4 variable endogeneity is non-existent or only minor. For the dependent variables Y1, Y2 and Y5, variable endogeneity may impose inconsistency in the OLS estimates. This needs to be kept in mind also in the interpretation of the OLS estimates presented in the previous sub-chapter. However, the estimation results for SUR and IV approach do not imply that the OLS estimates would be inefficient.

[53] In the SUR analysis, the number of observations utilised in the analysis is forced to be the same in all models. Thus the sample size is defined based on the shortest set of dependent variables in the model (N=243). OLS utilises all the data available, because models are estimated separately (N range from 252 to 307).

[54] See appendix 5.

6.3. Discussion of the key results

In the preceding sub-chapters estimation results for the five target variables were presented. The results were estimated for four control and three policy variables and analysed for each of the five target variables. In addition, the estimated results were compared to the estimated results of the models with control variables only.

Our results show that policy target variables have, in general, developed in the desired direction. The productivity of agriculture has increased, markets have been stable in terms of price development, self-sufficiency ratios have been achieved, and the real-term food prices have declined. However, as a rule farmers' incomes have declined as well.

Although the general development of the target variables is similar in all countries included in the analysis, the country-level heterogeneity is significant. While common policies have contributed to market stabilisation and food price development with a common impact, the impacts have been more diversified for productivity development and net entrepreneurial income.

Variables describing agricultural policy reforms improve the explanatory power of the models and thus capture the structural development in the policies via the implemented reforms. Moreover, Agenda 2000 policy reform imposes a structural break with high statistical significance in the development of all five target variables.

According to the results, the effects model was statistically more efficient for the analysis compared to the classical regression model in all but one of the cases. Thus, it can be concluded that the inclusion of individual aspects improved the explanatory power of the models. Moreover, country-level heterogeneity had a significant impact on the model outcome in six out of ten models estimated. Thus, the fixed effects approach was in general more suitable for the analysed data and the model setting.

The signs of the coefficients are mostly as expected across all models. However, the statistical significance of the control variables differs for each target variable. Although the selected control variables seem to generalize the structural and economic conditions relatively well, the impacts are not as effective across all models. Different control variables might have changed the relative explanatory power of the models in terms of the target variables while reducing the explanatory power of the others.

Given the data and specified research problem, some of the basic assumptions of the theory of economic policy had to be relaxed. This has direct implications on the ability to make theory-based conclusions on the estimated results. Due to the lack of defined target levels, the actual efficiency of policy variables cannot be compared in terms of each objective. Thus, it cannot be concluded whether policy objectives have been achieved or not. The actual policy analysis has to be based on the signs and the relative magnitudes of the estimated coefficients.

The most well-known lesson in the theory of economic policy is that there has to be at least one policy instrument for each policy objective (Tinbergen 1952, 1967; Theil 1965). Based on the analysis, it cannot be either confirmed or rejected whether the CAP is able to respond to this theoretical demand. This fact arises from two shortcomings in the analysis. First, the aggregation of policy instruments absorbs possible controversies in the effects of individual policy instruments in individual countries. Second, neither control nor policy variables fulfil the requirements set in the theory of economic policy. The actual level of the nominal rate of assistance is not under the direct control of policy-makers due to its relation to agricultural product prices determined on the markets.

The structure of our data is a major source of the statistical inefficiency of the models. The data set is a balanced panel from 1995 onwards and an unbalanced one from 1975 to 1994. One reason for the use of an unbalanced panel for the time period 1975-1994 is the chosen approach. The data evolve in line with the development of the EU, which is why the number of countries included in the analysis increases from 9 to 15. In addition, there are also some general inconsistencies in the data[55].

The overall functioning of the data could have been improved with justified data manipulation. Time-series with lack of observations could have been completed using trend base averages of the existing observations. However, the use of authentic data was seen to increase the added value of the study as a test for the direct applicability of several databases for empirical policy analysis.

Other justified data manipulation relates to the use of lagged variables. The actual effects of policies may take more than one year to be fully

[55] Part of the time series for Germany and Ireland are incomplete prior to 1991. Some minor data manipulation was also needed in the time series for Portugal. Greece, Belgium and Luxembourg lack data for dependent variables. The data set is available upon request from the author.

observed. This argument would justify the use of lagged dependent variables in the analysis. However, in the panel data setting where the data set evolves through time, there is a trade-off with lost data points in the first observed years for each country. Thus, the variables were not lagged for the analysis.

The analysis is also restricted by subjective characteristics, especially due to the lack of exactly defined target variables. These arise especially from the fact that the selection of target variables is not straightforward. A researcher can find several alternative variables to describe agricultural productivity or proportion the development of agricultural incomes to several income measurements of a general nature, among other things. The final selection, which of course always needs to be justified, is in the hands of the researcher. In addition, the lack of exactly defined target levels prevents a researcher from answering the precise research questions set.

7. CONCLUSIONS

In this dissertation the effectiveness of the Common Agricultural Policy of the European Union is analysed. The motivation of this study arises from the fact that there is a lack of empirical research on the effects of policy instruments on the stated policy objectives. In addition, most of the analysis in the literature has focused on the policy objective to secure farmers' incomes and, thus, on the efficiency of income redistribution.

The policy effectiveness is defined as the ability of agricultural policy to respond to the stated policy objectives, given the general economic and structural conditions under which the policies operate. In this study, an empirical analysis of the effects of implemented policies and policy reforms on the stated policy objectives in the Common Agricultural Policy of the European Union is conducted. The analysis is carried out at the EU15 level and the time period analysed ranges from 1975 to 2007.

In the empirical part, an econometric model utilising panel data for the EU15 countries is built. In the model, the development of the defined policy target variables is explained with policy variables and a set of economic and structural control variables. The results show that policy target variables have, in general, developed in the desired direction. The productivity of agriculture has increased, markets have been stable, self-sufficiency ratios have been achieved, and the real term food prices have declined. However, farmers' incomes have in general declined.

Although the general development of the target variables is similar in all the countries included in the analysis, there is significant heterogeneity on the country level. While common policies have contributed, with a common impact, to market stabilisation and food price development, the impacts have been more diversified for productivity development and net entrepreneurial income. It can be stated that the impact of agricultural policies is directly linked to structural and economic conditions in a particular country. This needs to be taken into account in policy planning and implementation.

The implemented agricultural policies impact on resource allocation. Increase in productivity and decrease in the use of agricultural labour input has contributed to more rapid general economic growth. Workforce made

available from agriculture has shifted relatively smoothly to other sectors. The general economic growth has also boosted the demand for agricultural products. In countries with slower general economic growth, the structure of the agriculture sector is likely to be less efficient and the relative role of the agriculture sector in the overall economy is likely to be greater.

Thus, due to the policy impact, more resources are being absorbed into the sector compared to a situation without policies. Often these resources would be used more efficiently in other sectors. Based on this logic, agricultural policies have kept more resources in the agriculture sector compared to a situation without policies, which has reduced the pace of productivity growth in terms of labour use. In addition, it has had a negative indirect impact on farmers' incomes in the sense that the agriculture sector may be significantly larger than it would be without the implemented agricultural policies.

The implemented agricultural policy reforms have improved the policy effectiveness in general. The main contribution of the implemented reforms has been to the use of resources in agriculture. A policy shift from coupled price support to direct payments has released resources from agriculture to be utilised in other sectors. In addition, policy reforms have led to increasing price variation. This is a self-explanatory impact in the sense that administrative price setting was reduced and later on abolished in the policy reforms.

According to this study, the impact of agricultural policy on the policy objectives is multifunctional. The implemented policy instruments may also have worked in the opposite direction compared to the targets set. While agricultural policies have clearly contributed to increasing agricultural productivity, they have also absorbed resources into the sector which could have been utilised more efficiently in other sectors.

Moreover, the development of the target variables analysed indicates that national governments may have set different or additional targets for agricultural policies. However, the policies as such have evolved in the same direction in all countries.

The economic and structural conditions under which the CAP has operated have changed markedly over the decades. Despite the major changes, the role of the CAP has remained extremely significant in both political and economic terms. Moreover, it is easy to argue that agricultural policies also have a major role to play in the current EU. This role is, however, under constant pressure. It can be stated that the impact of agricultural

policies is directly tied to structural and economic conditions in a particular country. This needs to be taken into account especially in the current policy planning and implementation.

The country-level heterogeneity of economic and agricultural structures has increased especially due to the recent enlargements of the EU from EU15 to EU28. The analysis in this study shows that country-level heterogeneity has a significant impact on the development of policy target variables. Although the implemented policy reforms have made a contribution towards the desired direction and improved the effectiveness of the policies, it is a major challenge for future agricultural policies to effectively tackle the different structures.

Based on the analysis, the ability of policies to achieve their stated objectives cannot be directly judged. This is due to the fact that no exact target levels have been set for the policy objectives. To improve the applicability of empirical policy analysis in the actual policy evaluation, policy-makers should put more emphasis on the comparable and clear measurement of the stated policy objectives. For appropriate policy analysis, exact target levels need to be set. In addition, appropriate measurement of all policy objectives needs to be defined already at the planning stage of a policy.

As shown in the study, given the increasing number of relevant data available, it is possible to conduct empirical policy analysis in this type of research setting using relevant econometric estimation procedures. In addition, by compiling different large international databases it is possible to construct vast data sets to be utilised in analysing a variety of research problems in agricultural policy economics.

The statistical efficiency of the analysis presented in this study could be further improved with a different modelling approach. Instead of fixing the control variables for all dependent variables, the control variables could be selected separately based on the statistical efficiency of the coefficient in each model. The added value would arise from the fact that two different estimation approaches could be compared.

In this study, policies are analysed at the aggregated level. Nominal rate of assistance is a variable that aims to capture the overall effect of policies, independent of which instruments are used at the country level. Disaggregating NRA to individual policy instruments would reveal possible controversies between policy objectives and particular policy instruments. In addition, it could provide more detailed information on the impacts of policy reforms and shortcomings in the policy process. However, this research

setting would require highly detailed country-level data, which we do not have as yet.

The actual efficiency of the policy reforms remains sometimes unclear. Even though it is clearly stated in the literature that the reforms of the CAP have improved the efficiency of policies especially in terms of reduced welfare losses, there is a lack of analysis on the effectiveness of policy reforms in terms of their objectives. Given the stated objectives of the CAP reforms, the analysis carried out in this study could be replicated in terms of the stated objectives of the policy reforms.

One of the key features in the policy analysis is to cover different aspects as widely as possible. In the estimation approach of this study, neither economic nor political factors behind the selection of policy instruments are discussed. The development of different statistical databases would provide an excellent basis for empirical analysis of the political economy of agricultural policies. Essential research questions are: which are the main economic and political factors affecting the selection of particular policy instruments and which are the main economic and political factors affecting the policy reform and its timing. However, this type of analysis would require a change from normative policy analysis to political economy and to positivistic policy analysis.

REFERENCES

Ackrill, R., Kay, A. & Morgan, W. 2008. The Common Agricultural Policy and Its Reform: The Problem of Reconciling Budget and Trade Concerns. Canadian Journal of Agricultural Economics 56: 393-411.

Alston, J. M. & Hurd, B. H. 1990. Some Neglected Social Costs of Government Spending in Farm Programs. American Journal of Agricultural Economics 72: 149-156.

Alston, J. M. & Larson, D. M. 1993. Hicksian vs. Marshallian Welfare Measures: Why Do We Do What We Do? American Journal of Agricultural Economics 75: 764-769.

Alston, J. M. & James, J. S. 2002. The Incidence of Agricultural Policy. In Gardner, B. L. & Rausser, G. C. (eds.): Handbook of Agricultural Economics, Vol. 2b Agricultural and Food Policy. North-Holland. pp. 1689-1749.

Anderson, K., Croser, J., Sandri, D. & Valenzuela, E. 2010. Agricultural Distortion Patterns since the 1950s. What Needs Explaining? In: Anderson, K. (ed.). The Political Economy of Agricultural Price Distortions. pp. 25-77.

Anderson, K. & Valenzuela, E. 2008. Estimates of Global Distortions to Agricultural Incentives, 1955 to 2007. World Bank, Washington DC, USA. October 2008. Available: http://cies.adelaide.edu.au/agdistortions/database/report/. Referred 2.11.2010.

Baltagi, B. H. 2008. Econometric Analysis of Panel Data. 4th edition. 351 p. John Wiley & Sons, ltd.

Bates, R. H. & Block, S. 2010. Agricultural Trade Interventions in Africa. In: Anderson, K. (ed.). The Political Economy of Agricultural Price Distortions. pp. 304-331.

Beck, T., Clarke, G., Groff, A., Keefer, P. & Walsh, P. 2001. New tools in comparative political economy: The Database of Political Institutions. 15:1, 165-176 (September), World Bank Economic Review. Updated December 2010. Database available at: http://go.worldbank.org/2EAGGLRZ40. Referred 23.10.2011.

Becker, G. S. 1983. A Theory of Competition Among Pressure Groups for Political Influence. Quarterly Journal of Economics 98: 371-400.

Bullock, D. S. 1992a. Redistributing Income Back to European Community Consumers and Taxpayers through the Common Agricultural Policy. American Journal of Agricultural Economics 74: 59-67.

Bullock, D. S. 1992b. Objectives and Constraints of Government Policy: The Countercyclicity of Transfers to Agriculture. American Journal of Agricultural Economics 74: 617-629.

Bullock, D. S. 1994. In Search of Rational Government: What Political Preference Function Studies Measure and Assume. American Journal of Agricultural Economics 76: 347-361.

Bullock, D. S. 1996. Pareto Optimal Income Redistribution and Political Preference Functions: An Application to EC Common Agricultural Policy. In Antle, J. M. & Sumner, D. (Eds.) Papers in honor of D. Gale Johnson. The Economics of Agriculture, vol 2. University of Chicago Press. Chicago. pp. 244-262.

Bullock, D. S. & Salhofer, K. 1998. Measuring the social costs of suboptimal combinations of policy instruments: A general framework and an example. Agricultural Economics 18: 249-259.

Bullock, D. S. & Salhofer, K. 2003. Judging agricultural policies: a survey. Agricultural Economics 28: 225-243.

Bullock, D. S., Salhofer, K. & Kola, J. 1999. The Normative Analysis of Agricultural Policies: A General Framework and Review. Journal of Agricultural Economics 50, 3: 512-535.

Burrel, A. & Oskam, A. (eds.). 2000. Agricultural Policy and the Enlargement of the European Union. CAB International. 252 p.

Burton, M. 1985. The implementation of the EC milk quota. European Review of Agricultural Economics 12: 461-471.

Coate, S. 2000. An Efficiency Approach to the Evaluation of Policy Changes. The Economic Journal 110, 463: 437-455.

Crommelynck, A. Kola, J. & Swinnen, J. F. M. 1998. Determinants of Agricultural Protection in Finland (1931-1990). Policy Research Group Working Papers No. 14. University of Leuven.

Davidova, S. & Hill, B. 2012. Understanding the Common Agricultural Policy. Earthscan from Routledge. 352 p.

de Gorter, H. & Meilke, K. D. 1989. Efficiency of Alternative Policies for the EC's Common Agricultural Policy. American Journal of Agricultural Economics 71: 592-603.

de Gorter, H. & Swinnen, J. 2002. Political Economy of Agricultural Policy. In Gardner, B. L. & Rausser G. C. (eds.): Handbook of Agricultural Economics, Vol. 2b Agricultural and Food Policy. North-Holland. pp. 1893-1943.

Dutt, P. & Mitra, D. 2010. Impacts of Ideology, Inequality, Lobbying and Public Finance. In: Anderson, K. (ed.). The Political Economy of Agricultural Price Distortions. pp. 278-303.

El-Agraa, A., M. 2001. The Common Agricultural Policy. In: El-Agraa, A. M. (ed.): The European Union. Economics & Policies. 6th. edition. 2001. Prentice Hall. pp. 231-265.

European Economic Community. 1957. The Treaty of Rome. Available: http://ec.europa.eu/economy_finance/emu_history/documents/treaties/rometreaty2.pdf. Referred 29.10.2011. 80 p.

European Commission. 1999. Fact-Sheet. CAP reform. A policy for the future. Available: http://ec.europa.eu/agriculture/publi/fact/policy/index_en.htm. Referred 10.1.2012.

European Commission. 2009. Agricultural statistics and indicators. Available: http://ec.europa.eu/agriculture/statistics/agricultural/index_en.htm. Referred: 12.11.2011.

European Commission. 2010. Agricultural statistics and indicators. Available: http://ec.europa.eu/agriculture/statistics/agricultural/index_en.htm. Referred: 12.11.2011.

European Commission. 2011. Financial programming and budget. Budget in figures. http://ec.europa.eu/budget/figures/index_en.cfm. Referred: 30.3.2011.

Eurostat. 2012. Economic Accounts for Agriculture. Data Description. Available: http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/en/aact_esms.htm. Referred 12.11.2011.

FAOSTAT. 2011. Statistics division. Food and Agriculture Organization of the United Nations. Avaliable: http://faostat.fao.org/

Floyd, J. E. 1965. The Effects of Farm Price Supports to the Returns to Land and Labor in Agriculture. The Journal of Political Economy, 73, 2: 148-158.

Gardner, B. L. 1975. The Farm-Retail Price Spread in a Competitive Food Industry. American Journal of Agricultural Economics 399-409.

Gardner, B. L. 1983. Efficient Redistribution through Commodity Markets. American Journal of Agricultural Economics 65: 225-234.

Gardner, B. L. 1987a. The Economics of Agricultural Policies. MacMillan, New York. 387 p.

Gardner, B. L. 1987b. Causes of U.S. Farm Commodity Programs. The Journal of Political Economy. 95, 2: 290-310.

Gardner, B. L. 1989. Economic Theory and Farm Politics. American Journal of Agricultural Economics 71, 5: 1165-1171.

Gawande, K. & Hoekman, B. 2010. Why Governments Tax or Subsidize Agricultural Trade. In: Anderson, K. (ed.). The Political Economy of Agricultural Price Distortions. pp. 241-277.

Gisser, M. 1993. Price Support, Acreage Controls and Efficient Redistribution. Journal of Political Economy 101: 584-611.

Greene, W. H. 2011. Econometric Analysis. 7th edition. Prentice-Hall. 1232 p.

Guyomard, H., Le Mouël, C. & Gohin, A. 2004. Impacts of alternative agricultural income support schemes on multiple policy goals. European Review of Agricultural Economics 31, 2: 125-148.

Hausman, J. A. 1978. Specification tests in Econometrics. Econometrica 46: 1251-1271.

Harberger, A. C. 1971. Three Basic Postulates for Applied Welfare Economics: An Interpretive Essay. Journal of Economic Literature 9, 3: 785-797.

Harvey, C. R. 2004. Policy dependency and reform: economic gains versus political pains. Agricultural Economics 31: 265-275.

Howlett, M. 2009. Governance modes, policy regimes and operational plans: A multi-level nested model of policy instrument choice and policy design. Policy Science 42: 73-89.

Hsiao, C. 2003. Analysis of Panel Data. 2nd edition. Cambridge University Press. 366 p.

Hueth, B. 2000. The Goals of U.S. Agricultural Policy: A Mechanism Design Approach. American Journal of Agricultural Economics 82: 14-24.

Hughes-Hallet, A. J. 1989. Econometrics and Theory of Economic Policy: The Tinbergen-Theil Contributions 40 Years On. Oxford Economic Papers 41: 189-214.

Isosaari, H. 1993. Policy Choice under Imperfect Competition with an Applicatino to the Finnish Sugar Markets. Dissertation. Pellervo Economic Research Institute Publications No. 14. 134 p.

James, J. S. & Alston, J. M. 2002. Taxes and quality: a market-level analysis. The Australian Journal of Agricultural and Resource Economics, 46, 3: 417-445.

Jensen, M. S., Lind, K. M. & Zobbe, H. 2009. Enlargement of the European Union and Agricultural Policy Reform. European Integration 31, 3: 329-348.

Jongeneel, R. & Brand. H. 2010. Direct income support and cross-compliance. In: Oskam, A., Meester, G. & Silvis, H. (eds.). 2010. EU policy for agriculture, food and rural areas. Wageningen Acedemic Publishers. p. 191-205.

Josling, T. E. 1969. A formal approach to agricultural policy analysis. Journal of Agricultural Economics 20, 2: 175-191.

Josling, T. E. 1974. Agricultural policies in developed countries: A review. Journal of Agricultural Economics 25, 3: 229-263.

Just, R. E., Hueth, D. L. & Schmitz, A. 2004. The Welfare Economics of Public Policy. A Practical Approach to Project and Policy Evaluation. Edgar Elgar. Cheltenham. 688 p.

Kola, J. 1991. Production Control in Finnish Agriculture. Publications No. 64. Agricultural Economics Research Institute, Finland. Helsinki. 133 p.

Kola, J. 1993. Efficiency of supply control programs in income redistribution. European Review of Agricultural Economics 20: 183-198.

LABORSTA. 2011. Database of the International Labour Organisation. Available: http://laborsta.ilo.org/. Referred: 12.11.2011.

Lianos, T. P. & Rizopoulos, G. 1988. Estimation of Social Welfare Weights in Agricultural Policy: The Case of Greek Cotton. Journal of Agricultural Economics 39: 61-68.

Lichtenberg, E. & Zilberman, D. 1986. The Welfare Economics of Price Supports in Agriculture. The American Economic Review 76, 5: 1135-1141.

Masters, W. A. & Garcia, A. F. 2010. Agricultural Price Distortions and Stabilization. In: Anderson, K. (ed.). The Political Economy of Agricultural Price Distortions. pp. 215-240.

Nedergaard, P. 2006. Market failures and government failures: A theoretical model of the common agricultural policy. Public Choice 127: 393-413.

Nerlove, M. 1958. The Dynamics of Supply: Estimation of Farmers' Response to Price. Baltimore. The John Hopkins Press. 267 p.

Niemi, J. 2005. The static welfare effects of the accession to the European Union on the Finnish agricultural markets. Agricultural and Food Science 14: 224-235.

Niemi, J. & Ahlstedt J. 2008. Finnish Agriculture and Rural Industries. Publications 108. MTT AgriFood Research Finland. 96 p.

Niemi, J. & Kola, J. 2005. Renationalization of the Common Agricultural Policy: Mission Impossible? International Food and Agribusiness Management Review 8, 4: 2005.

OECD. 2002. Agricultural policies in OECD countries: A positive reform agenda. Organisation for Economic Co-operation and Development. Paris. 40 s.

OECD. 2011. Economic Outlook No. 89. Organisation for Economic Co-operation and Development. Available: http://stats.oecd.org/Index.aspx. Referred 23.10.2011.

Oehmke, J. F. & Yao, X. 1990. A Policy Preference Function for Government Intervention in the U.S. Wheat Market. American Journal of Agricultural Economics 72: 631-640.

Olper, A. 1998. Political economy determinants of agricultural protection levels in EU member states: An empirical investigation. European Review of Agricultural Economics, 25: 463-487.

Olper, A. 2008. Constraints and Causes of the 2003 EU Agricultural Policy Reforms. In: Swinnen, J.F.M. (ed.). The Perfect Storm. The political Economy of the Fischler Reforms of the Common Agricultural Policy. Center for European Policy Studies. Brussels. pp. 83-101.

Olper, A. & Raimondi, V. 2010. Constitutional Rules and Agricultural Policy Outcomes. In: Anderson, K. (ed.). The Political Economy of Agricultural Price Distortions. pp. 358-391.

Oskam, A. 1988. Decision Based Economic Theory. Staff Paper P88-38. Department of Agricultural and Applied Economics. University of Minnesota. 41 p.

Oskam, A. & von Witzke, H. 1990. Agricultural Policy Preferences: Wheat in the United States 1981-1990. Staff Paper P90-68. Department of Agricultural and Applied Economics. University of Minnesota. 17 p.

Oskam, A., Meester, G. & Silvis, H. (eds.). 2010. EU policy for agriculture, food and rural areas. Wageningen Acedemic Publishers. 443 p.

Oskam, A. & van Witteloostuijn, A. 2010. Agriculture and the food chain. In: Oskam, A., Meester, G. & Silvis, H. (eds.). EU policy for agriculture, food and rural areas. Wageningen Acedemic Publishers. pp. 149-164.

Pokrivcak, J. Crombez, C. & Swinnen, J. F. M. 2006. The status quo bias and reform of the Common Agricultural Policy: impact of voting rules, the European Commission and external changes. European Review of Agricultural Economics 33, 4: 562-590.

Rausser, G. C. & Freebairn, J. W. 1974. Estimation of Policy Preference Functions: An Application to U.S. Beef Import Quotas. The Review of Economics and Statistics 56: 437-449.

Rausser, G. C. & Foster, W. E. 1990. Political Preference Functions and Public Policy Reform. American Journal of Agricultural Economics 72: 641-652.

Rausser G. C. & de Gorter, H. 1991. The political economy of commodity and public good policies in European agriculture: Implications for policy reform. European Review of Agricultural Economics 18: 485-504.

Rausser, G. C. & Goodhue, R. E. 2002. Public Policy: Its Many Analytical Dimensions. In Gardner, B. L. & Rausser G. C. (eds.): Handbook of Agricultural Economics, Vol. 2b. Agricultural and Food Policy. North-Holland. pp. 2057-2102.

Ritson, C. & Harvey, D. 1997. The Common Agricultural Policy. 2nd edition. CAB International. 440 p.

Salhofer, K. 1996. Efficient Support Policy for a Small Country Using Optimal Combined Policies. Agricultural Economics 13: 191-199.

Salhofer, K. 1997. Efficiency of Income Redistribution through Agricultural Policy. A Welfare Economic Analysis. European University Studies: Series 5, Frankfurt, Peter Lang. 164 pp.

Silvis, H. & Lapperre, R. 2010. Market, price and quota policy: half a century of CAP experience. In: Oskam, A., Meester, G. & Silvis, H. (eds.). EU policy for agriculture, food and rural areas. Wageningen Acedemic Publishers. pp. 165-182.

Sumner, D. A., Alston, J. M. & Glauber, J. W. 2010. Evolution of the Economics of Agricultural Policy. American Journal of Agricultural Economics 92: 403-423.

Swinnen, J. 1994. A Positive Theory of Agricultural Protection. American Journal of Agricultural Economics 76: 1-14.

Swinnen, J. F. & van der Zee, F. A. 1993. The political economy of agricultural policies: A survey. European Review of Agricultural Economics 20: 261-290.

Swinnen, J. 2008. The Perfect Storm. The political Economy of the Fischler Reforms of the Common Agricultural Policy. Center for European Policy Studies. Brussels. 182 p.

Swinnen, J. 2010. Political economy of agricultural distortions: the literature to date. Anderson, K.(ed.) 2010. The Political Economy of Agricultural Distortions.pp. 81-104.

Terluin, I., Strijker, D. and Munch, W. 2010. Economic dynamics in rural regions. In: Oskam, A., Meester, G. & Silvis, H. (eds.). EU policy for agriculture, food and rural areas. Wageningen Acedemic Publishers. pp. 309-323.

Theil, H. 1965. Economic Forecasts and Policy. 2nd revised edition. North-Holland. 567 p.

Thomson, K., Berkhout, P., Constantinou, A. 2010. Balancing between structural and rural policy. In: Oskam, A., Meester, G. & Silvis, H. (eds.). EU policy for agriculture, food and rural areas. Wageningen Acedemic Publishers. pp. 377-392.

Thies, C. G. & Porsche, S. 2007. The Political Economy of Agricultural Protection. The Journal of Politics 69: 116-127.

Tinbergen, J. 1952. On the Theory of Economic Policy. North-Holland. 78 p.

Tinbergen, J. 1967. Economic Policy: Principles and Design. 4th revised printing. Rand McNally. 276 p.

van der Zee, F. A. 1997. Political economy models and agricultural policy formation: empirical applicability and relevance for the CAP. Mansholt Studies 8. Wageningen Agricultural University. 269 p.

Wallace, T. D. 1962. Measures of Social Costs of Agricultural Programs. Journal of Farm Economics 44: 580-594.

Varian, H. 1992. Microeconomic Analysis. Third Edition. 563 p.

Wooldridge, J. M. 2010. Econometric Analysis of Cross Section and Panel Data. 2nd. edition. The MIT Press. 752 p.

World Bank. 2011. World dataBank. Available: http://databank.worldbank.org. Referred 23.10.2011.

APPENDICES

Appendix 1. Development of the common EU agricultural market and price policies (Source: Silvis and Lapperre 2010, 173)

Period	Characteristics
1960-1969	Establishment of various different common market organizations (CMOs)
1970-1980	In the early 1970s, sharp rises in world agricultural prices, leading to concerns over import dependency on protein sources. When world prices declined, a strong agricultural income-oriented market and price policy was pursued. However, the product markets seemed to be less manageable than before, causing major problems of surpluses and high expenditures.
1981-1992	The existing systems reach breaking point; price reductions introduced when production thresholds are exceeded; milk quotas come into force. Environmental problems receive more attention; the EU comes under huge pressure in the GATT to change CAP.
1993-2003	Transformation – started by the MacSharry reform of 1992 and followed by the 1999 decisions on Agenda 2000 – to price reduction and farm income compensation, coupled to volume restrictions (set-aside) obligation, and a more market oriented approach.
2003-2008	In the Fischler (2003/2004) and Health Check (2008) reforms, decoupling (from current production) of direct income payments, and introduction of management guidelines (cross-compliance). Export refunds substantially reduced. A single common market organization. Market, price and farm income policy partly replaced by rural development policy.

Appendix 2. List of variables in the dataset

Variable	Measurement	Source
Entrepreneurial Income	Index 2005=100	Eurostat
Value added in agriculture per worker	Constant 2000 USD	World Bank
Domestic wheat price (producers)	Euro/tonne	European Commission
Self-sufficiency in wheat	%-ratio	Agricultural Distortions Database
Self-sufficiency in milk	%-ratio	Agricultural Distortions Database
Self-sufficiency in pigmeat	%-ratio	Agricultural Distortions Database
Total value of production	million USD	Agricultural Distortions Database
Consumer tax equivalent	%	Agricultural Distortions Database
Value of consumption	million USD	Agricultural Distortions Database
Research and Development expenditures	million Euro	Eurostat
CAP expenditures	million Euro	European Commission
World Agricultural Prices	Index 2000=100	World Bank
General gross financial liabilities	% of GDP	OECD
Share of food in consumption expenditure	%	Eurostat
Agricultural employment	% of total employment	World Bank
Share of food in all exports	%	Agricultural Distortions Database
Share of food in all imports	%	Agricultural Distortions Database
Agricultural exports	USD	FAOSTAT
Agricultural imports	USD	FAOSTAT
Food exports	USD	FAOSTAT
Food imports	USD	FAOSTAT
GDP	USD	World Bank
GDP per capita	USD	World Bank
Net indirect taxes	Constant 2000 EUR	World Bank
Total population	number of people	World Bank
Rural population	number of people	World Bank

Urban population	number of people	World Bank
Nominal rate of protection	ratio	Agricultural Distortions database
Share of decoupled payments as a total value of production	%	Agricultural Distortions database
Food prices	Index 2000=100	LABORSTA
Consumer prices	Index 2000=100	LABORSTA
Gross value added in agriculture	Euro	Eurostat
Dummy MacSharry	0=1975-1991 1=1992-	
Dummy Agenda2000	0=1975-1999 1=2000-	
Dummy Milk Quota regime	0=1975-1984 1=1985-	
Executive party: rural	1= clear rural agenda 0=no rural agenda	Database of Political Institutions
Executive party: regional	1= clear regional agenda 0=no regional agenda	Database of Political Institutions
Seats	number of seats in the government	Database of Political Institutions
Votes	Percentage of votes as a share of total number of seats	Database of Political Institutions

Appendix 3. Summary of selected studies analysing the efficiency of policy instruments in terms of particular policy objectives

Author	Policy objective	Policy instruments	Type of analysis	Measure for efficiency
Wallace 1962	Increase producer price (farmers' income)	Marketing quota, deficiency payment; input restriction	Partial equilibrium analysis	Social costs (PS, CS)
Floyd 1965	Farmers' income	Price support; price support + acreage control; price support + marketing quota	Multi-market welfare analysis	Income distribution between producers and input suppliers
Josling 1969	Farmers' income; import displacement	Deficiency payment; minimum import price; price support + threshold price	Social welfare function (SWF)	Cost ratios for various programs
Rausser & Freebairn 1974	Maximise beef producers welfare (PS), consumers welfare (CS), policy instrument variable	Import measures	Political Preference Function	Cost of a market basket; CS; PS
Gardner 1983	Farmers' income	Production control; deficiency payment	Surplus transformation curves (STC); SWF	Deadweight losses (DWL); Efficient redistribution hypothesis
Burton 1985	Optimal timing in policy implementation	Production quota	PPF	
Lichtenberg & Zilberman 1985	Increase net welfare	Price support; production quota; import quota	Multi-market analysis	CS,PS,GS, net welfare
Gardner 1987a	Efficient redistribution	Deficiency payment; import quota	PPF	Political weights
Gardner 1987b	Farmers' income; efficient redistribution	Production control; deficiency payment; import tariff; import quota; export subsidy; tax; target price	Welfare analysis; multi-market analysis; STC; SWF	PS, CS, DWL, income distribution between producers and input suppliers; efficient redistribution hypothesis
Lianos & Rizopoulos 1988	Income redistribution	Price support; deficiency payment	PPF	Distribution weights
de Gorter & Meilke 1989	Efficiency in income redistribution	Production quota; two-price plan; price reduction; co-responsibility levy	STC	PS, CS, DWL; world price effects
Alston & Hurd 1990	Efficient redistribution to farmers with minimised costs to consumers and taxpayers	Production control; output subsidy; tariff; import quota; taxation; combinations of two measures	STC	Marginal welfare cost (MWC)
Oehmke & Yao 1990	Max PPF	Target price; stocks; public research expenditures	PPF	Political weights
Oskam & von Witzke 1990	Producer surplus, consumer surplus, budgetary expenditures, volume of export, volume of production	Loan rate, deficiency payment, export subsidy, base acreage and program yields, set-aside, storage operations, farmer owned reserve programs, payment limitations,	PPF (DEPET), linear programming	Weights in the objective function

		disaster payments, crop insurance, food aid, food stamps program		
Rausser & de Gorter 1991	Farmers income level	Price support; R&D	PPF	Political weights
Bullock 1992a	Income redistribution	Co-responsibility levy; support price; two-price program; production quota	Multiple STCs	Relative marginal efficiency of different programs (DWL)
Bullock 1992b	Income stabilisation	Target price; acreage reduction	STC	Countercyclicity of transfers
Gisser 1993	Efficient redistribution	Price support; acreage control; combinations		DWL
Kola 1993	Removing dairy product surpluses with least welfare losses to producers	Consumer subsidy; price reduction; production quota	STC	PS, CTS
Isosaari 1993	Self-sufficiency	Distributed quota, auction quota, deficiency payments	STC	Social welfare, DWL
Bullock 1996	Maximise political support	Price support; co-responsibility levy	SWF	Pareto optimality
Salhofer 1996	Minimised social costs at every support level	Floor price (intervention price); co-responsibility levy; deficiency payment (fully decoupled); combination of two measures	Comparing optimal combination STCs with the actual policies STCs	Reduction on costs to consumers and taxpayers
Bullock & Salhofer 1998	Optimal combinations of policy instruments	Price support; acreage control	Optimisation	Social costs; Pareto optimality
Grommelynck et al. 1998	Protection of domestic agricultural sector	National protection coefficients	Econometrics	
Olper 1998	Protection of domestic agricultural sector	Efficient rate of protection	Econometrics, RE, FE models	
Hueth 2000	Minimum level of net-income for farmers; efficient income transfer; net-income + efficient income transfer	Deficiency payment with total payment cap	Mechanism-design approach	
Alston & James 2002	Government revenue	Tax	Multi-market analysis	
Guyomard et al. 2004	Farmers' income; maximum number of farms; reduction of negative externalities	Output subsidy; land subsidy; decoupled payment with mandatory production; decoupled payment without mandatory production	Multi-market analysis	Effects on policy objectives
Niemi, J. 2005	Maximise social welfare	Reduction in border protection, direct payments, price support	Partial equilibrium analysis	PS, CS, TS
Ackrill et al. 2008	Maximise social welfare	Price support, border protection	Partial equilibrium analysis	Social costs, budgetary costs

Appendix 4. Descriptive statistics for model variables

Table A4.1. *Agricultural value added per worker (1000€) (Source: World Bank)*

Country	Mean	Std.Dev.	Minimum	Maximum	Cases	Missing
Austria	17.8653	1.94071	15.2862	22.1122	13	0
Belgium	37.9107	2.11130	35.4996	41.0150	8	25
Denmark	22.5150	10.6474	8.82545	38.2898	28	5
Finland	27.2067	4.77930	21.8517	38.2012	13	0
France	27.5509	12.4351	10.6808	49.6750	28	5
Germany	16.2985	6.71875	7.30517	30.0434	28	5
Greece						
Ireland	15.8195	2.06250	11.6691	18.1061	13	20
Italy	15.5064	6.96656	6.75222	27.6476	28	5
Luxembourg	28.8185	3.14330	25.0814	34.6243	8	25
Netherlands	27.1619	8.12228	14.5439	42.2846	28	5
Portugal	5.38542	.596968	4.33278	6.34365	22	0
Spain	13.3322	4.36376	6.27025	20.2976	22	0
Sweden	34.2574	6.92039	26.3422	47.7564	13	0
UK	21.3577	3.98972	14.0088	28.1434	28	5

Table A4.2. *Net entrepreneurial income deflated with consumer price index (ratio) (Source: Eurostat, ILO)*

Country	Mean	Std.Dev.	Minimum	Maximum	Cases	Missing
Austria	.964647	.939145E-01	.853759	1.13426	13	0
Belgium	1.62931	.479446	.900901	2.43831	28	5
Denmark	2.45268	1.69217	-.308411E-01	6.78635	31	2
Finland	.929485	.129503	.605649	1.16199	13	0
France	1.23725	.347032	.868020	2.19162	31	2
Germany	.718356	.368345	.317791	1.52533	17	16
Greece	1.27384	.357318	.780876	1.82897	15	12
Ireland	.852336	.139066	.646696	1.05215	18	15
Italy	1.53948	.696149	.731394	3.87004	28	5
Luxembourg	1.15530	.144209	.816522	1.46030	23	10
Netherlands	2.22594	.869322	.884173	3.74282	22	11
Portugal	1.06549	.247762	.695479	1.57174	22	0
Spain	1.03595	.138812	.764016	1.25305	18	4
Sweden	.800911	.223680	.489582	1.33046	13	0
UK	1.95444	1.32490	.708000	6.60517	31	2

Table A4.3. *Standard deviation in wheat prices over five year moving average (European Commission, own calculations)*

Country	Mean	Std.Dev.	Minimum	Maximum	Cases	Missing
Austria	-1.58815	4.05665	-9.44400	7.63600	13	0
Belgium	.162485	1.67884	-2.12600	5.74200	33	0
Denmark	.140626	1.54088	-1.75400	4.37600	33	0
Finland	-3.46262	5.67523	-17.5920	3.54800	13	0
France	.209788	1.66929	-2.03000	6.28400	33	0
Germany	.990909E-01	1.82824	-2.42600	5.90400	33	0
Greece	.179111	2.11032	-3.38400	7.49600	27	0
Ireland	.277672	1.76785	-2.97200	6.90000	33	0
Italy	.213909	1.89440	-3.39500	5.85700	33	0
Luxembourg	.278545	1.81628	-2.83600	6.84600	33	0
Netherlands	.159212	1.79866	-1.89600	6.66400	33	0
Portugal	-1.20236	2.44224	-6.05600	4.21800	22	0
Spain	-.230909	1.62679	-2.36600	5.15200	22	0
Sweden	.150923	1.93353	-.980000	6.43800	13	0
UK	.282606	1.93201	-2.86000	5.60200	33	0

Table A4.4. *Average self-sufficiency ratio of wheat and milk (aggregated) (Source: Valenzuela & Anderson 2008)*

Country	Mean	Std.Dev.	Minimum	Maximum	Cases	Missing
Austria	1.15261	.334250E-01	1.09807	1.20866	13	0
Belgium	.803074	.942052E-01	.655253	.924018	33	0
Denmark	1.22703	.123505	1.04082	1.46563	33	0
Finland	.919312	.764456E-01	.699791	.980418	13	0
France	1.55150	.147561	1.28363	1.85510	33	0
Germany	1.12191	.113154	.909861	1.32869	33	0
Greece	.639794	.684275E-01	.507773	.779807	27	0
Ireland	.842086	.480154E-01	.753421	.919146	33	0
Italy	.828371	.555365E-01	.725903	.932667	33	0
Luxembourg	.803060	.941934E-01	.655253	.923794	33	0
Netherlands	.802815	.941867E-01	.655253	.922434	33	0
Portugal	.632734	.729838E-01	.507773	.779807	22	0
Spain	.883582	.798746E-01	.758055	1.08679	22	0
Sweden	1.05745	.659539E-01	.923742	1.20413	13	0
UK	1.04314	.109733	.774709	1.21986	33	0

Table A4.5. *Food price index deflated with GDP deflator (2000=100, ratio) (Source: ILO, World Bank)*

Country	Mean	Std.Dev.	Minimum	Maximum	Cases	Missing
Austria	1.00891	.207584E-01	.972838	1.03893	13	0
Belgium	1.07316	.646080E-01	.996419	1.19258	33	0
Denmark	1.01492	.374036E-01	.956326	1.07812	33	0
Finland	1.03642	.182449E-01	1.00000	1.06665	13	0
France	1.00920	.192559E-01	.977270	1.04360	33	0
Germany	1.03644	.504997E-01	.997763	1.14724	17	16
Greece	1.54647	.726120	1.00000	2.77911	27	0
Ireland	1.08372	.846199E-01	.916549	1.22947	33	0
Italy	1.11898	.122017	.988480	1.36966	33	0
Luxembourg	1.05903	.568270E-01	.952085	1.17160	33	0
Netherlands	1.16510	.142360	.917490	1.34943	33	0
Portugal	1.05823	.757843E-01	.948891	1.17364	22	0
Spain	1.04189	.724281E-01	.947132	1.16164	22	0
Sweden	1.00725	.318828E-01	.965873	1.09852	13	0
UK	1.12405	.135725	.936893	1.42822	33	0

Table A4.6. *Export-import ratio (Food trade balance) (Source: FAOSTAT 2013)*

Country	Mean	Std.Dev.	Minimum	Maximum	Cases	Missing
Austria	.801462	.804162E-01	.641000	.926000	13	0
Belgium						
Denmark	2.25424	.700580	1.21000	4.00000	33	0
Finland	.567692	.851620E-01	.430000	.750000	13	0
France	1.34364	.180118	1.12000	1.78000	33	0
Germany	.829091	.228929	.540000	1.26000	33	0
Greece	.429259	.142988	.220000	.670000	27	0
Ireland	2.15182	.450121	1.65000	3.68000	33	0
Italy	.550909	.101746	.420000	.750000	33	0
Luxembourg						
Netherlands	1.65394	.111157	1.44000	1.85000	33	0
Portugal	.430000	.134341	.290000	.700000	22	0
Spain	1.27591	.239914	.830000	1.79000	22	0
Sweden	.393846	.786912E-01	.320000	.580000	13	0
UK	.344242	.140669	.230000	.790000	33	0

Table A4.7. *GDP per capita (constant 2000 USD) (Source: World Bank)*

Country	Mean	Std.Dev.	Minimum	Maximum	Cases	Missing
Austria	30631.0	6525.84	23642.3	44850.1	13	0
Belgium	19764.0	9818.60	6614.87	43161.4	33	0
Denmark	25532.5	13174.6	7824.76	57021.2	33	0
Finland	29943.4	7509.03	23514.5	46505.0	13	0
France	19478.6	9036.81	6598.52	40459.7	33	0
Germany	20188.4	9736.23	6034.59	40467.9	33	0
Greece	11611.3	6138.01	4632.39	27766.9	27	0
Ireland	18306.0	15543.7	2842.35	59489.0	33	0
Italy	16495.7	8793.90	3885.85	35641.1	33	0
Luxembourg	36882.2	25263.9	8590.47	106902.	33	0
Netherlands	20602.9	10682.3	6821.86	47770.8	33	0
Portugal	11551.2	4685.97	3814.65	21845.2	22	0
Spain	16246.3	6424.84	6335.02	32129.6	22	0
Sweden	33780.0	7749.91	25563.2	50558.4	13	0
UK	18326.9	11187.5	4041.04	46091.6	33	0

Table A4.8. *Net indirect taxes as a share of GDP ratio (constant 2000) (Source: World Bank)*

Country	Mean	Std.Dev.	Minimum	Maximum	Cases	Missing
Austria	.106125	.374064E-02	.991933E-01	.112812	13	0
Belgium	.103317	.126359E-01	.841662E-01	.120868	33	0
Denmark	.166995	.109219E-01	.151289	.190083	33	0
Finland	.146776	.485772E-02	.139151	.154850	13	0
France	.116624	.485500E-02	.110934	.129677	33	0
Germany	.112891	.751459E-02	.931916E-01	.120825	33	0
Greece	.114947	.760832E-02	.106182	.132408	27	0
Ireland	.113311	.530507E-02	.106899	.122315	13	20
Italy	.114491	.512862E-02	.108159	.128008	33	0
Luxembourg	.118483	.105178E-01	.977916E-01	.137405	33	0
Netherlands	.104908	.788007E-02	.928217E-01	.116213	33	0
Portugal	.118896	.104948E-01	.103076	.134642	22	0
Spain	.100742	.562597E-02	.942648E-01	.111239	22	0
Sweden	.136526	.326015E-02	.132853	.143036	13	0
UK	.119658	.642406E-02	.986265E-01	.126578	33	0

Table A4.9. *Rural population (million people) (Source: World Bank)*

Country	Mean	Std.Dev.	Minimum	Maximum	Cases	Missing
Austria	2.73917	.118188E-01	2.71995	2.75816	13	0
Belgium	.370257	.771159E-01	.282644	.538725	33	0
Denmark	.802362	.380559E-01	.741663	.905740	33	0
Finland	1.98632	.172211E-01	1.95683	2.01354	13	0
France	14.8052	.146250	14.5907	15.0694	33	0
Germany	21.6050	.341004	21.1258	22.1145	33	0
Greece	4.27522	.116984	4.10175	4.39975	27	0
Ireland	1.54560	.504329E-01	1.47413	1.69659	33	0
Italy	18.8524	.112597	18.6441	19.0717	33	0
Luxembourg	0.073790	.394686E-02	.698749E-01	.837108E-01	33	0
Netherlands	4.33623	.651470	3.06665	5.02909	33	0
Portugal	4.85651	.317240	4.36639	5.42380	22	0
Spain	9.70082	.256115	9.47603	10.3311	22	0
Sweden	1.42115	.483094E-02	1.41677	1.43062	13	0
UK	6.62787	.687957	6.18405	9.14007	32	1

Table A4.10. *Nominal rate of assistance (Source: Valenzuela & Anderson 2008)*

Country	Mean	Std.Dev.	Minimum	Maximum	Cases	Missing
Austria	.379756	.129522	.143166	.634890	13	0
Belgium	.654318	.301846	.132522	1.34849	33	0
Denmark	.580271	.276208	.116174	1.11887	33	0
Finland	.397294	.162739	.102023	.715550	13	0
France	.533767	.243255	.126021	1.10891	33	0
Germany	.599258	.259917	.141092	1.15473	33	0
Greece	.279070	.137349	.634577E-01	.565129	27	0
Ireland	.856067	.373506	.186748	1.73380	33	0
Italy	.407143	.174493	.102617	.743250	33	0
Luxembourg	.654318	.301846	.132522	1.34849	33	0
Netherlands	.654318	.301846	.132522	1.34849	33	0
Portugal	.317182	.121992	.129134	.565129	22	0
Spain	.361297	.170482	.122533	.744770	22	0
Sweden	.386708	.150772	.110115	.699997	13	0
UK	.631487	.261757	.171425	1.23001	33	0

Appendix 5. Alternative estimation procedures

Seemingly unrelated regression

Alternatively, the research setting would have allowed the estimation of selected target variables as a linear system of equations. Thus, the model for all target variables could have been estimated simultaneously for all independent variables using the seemingly unrelated regression (SUR) approach. In the SUR model, the basic assumption is that regressors are unrelated but analysed simultaneously. Usually the SUR model is used to gain efficiency when equations are only related through the error term, and the parameters in the model vary from equation to equation (Woolridge 2002, 143-144). Moreover, according to Woolridge (2002, 146), the statistical properties of estimators in the SUR and panel data models can be analysed within the same structure. When model parameters are the same over all dependent variables, the SUR estimator is equivalent to single-equation OLS and its interpretation is as straightforward. The general equation to be estimated in the SUR approach is

$$y_{it} = x_{it}\beta + u_{it}.$$

It differs from equation (28) only in terms of c_i, or in other words, in the way it treats the country level heterogeneity.

Instrumental variable approach

To better tackle the endogeneity of model variables, the instrumental variable approach could be utilised. The OLS regression model specifies

$$y_{it} = x_{it}\beta + u_{it}.,$$

where u is an error term. Regression of y on x yields OLS estimate $\hat{\beta}$ of β. Standard regression results make the assumption that the regressors are uncorrelated with the errors in the model. Then the only effect of x on y is a direct effect via the term βx. In this setting the possible endogeneity of x would lead to inconsistent OLS estimates. That is, the changes in x are associated not only with changes in y, but also changes in the error u. To reveal the possible endogeneity of the model variables, an instrument variable z needs to be defined. To test the endogeneity of the variables, the instrument variable of z is defined based on the estimated residuals model for each dependent variable. Thus, first the model

$$y_{it} = x_{it}\beta + u_{it}.$$

is estimated. At the second stage, the estimated residuals (res) are used as a dependent variable over the target variables

$$resy_1 = y_{n-1} + u_{it}.$$

Our results show that for the dependent variables Y3 and Y4 variable endogeneity is non-existent or only minor. For the dependent variables Y1, Y2 and Y5, variable endogeneity may impose inconsistency in the OLS estimates.

Table 1. *Revealed endogeneity in the model*

Residuals (independent)					
Dependent	Y1	Y2	Y3	Y4	Y5
Y1	.	endog.	ok	ok	endog.
Y2	ok	.	ok	ok	ok
Y3	ok	ok	.	ok	endog.
Y4	endog.	endog.	ok	.	endog.
Y5	endog.	endog.	ok	ok	.

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251. Hietala, M., Huovari, J., Kaleva, H., Lahtinen, M., Niemi, J., Ronikonmäki, N-M., Vainio, T. 2015. Asuinrakennusten korjaustarve.
250. Noro, K ja Lahtinen, M. 2015. Pohjoismainen asuntomarkkinaselvitys.
249. Holm, P., Hietala J. ja Härmälä, V. 2015. Liikenneverkko ja kansantalous – Suomi–Ruotsi vertailua.
248. Alho, E. – Noro, K. – Pyykkönen, P. 2014. Ruokakorista sijoitus-salkkuun – Näkemyksiä kotimaisesta ruokaketjusta sijoituskohteena.
247. Hietala, J., Alhola, K., Horne, P., Karvosenoja, N., Kauppi, S., Kosenius, A-K., Paunu, V-V., Seppälä, J. 2014. Kaivostoiminnan taloudellisten hyötyjen ja ympäristöhaittojen rahamääräinen arvottaminen.

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171. Hietala, J., Haltia, E., Horne, P., Huovari, J. ja Härmälä, V. 2015. Puurakentamisen edistäminen julkisissa hankinnoissa.
170. Karikallio, H. 2015. Cross-commodity price transmission and integration of the EU livestock market of pork and beef: panel time-series approach.
169. Holappa, V., Huovari, J., Karikallio, H. ja Lahtinen, M. 2015. Alueellisten asuntomarkkinoiden kehitys vuoteen 2017.
168. Yrjölä, T. 2014. Melan myöntämien työturvallisuusapurahojen vaikuttavuusarviointi.
167. Huovari, J. 2015. Päästökaupan epäsuorien kustannusten kompensaatio.
166. Peltoniemi, A., Arovuori, K., Karikallio, H., Niemi, J. ja Pyykkönen, P. 2014. Viljasektorin hintarakenteet.
165. Kosenius, A-K., Tulla, T., Horne, P., Vanha-Majamaa I. ja Kerkelä, L. 2014. Metsäpalojen torjunnan talous ja ekosysteemipalvelut – Kustannusanalyysi Pohjois-Karjalasta.