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Empirical analysis on the development of policy objectives of the CAP

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Abstract.

The objective of this study is to empirically analyze the effectiveness of the Common Agricultural Policy of the EU, given the general economic and structural conditions under which the policies operate. The effectiveness of policies is measured in terms of the impacts of the policies on the stated policy objectives. The results show that policy target variables have developed in the desired direction. However, 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 and had a negative indirect impact on farmers' incomes. Agricultural policy reforms have led to less stabilized markets in terms of increased price volatility.

Keywords: policy effectiveness, CAP, instruments, objectives

JEL codes: Q18



1. Introduction

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)ⁱ 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 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.

After almost 60 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 efficient in terms of its objectives? What is the contribution of the policy reforms to reaching the objectives?

1.1. 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 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 variable 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 variable aim to capture the development of initial policy instruments 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 2011.

Based on the empirical analysis, this study seeks to answer two interrelated 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 decreasesⁱⁱ.

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.

2. Policy development of the CAP

Until 1990s the core element of the CAP was price support, secured with a high level of market protection. 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. 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 reform, the administrative prices were further reduced and farmers received a partial compensation for this. In the Fischler reform 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 emphasis was also placed on cross compliance introduced in Agenda 2000ⁱⁱⁱ. 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).

3. Theory and Empirics of the Policy Analysis

The theory of economic policy (Tinbergen 1967) holds as the normative premises 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). This 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 ultimate goal of economic analysis is to measure the impacts of different economic phenomena on selected variables. In an econometric model, a causal relationship between two or more variables is established holding other factors constant. For the analysis, the set of control variables x that are explicitly hold fixed when studying the effect of z on the expected value of y is selected. The reason for controlling these variables is that it is assumed z is correlated with other factors that influence y .

In this paper, 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.

Deciding on the list of proper controls is not always straightforward. Using different controls can lead to different conclusions about 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 underlying economic theory, research literature, among others.

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

$$y = f(X, z_i) \quad (1)$$

on 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

$$y = f(X, z_i, \varepsilon) \quad (2)$$

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

$$y = X\beta + z_i\alpha + \varepsilon, \quad (3)$$

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 analysed is agricultural policy and its impact on the selected variables is analysed. In the analysis the effects of a vector of policy variables $Z=(z_1, z_2, \dots, z_n)$ on a particular policy target variable y holding the vector of control variables $X=(x_1, x_2, \dots, x_n)$ fixed over time and 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 in to the analysis. The linear econometric specification for panel data analysis is

$$y_{it} = X'_{it}\beta + z_i\alpha + \varepsilon_{it}. \quad (4)$$

3.1. Model specifications and data

For empirical analysis, the stated agricultural policy objectives are incorporated into an econometric model as 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

$$Y = \alpha + \beta_1x_1 + \beta_2x_2 + \dots + \beta_Kx_K + u, \quad (5)$$

where y is a policy target variable, x_i the vector of j explanatory variables, α_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 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), and World Bank as well as the Database of Agricultural Distortions (Anderson and Valenzuela 2008).

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 2011. From 1975 to 1994 the panel is unbalanced, since the number of countries evolves throughout the period. From 1995 onwards the panel is balanced. That is, all countries have the same number of observations in all variables from 1995 to 2011.

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

$$Y_i = \alpha + \beta_1 foodeximratio + \beta_2 logGDPperCapita + \beta_3 logNetTax + \beta_4 logRurPop + \beta_5 logNRA + \varepsilon, \text{ where } i = 1 - 5 \quad (6)$$

3.2. Development of the 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; stability of the producer prices is measured using the standard deviation over a five-year annual moving average in wheat prices; availability of supplies is measured in terms of self-sufficiency ratio for wheat; 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 1.

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 not specified. For the analysis, this means lack of exactness. Our analysis reveals the direction and magnitude to which agricultural policies 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.

3.2.1. To increase agricultural productivity^{iv}

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 1.

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.

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. The between-country variation is considerable, ranging in real terms from a little above 5000 USD in Portugal to nearly 60000 USD in France. For the EU9 in 1980, the range was from around 6000 USD in Italy to 15000 USD in Germany.

3.2.2. To ensure a fair standard of living

A ratio of net entrepreneurial income is used to measure the development of farmers' incomes and thus, to approximate a fair standard of living. The indices for individual countries are presented in Figure 2. 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^v. 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.

3.2.3. To stabilise markets

Stability in producer prices is measured in terms of the annual standard deviation of wheat producer prices over a five-year moving average^{vi}. 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 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 increasing producer prices towards the end of the research period are also clearly seen in the graph. 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 until late 2000s, but very unstable in the final years of the analysis.

3.2.4. 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. In this analysis, a country-level self-sufficiency ratio of 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 5^{vii}.

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 direct effect on the actual self-sufficiency level. Changes in policies are not likely to contribute on an annual basis but, instead, impacts are observed over longer term.

3.2.5. 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 6. Until the most recent years of the research period, food prices have evolved with decreasing real-term trend in all EU15 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 administrative producer prices does not seem to have remarkable direct impact on the consumer price levels in 1992 and 2000.

3.3. Development of the policy instrument variable

Nominal rate of assistance aggregates all policy instruments which distort agricultural markets. It describes mainly the government-imposed distortions that create a gap between the domestic prices and what they would be under free markets. According to Anderson et al. (2010, 31), ‘the NRA is computed as the percentage by which government policies have raised gross returns to farmers above what they would be without government intervention. 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 percentage of the distorted price.

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)

$$NRA \equiv \frac{P_d - P_f}{P_f}, \quad (7)$$

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 6). Until 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, 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. 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 and 2010. Correspondingly, NRAs were high in 1986 and 2001, when international agricultural product prices slumped. In addition, the implementation of the CAP reforms in 1992 and 2000 led to decreases in NRA. 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.

3.4. Control variables

The independent variables were selected based on intuition 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 export-import ratio for food, 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 2. In the final model, independent variables are included as logarithmic transformations.

3.5. 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 3.

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 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. The share of 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 (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^{viii}. 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, 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^{ix} 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).

4. Results

The estimation results are analysed based on the test statistics provided in the R estimation procedures. 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 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. The estimation results are presented in Table 4.

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 random 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 two target variables.

The coefficient for Nominal rate of assistance is statistically significant in four out of five estimated models. The signs of the coefficients are as expected for three out of four statistically significant models. Implemented agricultural policies have contributed negatively on the agriculture value added per worker and net-entrepreneurial income. Thus, the implemented policies have kept more resources, particularly labour, in the agriculture sector than would have remained without the policies. Hence, under the economic and structural conditions under which it has been operated, agricultural policies have not been able to contribute positively on the net-entrepreneurial income.

For the food price development, the results indicate that price support based agricultural policies kept the food prices at the higher level compared to a situation without policies. Moreover, the results indicate that during the research period, the self-sufficiency ratios have been a stable policy element developing more in line with the general economic and structural development than in line with the development in agricultural policies.

5. Conclusions

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, 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 countries included in the analysis, the country-level heterogeneity is significant. While common policies have contributed to productivity development, market stabilisation and self-sufficiency ratios with a common impact, the impacts have been more diversified for net entrepreneurial income and food price development.

The signs of the coefficients are mostly as expected over all models. However, the statistical significance of the control variables differs over each target variable. Although the selected control variables seem to generalize the structural and economic conditions relatively well, the impacts are not as effective over 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.

The results of this study support the view, that 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.

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Table 1. 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 stabilisation. 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 for wheat (%)	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 (2000=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

Table 2. 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 (as a share of total population)	The share of rural population on total population indicates the structure of a country and the importance of rural economy in the overall economy.	World Bank
Policy variable		
Nominal rate of assistance (%)	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

Table 3. *Comparative statics of model variables*

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

Table 4. Estimation results for the model with policy variable ^x

Target variable	Y1	Y2	Y3	Y4	Y5
Fixed effects (FE)/ Random effects (RE)	RE	FE	FE	RE	FE
Food trade balance (export-import ratio)	2.23* (1.26)	1.66*** (0.41)	1.01*** (0.30)	0.03** (0.01)	3.94 (2.87)
GDP per capita (constant USD) log	20.9*** (2.51)	-7.29*** (0.78)	-1.50** (0.67)	0.04* (0.03)	62.0*** (5.39)
Net indirect taxes constant USD log	-21.67*** (4.65)	6.43*** (1.44)	0.93 (1.18)	0.15*** (0.05)	4.28 (11.0)
Rural population log	-14.38*** (2.95)	1.72* (1.01)	-0.31 (0.74)	0.18*** (0.04)	86.1*** (7.82)
Nominal rate of assistance log	-4.66*** (.597)	-0.31* (0.17)	-1.32*** (0.19)	-0.001 (0.01)	6.28*** (1.37)
Constant	-269.99*** (29.6)		16.0** (7.63)	1.17*** (0.30)	
Country-specific dummies					
Austria		94.8			-442.6
Belgium		-			
Denmark		95.4			-383.0
France		96.0			-379.5
Finland		94.8			-401.8
Germany		95.5			-408.8
Greece		92.0			-385.0
Italy		94.8			-472.0
Ireland		95.5			-427.8
Luxembourg		-			
Netherlands		96.4			-390.9
Portugal		89.8			-421.6
Spain		92.5			-381.7
Sweden		96.0			-377.7
United Kingdom		96.2			-388.2
OLS statistics					
Number of observations	299	315	307	373	341
R-squared	0.74	0.45	.39	.19	.39
Adj. r-squared	0.72	0.42	.35	.18	.37
F-test	165.4 (.000)	48.05 (.000)	9.79 (.000)	16.7 (.000)	25.3 (.000)
Fixed vs. random effects					
Hausman test	5.78 (.33)	50.67 (.00)	15.26 (.03)	13.04 (.02)	61.9 (.00)

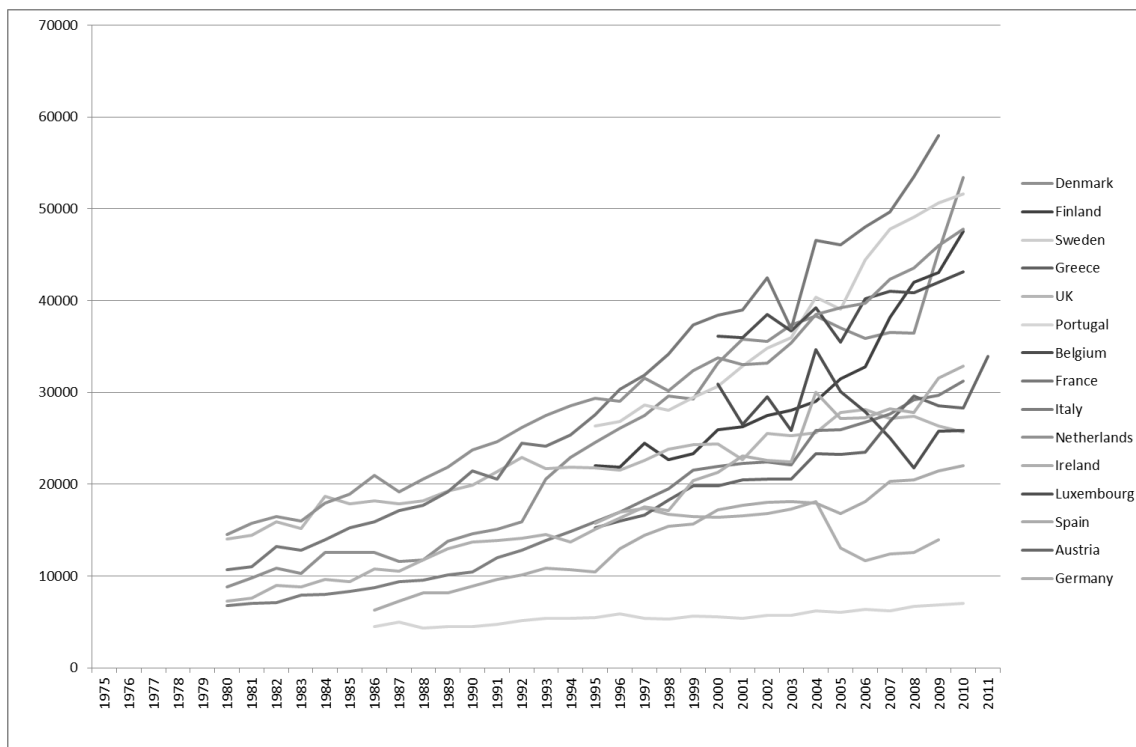


Figure 1. Agriculture value added per worker 1980-2011 (Source: World Bank 2014)

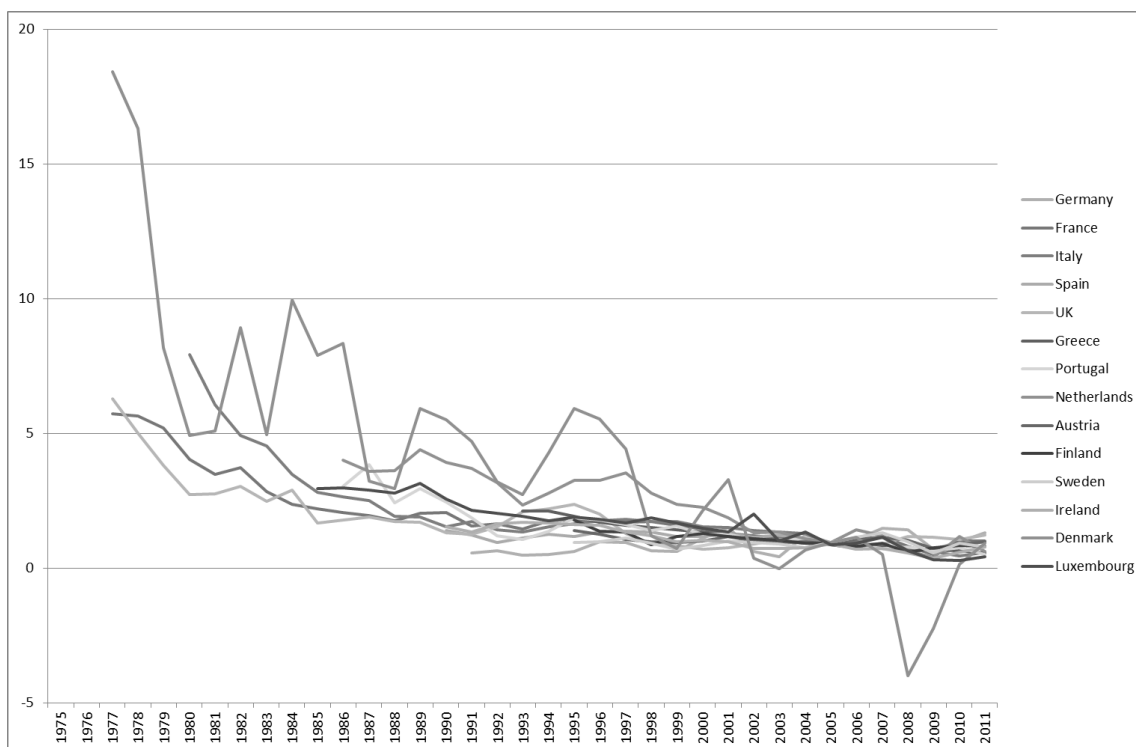


Figure 2. Net-entrepreneurial income 1977-2011 (Source: World Bank 2014)



Figure 3. Standard deviation in wheat prices over five year moving average 1975-2011 (Source: European Commission, own calculations 2014)

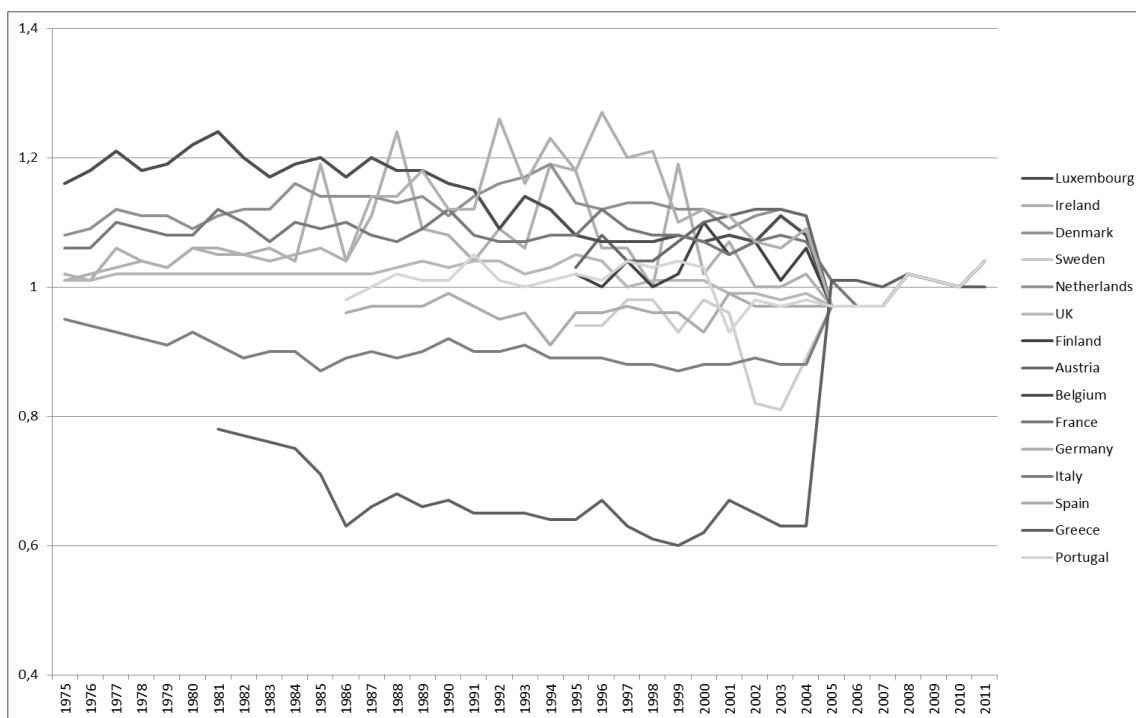


Figure 4. Wheat self-sufficiency ratios 1975-2011 (Source: World Bank 2014)



Figure 5. Food price development 1975-2011 (Source: World Bank 2014)

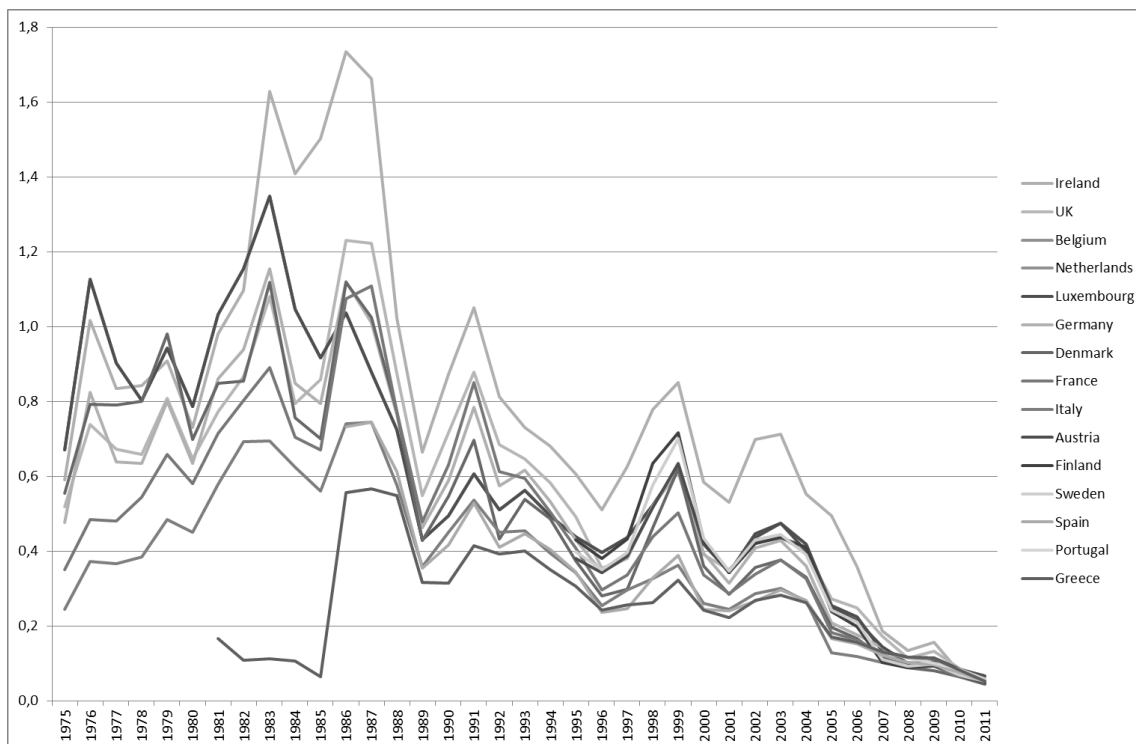


Figure 6. Country-level NRAs 1975-2011 (Source: Anderson & Valenzuela 2008, World Bank 2014)

ⁱ 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).

ⁱⁱ 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.

ⁱⁱⁱ 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).

^{iv} For this variable, data were available only starting from 1980. Greece is not included in the figure due to lack of observations.

^v For Denmark, France, and the UK first observations are from 1978, for Belgium and Italy 1980, for Luxembourg 1985, for Portugal and the Netherlands 1986, Spain and Ireland 1990, Germany 1992, Greece 1993, and Austria, Finland and Sweden from 1995.

^{vi} $MA = \frac{(p_n + p_{n-1} + \dots + p_{n-4})}{n}$, and $Y_i = \left((MA_{n-m} - \frac{P_{m-n}}{n} + \frac{P_m}{n}) - p \right)$, where $n = 1, \dots, 5$, and $i = 1975, \dots, 2007$, and p = annual wheat producer prices (eur/tn).

^{vii} 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.

^{viii} See e.g. Thomson et al. 2010 for discussion especially on the role and impacts of the structural policy measures included in the CAP.

^{ix} 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).

^x All fixed effects models are OLS estimates with group dummy variables, all random effects models are GLS estimates. ***, **, * are statistically significant with 99, 95 and 90 per cent confidence levels, respectively, standard errors are in the parenthesis.